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Dageford

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[54] **REMOTE ULTRASONIC SENDING DEVICE FOR AIRCONDITIONER**

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[52] **U.S. Cl.** .....**340/419,** 236/1 R

[51] **Int. Cl.** **G05d 23/00,** G08b 21/00

[58] **Field of Search**.....340/222, 417, 419, 340/416, 148; 343/225; 236/1 R, 49

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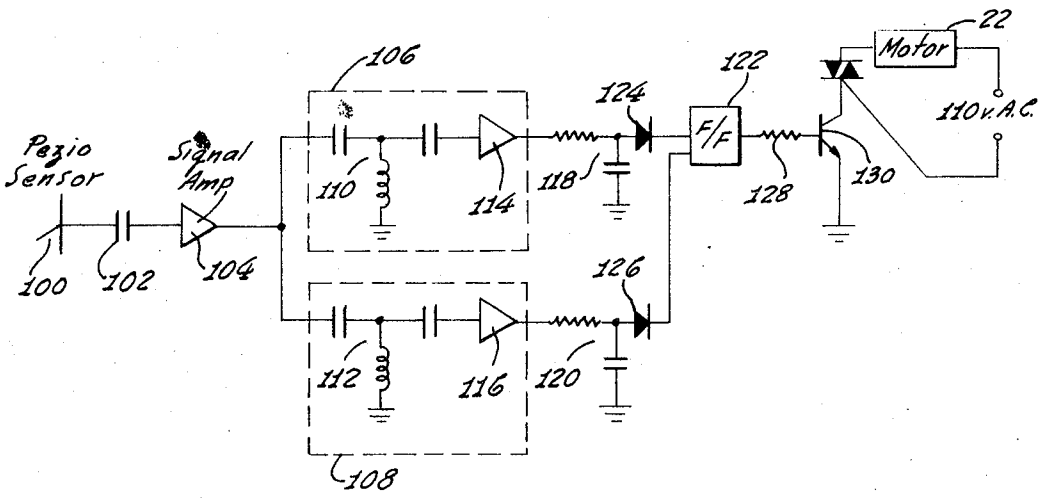
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Primary Examiner—Donald J. Yusko
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[57] **ABSTRACT**

A remote sending device controlled by the opening or closing of a window to turn an air conditioning system on and off. The window actuator unit is an ultrasonic transmitter using a tuning fork and the ultrasonic transmitter may include either one tuning fork to provide a single frequency system or two tuning forks to provide a double frequency system which is fail safe. The receiving unit controls a motor switch to activate or deactivate the blower motor in an air conditioning unit so as to control the air conditioning to a given area.

12 Claims, 10 Drawing Figures



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3 Sheets-Sheet 1

Fig. 1

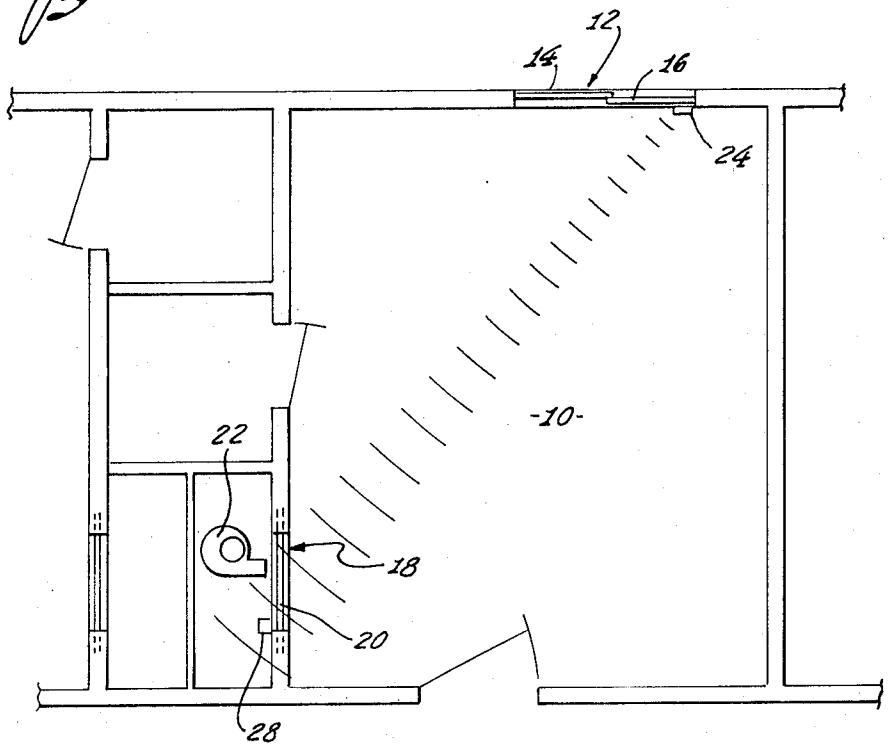
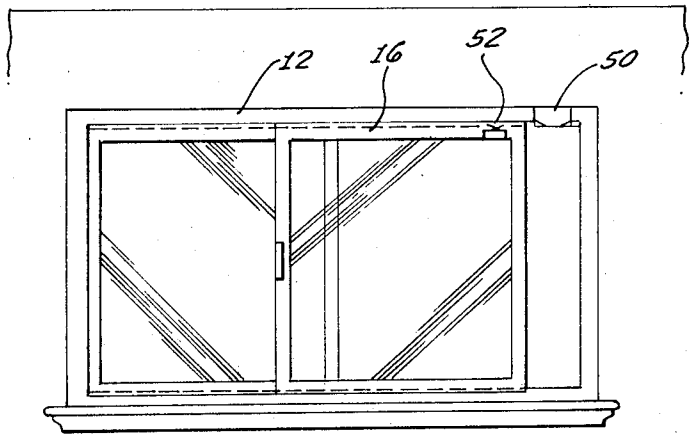


Fig. 2



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Fig. 3

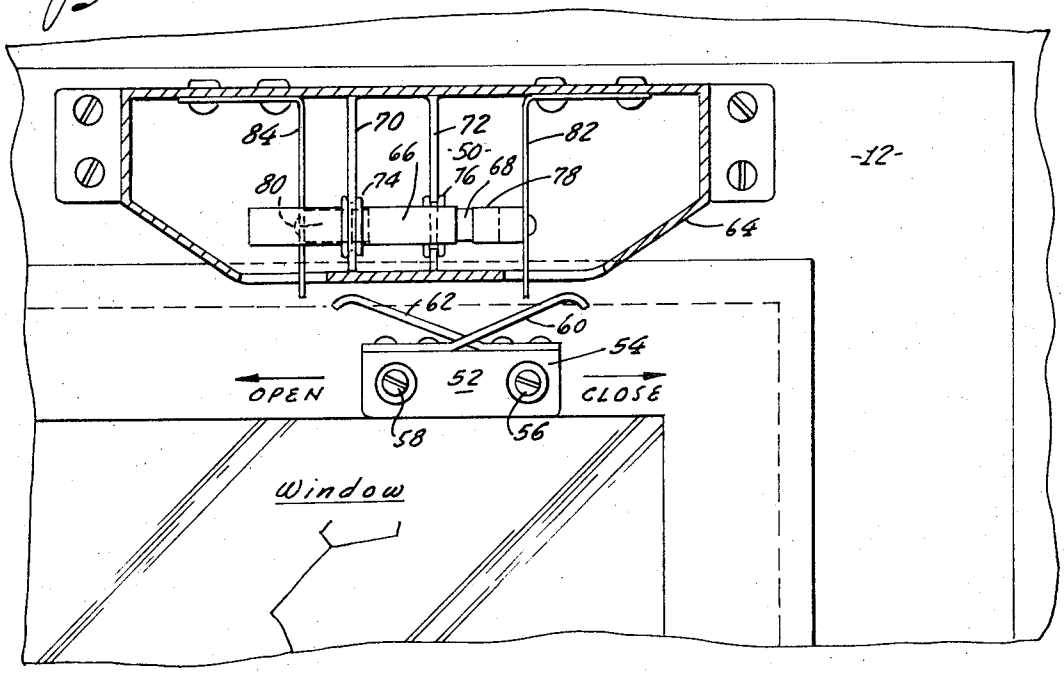


Fig. 3a

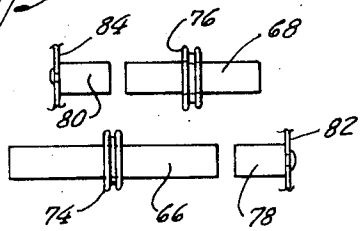
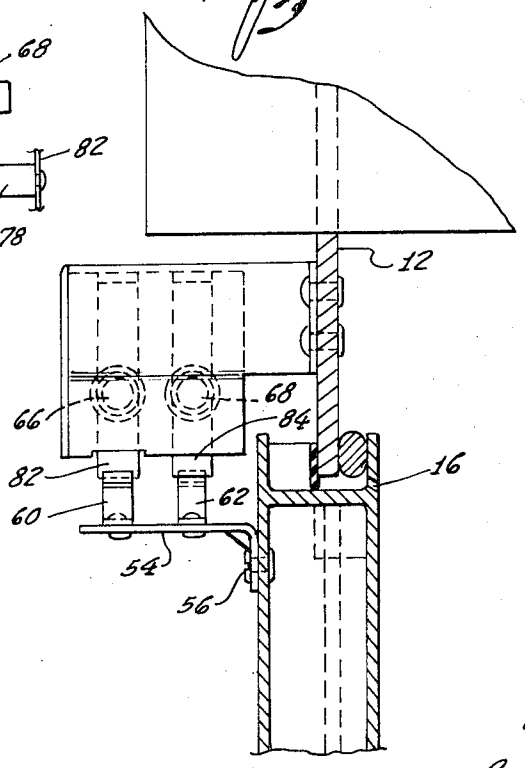


Fig. 4



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Fig. 5

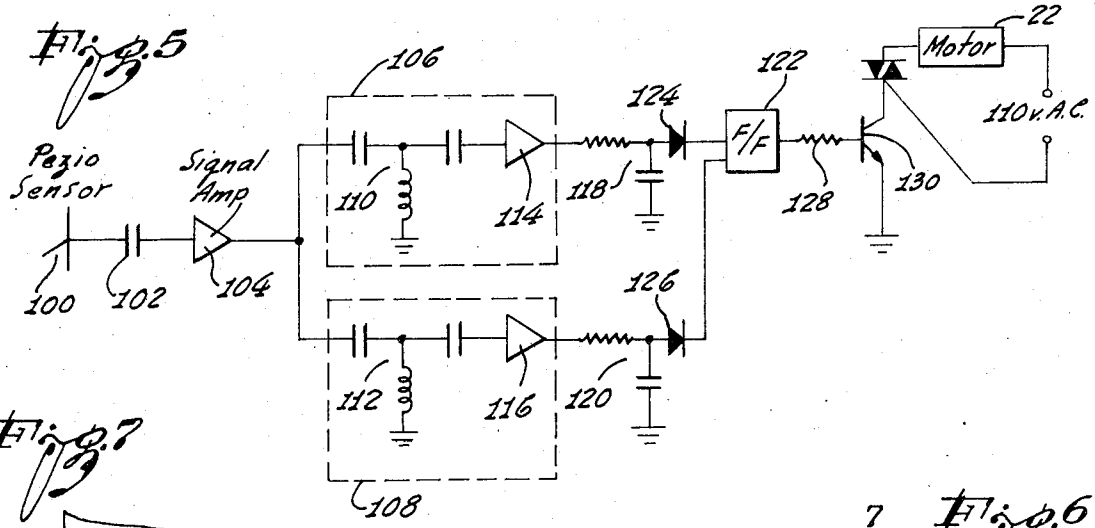


Fig. 7

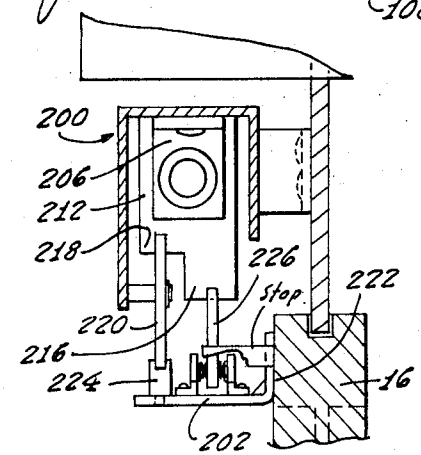


Fig. 6

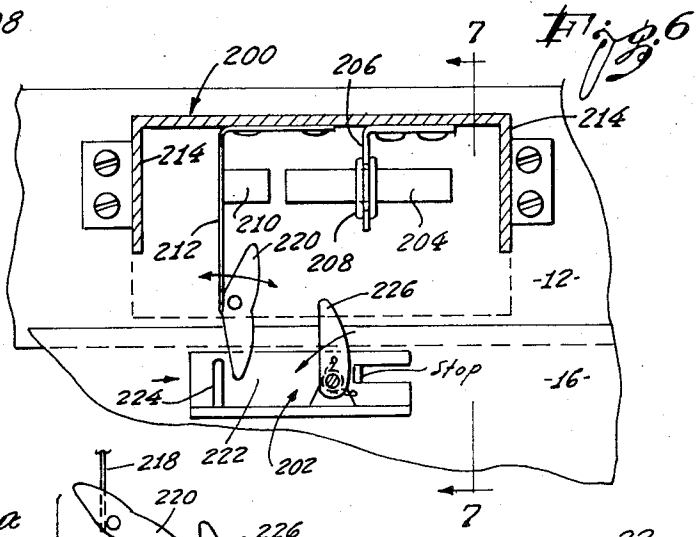
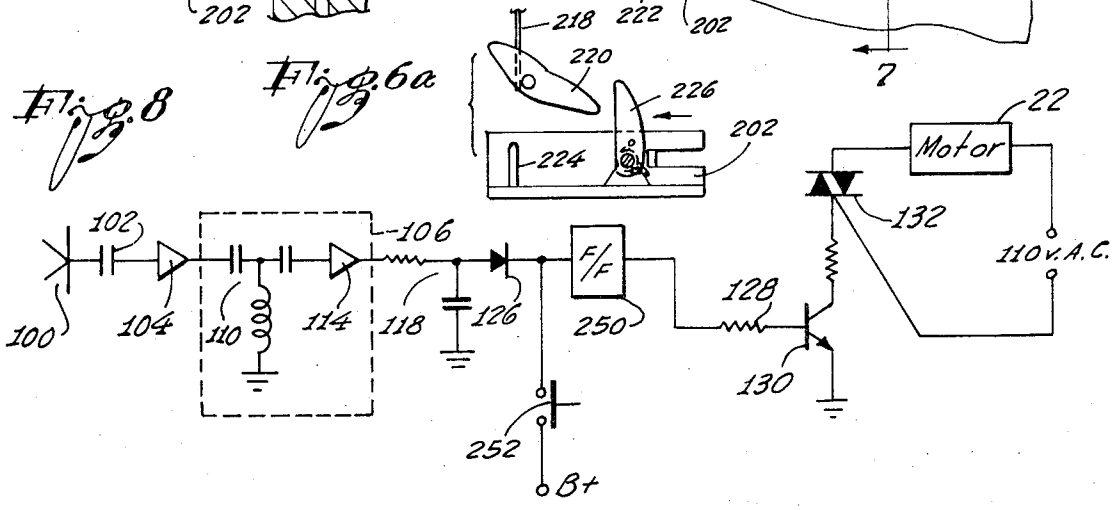


Fig. 8

Fig. 6a



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REMOTE ULTRASONIC SENDING DEVICE FOR AIRCONDITIONER

The present invention is directed to a remote sending device to control an air conditioning system upon the opening or closing of a window.

In many hotels or office buildings, a central air conditioning system provides air conditioning for a number of separate rooms. Specifically, a liquid such as water is cooled to a low temperature and is sent via pipes throughout the building so as to provide for a supply of cooled liquid at a plurality of locations. For example, each room may have a vent and with a pipe or pipes running behind each vent through the walls of the building. The coolant is then available at the vent opening and cool air may be supplied into the room merely by providing an airflow across the pipe or pipes and into the room.

This airflow may be provided by individual blowers located behind the system of pipes. In tropical areas, the blower motor may be on at all times to provide a constant source of cool air into the room. As an alternative, the room may have an individual control so that the blower motor may be turned on or off under the command of the occupant of the room or there may even be a thermostatic control to control either the speed of the motor or the supply of the coolant to the vent area.

A problem which arises with this type of air conditioning system, and specifically when the system is used in a hot, humid climate, is that it is undesirable to run the air conditioning when a window in the room is opened. What occurs in this situation is that, upon the opening of a window, hot, humid air rushes into the room and the cool air provided by the air conditioning system provides for a condensation of the moisture in the hot, humid air. The condensation settles over the furniture, walls and floor of the room. It can be seen that this is very undesirable since the condensation may produce damage to the furniture and is certainly uncomfortable to the occupant of the room.

Unfortunately, a person, when entering the room from the outside where the weather conditions are quite hot and humid, may feel that the room is too cold and may wish to raise the temperature of the room by opening the window. This provides the condensation of the moisture in the air as described above. In order to alleviate this situation, applicant has provided a unique remote sending device controlled by the opening or closing of the window to turn the air conditioning system on and off and specifically to control the operation of the blower motor in the air conditioning system.

In the present invention, a remote sending unit is mounted on the window. When the window is opened, the remote sending unit transmits a signal such as an ultrasonic signal from a tuning fork device, which signal is received by a receiver located adjacent to the blower motor. Upon reception of the signal indicative of the opening of the window, the blower motor is placed in an inoperative condition to discontinue the blowing of cold air into the room. This allows the outside hot air to enter the room without further introduction of cold air from the air conditioning system. Although some of the moisture in the humid air entering the cool room is condensed, since cold air is not being constantly introduced by the air conditioning system, the amount of condensation is greatly reduced. When the room has reached the desired temperature for the occupant, the occupant, upon closing the window, again actuates the remote sending device. The second signal is received and the motor is placed in an operative condition to once again provide for cool air to enter the room. It can be seen, therefore, that any condensation would be greatly reduced since the cool air is discontinued when the window is opened.

In one embodiment of the invention, the sending and receiving units are dual frequency devices to provide a first frequency signal when the window is opened and a second frequency signal when the window is closed. This ensures a differentiation between the open and closed position of the window so that the motor is always in the proper condition in accordance with the window's being open or closed. This two frequency system, therefore, is fail safe in that the sequence cannot be reversed deliberately or inadvertently by the occupant of the room.

A second embodiment of the invention uses a single frequency so that a similar signal is sent out upon either opening or closing of the window. When the sequence is properly maintained, the motor will be in the proper state in accordance with the window's being open or closed. In order to ensure that the proper sequence is maintained, the second embodiment of the invention may include a manual override.

A clearer understanding of the invention will be had with reference to the following description and drawings, wherein:

FIG. 1 illustrates an overview of a room such as a hotel room incorporating a central air condition system but using individual blower motors for each room and with the remote sending device of the present invention;

FIG. 2 illustrates a remote sending device of the first embodiment of the invention positioned on a window structure;

FIG. 3 illustrates a detailed cutaway view of the remote sending device used in the first embodiment of the invention and FIG. 3*a* is a top detailed view of the two tuning forks;

FIG. 4 is a side view of the remote sending device of FIG. 3;

FIG. 5 is a schematic of a first receiver embodiment of the invention used for a two-frequency system;

FIG. 6 is a detailed cutaway view of a remote sending device used in the second embodiment of the invention with the actuators in a first position, and FIG. 6*a* is fragmented view of the actuators in a second position;

FIG. 7 is a side view of the remote sending device of FIG. 6; and

FIG. 8 is a schematic of a second receiver embodiment of the invention operating on a single frequency.

In FIG. 1, a room 10 represents a given area to be air conditioned. The room 10, for example, may be a room in an office building or may be a hotel room. The room 10 includes a window structure 12 having a fixed portion 14 and a sliding portion 16 so that the window may be opened by sliding the sliding portion 16 to the left. A vent structure 18 is incorporated in one wall of the room and a plurality of cooling pipes 20 pass through the wall at the vent opening. A central air conditioning unit not shown provides for a coolant such as chilled

water to be circulated through the pipes adjacent the vents in all of the rooms in the office building or hotel. An air conditioning blower 22 is positioned behind the vent 18 so as to direct air across the pipes 20 and into the given area 10. It can be seen, therefore, that when the blower is operating, the air in passing over the pipes 20 is chilled so as to provide cool air for the room 10.

In many office buildings or hotels located in areas where the outside temperature is generally higher than a desired temperature for the rooms, the blower motor operates all of the time so as to provide a constant supply of cool air into the given area 10. In many of these office buildings or hotels there is no control of the air conditioning in the room so that the temperature conditions in the room are maintained at a desired level, which is centrally controlled. For example, if the outside temperature goes down, the temperature of the coolant flowing through the pipes 20 may be raised. However, it is to be appreciated that the concepts of the present invention would be equally applicable if the air conditioner blower 22 or the flow of coolant to the pipes 20 were controlled by some control mechanism in the room. For example, the blower motor could be controlled to be in an on or off position in accordance with a desired temperature setting in a room. Also, the flow of coolant through the pipes 20 may also be controlled in accordance with a desired temperature condition in the room.

A major difficulty that occurs with an air conditioning system as shown in FIG. 1 is that a person, upon entering a room, may determine that the room is too cool and opens the window 12 in order to raise the temperature in the room. When the window 12 is open, hot air rushes into the room. In those climates where the atmospheric conditions are very hot and humid, the air which enters the room from the outside is heavily laden with moisture. It is readily apparent that when this hot, humid aid enters the room, the continued blowing of the cool air into the room by the blower 22 provides for a rapid condensation of the moisture in the air. This condensation settles on furniture, rugs and other furnishings of the room and may cause damage to such furnishings. At a minimum, the condensation provides for a damp, uncomfortable environment in the room.

In order to alleviate the above situation, the present invention provides for a remote sending device 24 located adjacent to the window 12, which device provides for the sending of a signal such as an ultrasonic signal, designated by wave pattern 26, to a receiver and motor switch device 28. Specifically, when the window is opened, a signal is sent which is received by the receiver 28 so as to place the motor in an inoperative state. This discontinues the production of cool air so as to alleviate the condensation of the moisture in the humid air which enters the room through the open window. When the window is closed, the remote sending device 24 provides for a second signal to place the motor in an operative state so that the production of cool air may again be introduced into the room 10. The present invention provides for alternate embodiments which operate either on a dual-frequency or a single-frequency basis.

Turning now to FIGS. 2, 3 and 4, a first embodiment of a remote sending device is shown which operates on a dual-frequency basis. In FIG. 2, the remote sending device includes a first portion 50 fixed to the window frame and a second portion 52 fixed to the sliding member 16 of the window 12. FIGS. 3 and 4 illustrate in clearer detail the structure of the two portions 50 and 52. As can be seen, the actuating portion 52 includes a support member 54 which is bolted to the frame of the sliding portion 16 through the use of bolt members 56 and 58. A pair of oppositely disposed spring members 60 and 62 may be mounted on the support member 54 using bolt members or using rivets. The spring members 60 and 62 operate to actuate tuning fork actuators within the fixed portion 50.

The fixed portion 50 includes a housing 64 which is mounted on the window 12. Contained within the housing 64 are a pair of tuning forks 66 and 68, which tuning forks are supported by supporting structure including arm members 70 and 72 which engage grommet members 74 and 76. The relative position of the tuning forks 66 and 68 is shown in greater detail in the top view of FIG. 3*a*.

The tuning forks 66 and 68 actually take the shape of rod members and such rod members are actuated by hammer devices 78 and 80. These hammer devices are supported at the ends of spring members 82 and 84. It can be seen, therefore, that as the sliding portion 16 is opened or closed, one or the other of the actuators 60 or 62 engages the spring members 82 or 84 to draw one of the spring members back and, at an appropriate time, the actuator 60 or 62 slips by to allow the spring member to propel the hammer member 78 or 80 against one or the other of the tuning forks 66 or 68.

The tuning fork 66 is actuated when the window is being closed and the tuning fork 68 is actuated when the window is being opened. The tuning forks 66 and 68 provide for two different frequencies since they have different lengths, as shown in FIG. 3*a*, so that there is always a differentiation in the signal produced in accordance with the opening or closing of the window.

FIG. 5 illustrates a schematic of a receiver for use with the remote sending device of FIGS. 2, 3, and 4. In FIG. 5, the signal produced by the remote sending device is received by a sensor 100, such as a piezoelectric sensor. The signal received by the sensor 100 is coupled through a coupling capacitor 102 to a signal amplifier 104 which provides amplification. The signal from the signal amplifier 104 is introduced into a pair of frequency discriminators 106 and 108. The output from the frequency discriminator 108 may represent the reception of the signal to maintain the blower motor 22 on, and the output from the frequency discriminator 108 may represent the reception of the signal to maintain the blower motor 22 off.

The frequency discriminators 106 and 108 individually include low-pass filters 110 and 112, and each filter consists of a pair of series capacitors and a parallel inductor. These low-pass filters 110 and 112 attenuate undesirable signals above a particular frequency. The output signals from the filters 110 and 112 are introduced to bandpass amplifiers 114 and 116, which bandpass amplifiers provide for an amplification of the signals around a narrow frequency band. For example, the amplifier 114 may provide for an amplification of a signal band having a center frequency such as 38.5 kilocycles and the amplifier 116 may provide for an

amplification of a signal band having a center frequency of 41.5 kilocycles. In this way, the output signals from the frequency discriminators **106** and **108** provide for differentiation between the two possible frequency signals detected by the sensor **100**.

The output from the discriminators **106** and **108** is applied to integrators **118** and **120**. The integrators **118** and **120** are used to set the d-c level for a flip-flop **122**. A pair of diodes **124** and **126** are used to ensure the proper direction for the current input to the flip-flop **122**. It can be seen, therefore, that the flip-flop **122** has a pair of inputs to control the output state of the flip-flop and with the flip-flop having a first state when a first frequency signal is detected by the sensor **100** and with the flip-flop having a second state when a second frequency signal is detected by the sensor **100**. The state of the flip-flop **122** therefore depends upon the particular frequency detected by the sensor **100** and the state of the flip-flop can be therefore controlled in accordance with the frequency of the signal transmitted by the remote sending device shown in FIGS. **2**, **3**, and **4**.

The output from the flip-flop is used as an input to a gate **130** through a resistor. The gate transistor **130** controls a triac **132** which is a bilateral thyristor and the triac **132** controls the application of power from an a-c source through the motor **22**. It can therefore be seen that upon the reception of the first frequency signal, the flip-flop **122** may control the gate **130** to have the triac **132** in a closed state so that power is applied to the motor **22**. When the window is opened, a second frequency signal may be produced so that the triac is in an open state so that power is discontinued to the motor **22**. In this way, a positive fail-safe remote sending device is provided so that the motor **22** is always in an inoperative state when the window **16** is open and so that the motor **22** is in an operative state when the window **16** is closed. The dual frequency system is fail safe since opening or closing the window when the motor is not operating will not place the system out of synchronism. For example, if the room has a thermostatic override which also controls the motor, this could place the system out of synchronism if the dual frequency system were not used.

FIGS. **6**, **7**, and **8** illustrate a remote sending device of a second embodiment of the invention which includes a single tuning fork to provide a single frequency. In FIGS. **6** and **7**, the remote sending device also includes a stationary portion **200** and an actuating portion **202**. The stationary portion includes a single tuning fork such as a rod **204** which is supported on an arm **206** using a grommet member **208**. A hammer member **210** is held at the end of a spring arm **212**. All of these are mounted within a housing **214**. It should be noted, as shown in FIG. **7**, that the spring member **212** includes a pair of actuating surfaces **216** and **218** and with the surface **216** extending lower than the surface **218**. Also mounted on the housing **214** is a rotatable actuator **220** which can rotate both clockwise or counterclockwise but is generally maintained by a spring in the position shown in FIG. **7**.

The actuating portion **202** includes a support member **222** which is mounted on the sliding window portion **16**. The actuating member includes a post **224** and a rotatable arm member **226**. The rotatable arm member **226** may only rotate in a counterclockwise direction, as shown by the arrow, and is spring-biased to the position shown in FIG. **6**.

As can be seen with reference to FIG. **6**, when the window **16** is moved to the right and to a closed position, the rotatable arm member **226** engages the portion **216** of the spring member **212** and rotates to slip by without providing actuation of the hammer **210**. The post **224** then engages the rotatable actuating member **220** so as to move the spring arm **212** to the left. After a certain distance the arm **220** slips by the spring arm **212** to allow the spring arm to propel the hammer **210** against the tuning rod **204** so as to provide for an ultrasonic signal. The rotatable member **220** remains in the position shown in FIG. **6***a*.

When the window **16** is moved to an open position, as shown in FIG. **6***a*, the arm member **226** which cannot rotate in a counterclockwise direction engages the portion **216** of the spring member **212** so as to again move the spring member **212** so as to cock the hammer **210**. The rotatable actuating member **220** slips by the spring member **212** after a particular distance so as to return to the position shown in FIG. **6**. After a further movement of the arm member **226** to the left, the member **226** slips by the spring member **212** so that the hammer **210** is propelled to strike the tuning fork **204** to produce the ultrasonic signal.

FIG. **8** illustrates a receiver for use with the single frequency embodiment of the invention. In FIG. **8**, elements having similar functions to those shown in FIG. **5** are given similar reference characters. For example, in FIG. **8** a sensor such as a piezoelectric sensor **100** detects the ultrasonic signal and the signal is coupled through a coupling capacitor **102** to a signal amplifier **104**. The output from the signal amplifier is supplied to a frequency discriminator **106** which includes the low-pass filter **110** and the bandpass amplifier **114**. This amplifier provides an output signal at a frequency such as 38.5 kilocycles when such a frequency signal is detected by the sensor **100**.

The output from the frequency discriminator **106** is applied through an integrator **118** and a diode **124** to a flip-flop **250**. The flip-flop **250** of FIG. **8** is different from the flip-flop **122** of FIG. **5** in that the flip-flop **250** has a single input which provides a change between first and second states each time an input signal is received. On the other hand, the flip-flop **122** of FIG. **5** has separate inputs to change the output state of the flip-flop. Therefore, the flip-flop **122** of FIG. **5** requires two positive input signals to change the condition of the gate **130** from an on to an off condition, whereas the flip-flop **250** merely requires a single signal to switch the flip-flop between states to control the gate **130**. As indicated above, the output from the flip-flop is applied through the resistor **128** to control the gate **130** which in turn controls the triac **132** which provides for the application of power to the motor **22** from the line such as 110 volts a-c.

Each time the window is opened or closed, the state of the flip-flop **250** is changed. In order to ensure that the system is in the proper synchronism, a manual reset switch **252** is used to provide for an application of power to the flip-flop from a source of positive voltage such as B+. It can be seen therefore, that if the motor is in an off condition because of some external situation

such as a thermostatic override, that when the window is opened, this cannot produce any change in the application of power to the motor. The motor may then be turned on by the thermostatic override even though the window is open. In order to ensure that the synchronism is proper, the manual reset button **252** is used. For example, in a hotel room during the cleaning of the room it could be the job of one of the chamber maids to ensure that the synchronism of the motor control circuit is proper.

The present invention is directed to a unique system for controlling the operation of an air conditioning system and specifically the operation of a blower motor so as to ensure that the air conditioner is not providing for the introduction of cool air into a given area at the same time that hot, humid air is being supplied to the given area through an open window. It is to be appreciated that the concepts of the invention may be used for other applications. For example, the remote sending device of the present invention may be used to control a situation reversed to heat described above. If warm air is being supplied by a heating system, it is undesirable to continue to supply such warm air if a window is opened to allow the introduction of cold air into the room. The present invention may be used in such a situation.

Although the invention has been shown with reference to particular embodiments, the invention is only to be limited by the appended claims.

I claim:

1. A remote sending and receiving device for controlling the state of operation of an air supply system for supplying air into a given area and additionally including aperture means communicating with the given area for allowing outside air to enter the given area when the aperture means is in an open state and for preventing outside air to enter when the aperture means is in a closed state, including

wireless transmitter means coupled to the aperture means for monitoring the state of the aperture means and for transmitting signals in response to the aperture means changing from one state to the other, and

receiver and control means responsive to the signals transmitted by the transmitter means and coupled to the air supply system for controlling the state of operation of the air supply system in accordance with the signals transmitted by the transmitter and with the air supply system in an operative state when the aperture means is in a first state and with the air supply system in an inoperative state when the aperture means is in a second state.

2. The remote sending and receiving device of claim **1** wherein the wireless transmitter means produces signals at ultrasonic frequencies.

3. The remote sending and receiving device of claim **1** wherein the wireless transmitter means produces signals at a first particular frequency when the aperture means changes from the closed to the open state and signals at a second particular frequency differ from the first when the aperture means changes from the open state to the closed state.

4. The remote sending and receiving device of claim **1** wherein the wireless transmitter means produces signals of the same frequency when the aperture means changes between states and wherein the receiver and control means automatically changes the state of operation of the air supply means each time a signal is received.

5. The remote sending and receiving device of claim **4** additionally including a manual control for changing the state of operation of the air supply system to ensure the proper state of operation of the air supply system.

6. The remote sending and receiving device of claim **1** wherein the air supply system includes a blower to blow air into the given area and wherein the given area is a room and the aperture means is a window and wherein the wireless transmitter means includes actuator means operative in accordance with the opening and closing of the window to control the transmission of the signals wherein the blower is in an inoperative state when the window is open and the blower is in an operative state when the window is closed.

7. The remote sending and receiving device of claim **1** wherein the blower is part of an air conditioning system to blow cold air into the room and wherein the transmitter is wireless and includes actuator means operative in accordance with the opening and closing of the window to control the transmission of the signals wherein the blower is in an inoperative state when the window is open and the blower is in an operative state when the window is closed.

8. A remote sending and receiving device for controlling the state of operation of a blower for supplying air into a room and with the room including a window, including

transmitter means mounted by the window and responsive to the opening and closing of the window for producing signals in accordance with the opening and closing of the window, and

receiver and control means coupled to the blower and responsive to the signals from the transmitter for controlling the blower to an operative state for supplying air when the window is closed and for controlling the blower to an inoperative state when the window is opened.

9. The remote sending and receiving device of claim **8** wherein the transmitter means is wireless and produces signals at ultrasonic frequencies.

10. The remote sending and receiving device of claim **8** wherein the transmitter means is wireless and produces signals at a first particular frequency when the window is opened and signals at a second particular frequency different from the first when the window is closed.

11. The remote sending and receiving device of claim **8** wherein the transmitter means is wireless and produces signals of the same frequency when the window is opened and closed and wherein the receiver and control means automatically changes the state of operation of the blower each time a signal is received.

12. The remote sending and receiving device of claim **11** additionally including a manual control for changing the state of operation of the blower to ensure the proper state of operation of the blower.

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