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(54) **RESIDENTIAL INTEGRATED VENTILATION ENERGY CONTROLLER**

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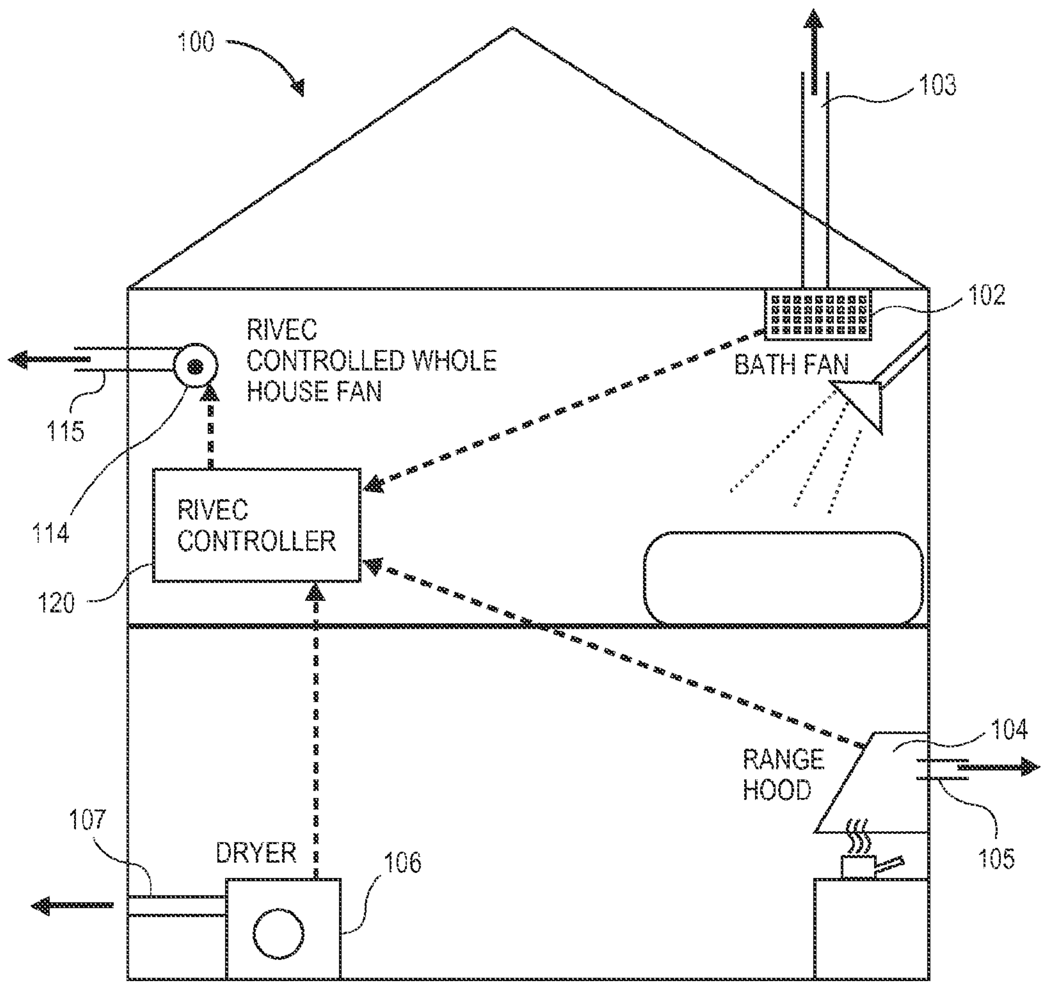
(57) **ABSTRACT**

A residential controller is described which is used to manage the mechanical ventilation systems of a home, installed to meet whole-house ventilation requirements, at the same time reducing energy costs. This is achieved in part by shifting the ventilation load of the whole-house system to off peak hours and by taking into account exogenous mechanical ventilation induced by other systems. The controller is linked by wire or wirelessly to other house ventilation systems using any one of a number of communication protocols, sensing the on-off status of such exogenous systems. An operational algorithm preloaded and/or modified at the point of use is used to control the on-off status or fan speed of a whole-house ventilation fan which forms a part of the home ventilation system, the operating status of the whole-house fan in part responsive to the status of other home ventilation systems, and in part based on time of day.



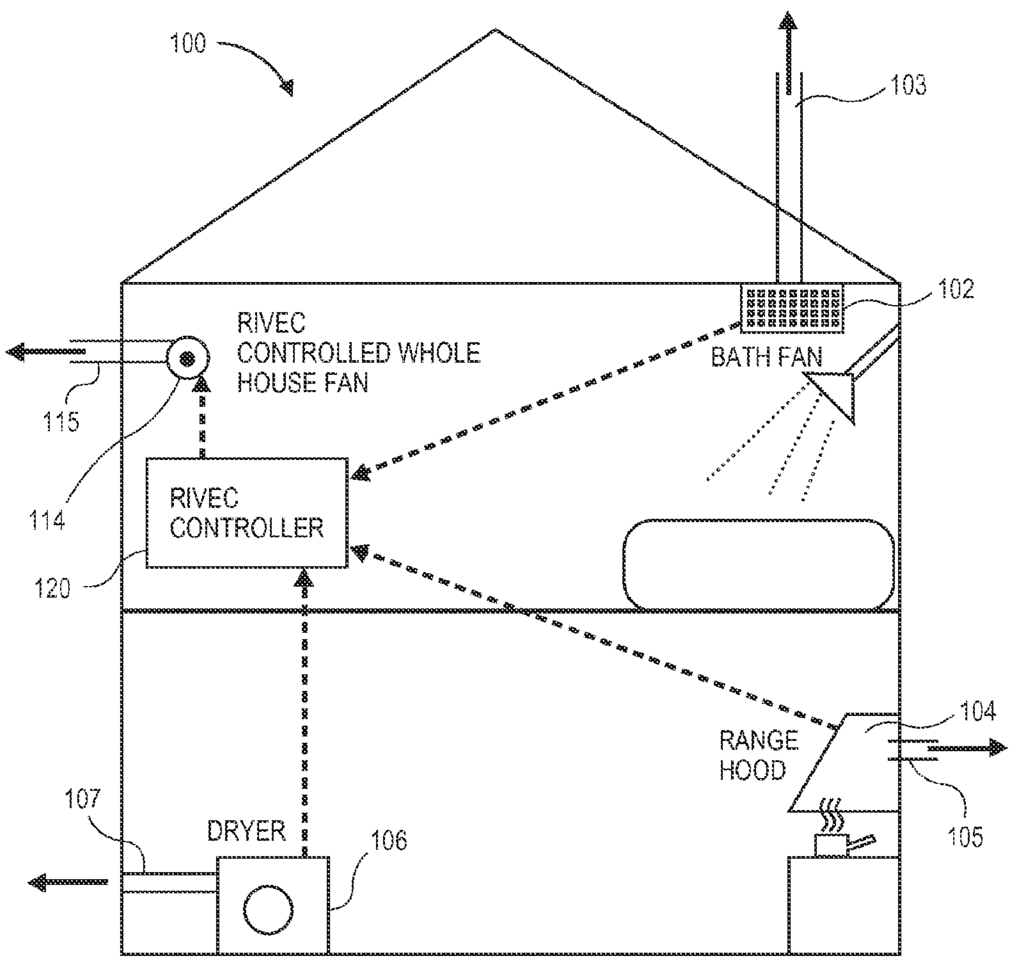

100
103
102
RIVEC
CONTROLLED WHOLE
HOUSE FAN
BATH FAN
115
114
RIVEC
CONTROLLER
120
104
RANGE
HOOD
105
107
DRYER
106

FIG. 1

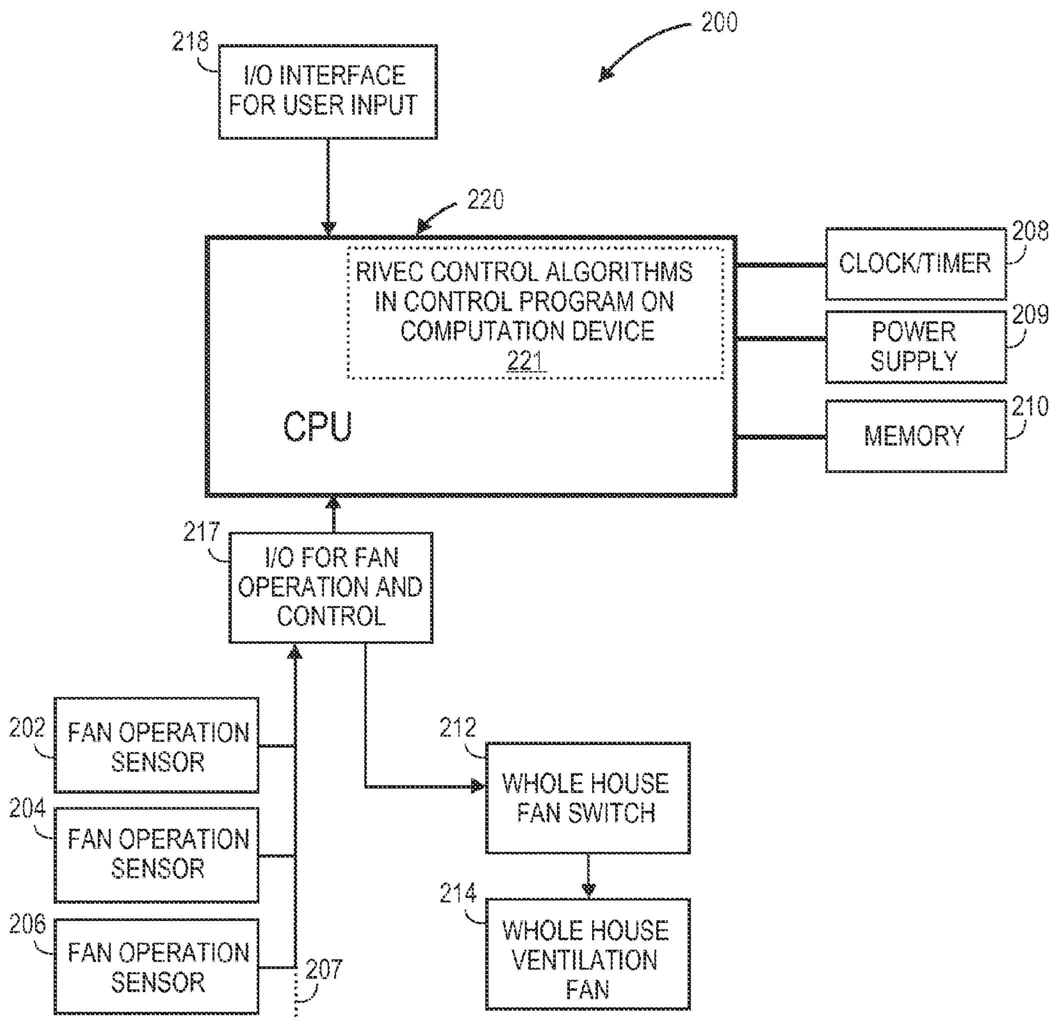
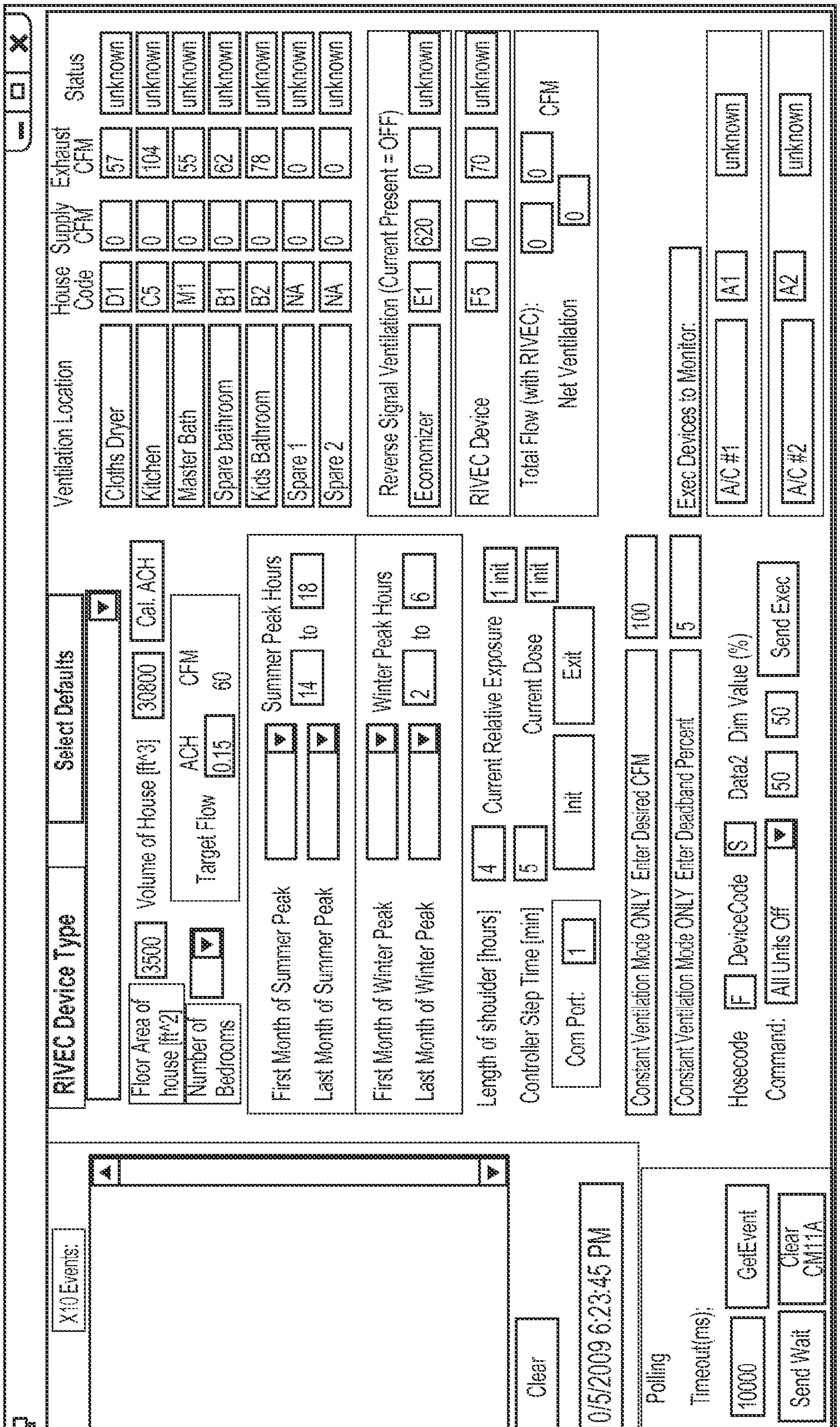

200
218
I/O INTERFACE FOR USER INPUT
220
RIVEC CONTROL ALGORITHMS IN CONTROL PROGRAM ON COMPUTATION DEVICE
221
CPU
208
CLOCK/TIMER
209
POWER SUPPLY
210
MEMORY
217
I/O FOR FAN OPERATION AND CONTROL
202
FAN OPERATION SENSOR
204
FAN OPERATION SENSOR
206
FAN OPERATION SENSOR
207
212
WHOLE HOUSE FAN SWITCH
214
WHOLE HOUSE VENTILATION FAN

FIG. 2

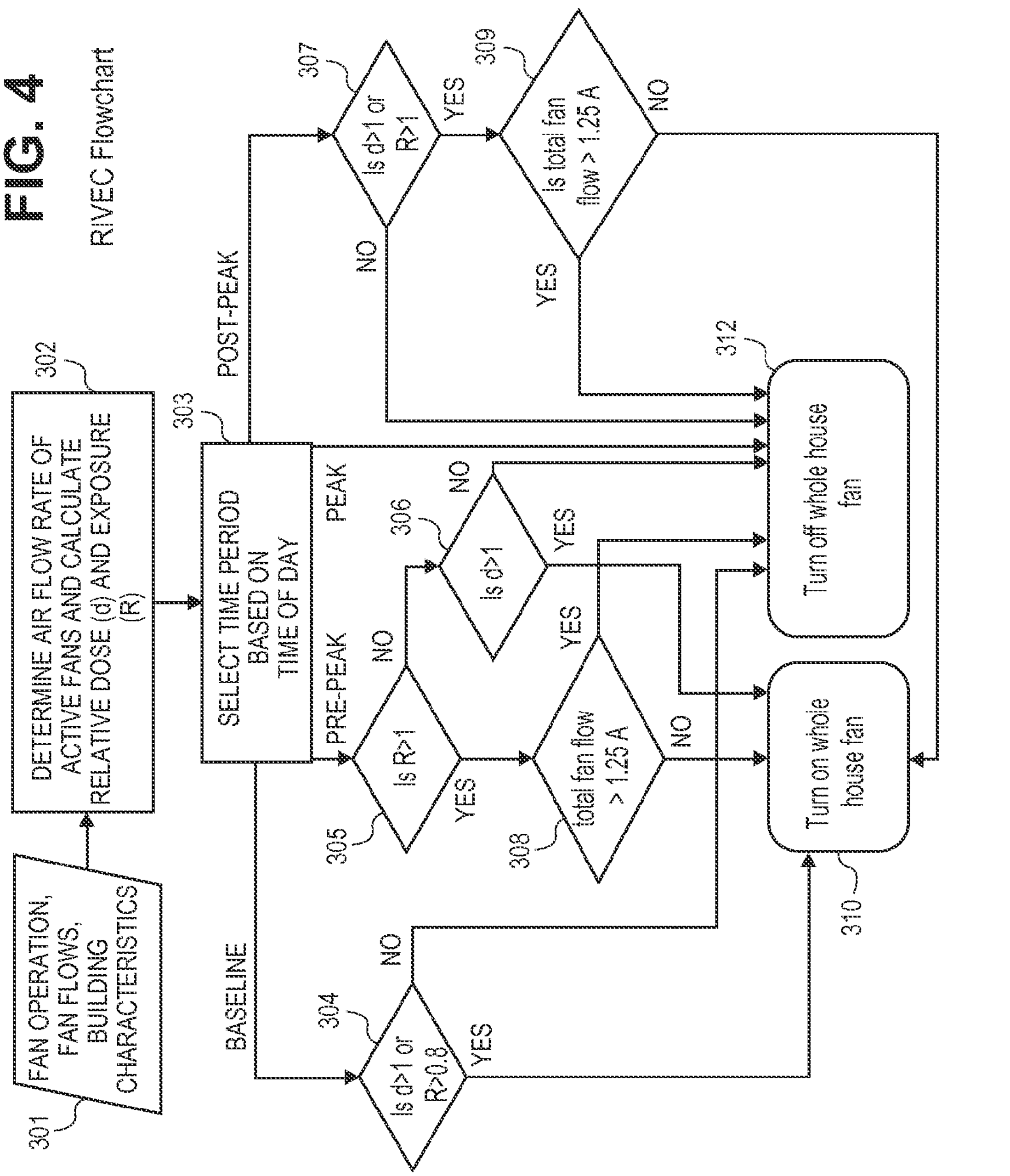


The RIVEC controller GUI has Developer sections dedicated to the X10 communication monitoring devices other than ventilation devices, and program debugging

FIG. 3

FIG. 4

RIVEC Flowchart



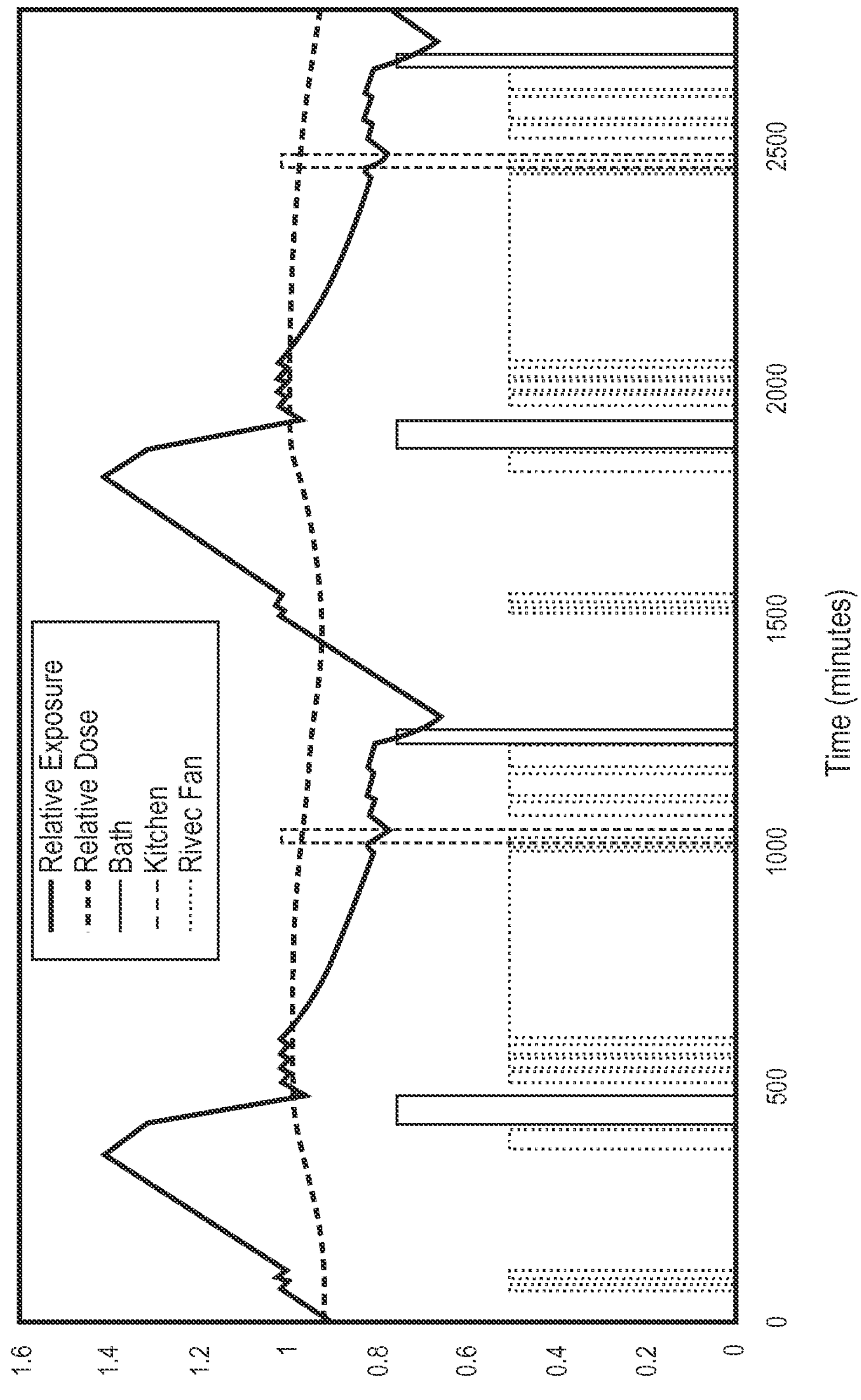

Relative Exposure
Relative Dose
Bath
Kitchen
Rivec Fan
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
0
500
1000
1500
2000
2500
Time (minutes)

FIG. 5

RESIDENTIAL INTEGRATED VENTILATION ENERGY CONTROLLER

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This Non Provisional US patent application claims priority to U.S. Provisional Patent Application No. 61/287,356, filed Dec. 17, 2009, entitled Residential Integrated Ventilation Energy Controller, the contents of said application incorporated in its entirety, as if fully set forth herein.

STATEMENT OF GOVERNMENTAL SUPPORT

[0002] The invention described and claimed herein was made in part utilizing funds supplied by the U.S. Department of Energy under Contract No. DE-AC02-05CH11231 between the U.S. Department of Energy and the Regents of the University of California for the management and operation of the Lawrence Berkeley National Laboratory. The government has certain rights in this invention.

BACKGROUND OF THE INVENTION

[0003] 1. Field of the Invention

[0004] This invention relates generally to ventilation systems for residential homes, designed to meet new and emerging air quality standards, and more specifically to a programmed/programmable device, the Residential Integrated Ventilation Energy Controller (RIVEC) which provides for dynamic control of the operation of a whole-house ventilation fan which forms part a residence ventilation system in a way that minimizes energy usage.

[0005] 2. Description of the Related Art

[0006] Ventilation, and thus the transport of contaminants and clean air, is becoming an ever more important issue as energy efficiency of buildings and indoor air quality within buildings is being sought to be improved.

[0007] Indoor air quality is a complex result of occupant activities, human responses, source emission, and contaminant removal. The key variables that requirements can be set for are usually ventilation and source control. Virtually every building code contains requirements related to ventilation and indoor air quality, but an integrated approach to looking at residential indoor air quality is usually lacking. The nation's first consensus standard on residential ventilation and indoor air quality was recently published by the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE Standard 62.2-2003, last updated 2007).

[0008] The ASHRAE standard in its simplest form requires continuous whole-house mechanical ventilation at a rate which is based on the size and occupancy load of the house. While it does not specify specific performance conditions for the mechanical ventilation, it does allow the use of dual purpose fans (e.g. a bath exhaust, or kitchen exhaust) to meet whole-house requirements. The basic requirement of the standard is that there be mechanical ventilation operating at a rate equal to 1 cubic foot per minute (cfm) per hundred square feet of floor area plus 7.5 cfm per person, where the number of people is presumed to be equal to one more than the number of bedrooms. In more general terms, the present standard calls for about ⅓ of the home air volume to be change per hour (0.33 ACH) using combined mechanical and natural ventilation, or about 8 air changes per day, in order to maintain reasonable air quality conditions within a house

[0009] Many newer homes are now required to be well insulated in order to improve energy efficiency by, on the one hand, reducing heating and cooling requirements. However, as a consequence of air tightness requirements needed to meet such mandated energy efficiencies, without provision for ventilation, contaminant build up within the house can quickly become unacceptable. Thus, new homes in some jurisdictions are also required to include a whole-house ventilation system in order to maintain acceptable indoor air quality. The most common method for meeting this ventilation requirement is to have a ventilation fan than operates continuously, every hour of the day, 24 hours a day.

[0010] Currently, in older homes, ventilation is typically achieved via operable windows or envelope leakage (i.e. infiltration) combined with a mixture of low-efficiency ventilation fans. However, these simple solutions cannot be relied upon for adequate ventilation as most new insulative dual pane windows are kept shut most of the time to keep heat in during the winter months, heat out during the summer months, or for reasons relating to noise or security. With retrofit sealing of older homes, the problem is exacerbated by the fact the contribution of infiltration to home ventilation is reduced such that infiltration alone can no longer be relied upon as a means for achieving adequate air exchange.

[0011] Accordingly there is a need for the providing of ventilation systems to supplement open windows and envelope leakage/natural infiltration. However, there remains a concern that such ventilation systems with their own energy requirements can add significantly to the costs of operating a home. Thus there remains a need for a whole-house ventilation system with minimal energy requirements.

BRIEF SUMMARY OF THE INVENTION

[0012] By way of this invention, a smart fan controller is provided that can substantially reduce the energy and peak power required to provide mechanical ventilation to a home in a way that effectively maintains home air quality. The smart fan controller achieves this by communicating with other exhaust or supply air systems in the home, such as those commonly found in bathrooms, kitchens, dryers, and the like, and controlling the operation of the whole-house ventilation fan which comprises a vital component of the mechanical ventilation system, turning it off (or down in the case where the fan can operate at variable speeds) in response to the status of other exhaust and supply fans in the home. In one embodiment, the smart fan controller is used detect whether or not such other, exogenous home exhaust or supply fans are on, and if so, it directs the whole-house fan to turn off. In another embodiment, where the whole-house fan can operate at variable speeds, the smart fan controller can also be used to detect the speed at which exogenous, variable speed supply or exhaust fans are operating, and adjust the speed of a variable speed whole-house fan in response. In yet another embodiment, using an on-off control algorithm, the ventilation load of the whole-house ventilation system can be shifted to off peak hours. In one embodiment, this is achieved by dividing the day into several segments, during one of which the ventilation fan is programmed to be completely shut off.

[0013] In yet a further exemplary refinement, the on-off algorithm can divide the day into four parts, a base line, peak, pre-peak and post peak periods. In one mode of operation, during peak times of the day, the whole-house fan is turned completely off. During both the pre and post peak periods, the fan is turned on, with the fan being turned off or down, as the case may be in the case where the whole-house fan can operate at variable speeds, when other supply or exhaust fans are running in the house.

[0014] In another embodiment, a computer program is provided which can be web accessible and can be programmed using a browser. A graphic user interface (GUI) allows a technician or the homeowner to program or reprogram the smart fan controller, taking into account variables such as the number of rooms in the house, the square footage and volume of the house, the number of occupants, and the number and air flow at single or variable speeds of the other supply and exhaust fans within the house. Based on a control algorithm that computes the exposure to pollutants relative to the exposure based on continuous fan operation, the controller according to its embedded logic decides if the whole-house ventilation fan needs to be on or off, or at a intermediate speed in the case where the fan can operate at variable speeds to insure relative dose and exposure levels are maintained within acceptable limits. The parameters used in the control algorithm are: Relative Exposure (R), defined as the occupant exposure to pollutants relative to the exposure resulting from use of continuous ventilation at the target air change rate (A) (e.g., as set by ASHRAE 62.2), and Relative Dose (d), defined as average value of relative exposure over representative exposure time (e.g., 24 hours). In one embodiment, the control algorithm can be preloaded. In another embodiment, the GUI allows an installer or homeowner to modify the program at the point of use.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The foregoing aspects and others will be readily appreciated by the skilled artisan from the following description of illustrative embodiments when read in conjunction with the accompanying drawings.

[0016] FIG. **1** is a schematic depiction of a typical home showing how a whole-house ventilation system might be set up.

[0017] FIG. **2** is a schematic depiction illustrating the interconnectivity of the whole-house ventilation fan with the other components of the home ventilation system.

[0018] FIG. **3** is a screen shot of the Input/Output interface allowing for user input for the set up of the operational control algorithms of the smart fan controller.

[0019] FIG. **4** is a flowchart of the software logic used to control the on-off periods of operation of the whole-house fan.

[0020] FIG. **5** is a plot of relative exposure vs. relative dose over a period of time, plotted against the on-off cycles for various home exhaust and supply fans and the whole-house fan.

DETAILED DESCRIPTION

[0021] New homes in some jurisdictions are required to meet the ASHRAE Standard on residential ventilation (62.2-2007). This standard specifies minimum continuous mechanical ventilation rates. While it does not specifically address the issues of source control or ventilation load shifting, it does allow alternative approaches to be used if they can be shown to provide equivalent performance.

[0022] Existing building stock is substantially leakier than typical new construction. Despite the natural and increasingly legal incentives to control energy costs, a key barrier to improved envelope air tightness is the real concern that indoor air quality will be compromised. Unlike new construction, existing homes have no mandate to meet any ventilation or indoor air quality standard. Thus, if air tightness is to be improved, provision at the same time needs to be made for maintenance of indoor air quality.

[0023] To address this indoor air quality issue, a low cost, energy efficient home ventilation system has been developed which utilizes existing home ventilation systems in combination with a whole-house ventilation fan. To maximize indoor air quality, while reducing costs of operation, an electronic controller, a residential integrated ventilation energy controller (RIVEC), is employed to control the on-off operations of the whole-house fan. This control is achieved in part by monitoring the use of other supply or exhaust systems in the house. If they are on during a time when the whole-house fan would otherwise be programmed to be on, the controller directs the whole-house fan to turn off, or in the case of a variable speed whole-house fan, to reduce fan speed.

[0024] With reference now to FIG. **1**, a residential home is illustrated, showing several existing ventilation systems, including a bath exhaust fan **102** connected to an exhaust duct **103**, a cooking range ventilation fan **104** connected to an exhaust duct **105** and a dryer **106** having its own, internal exhaust (not shown) connected to a dryer exhaust duct **107**. A controlled whole-house exhaust fan **114** is shown connected to its own exhaust dust **115**. The placement of the fan **114** is not critical, being on a first or second floor, or even in an attic, so long as it is in communication with the rest of the house. RIVEC controller **120** is the brains of the system and is used to control the on-off status of fan **114**.

[0025] Communication between fans **102**, **104** and **106** to the RIVEC controller is shown by dotted lines. In a new house, internal wiring can be provided to connect these units to the controller, providing a pathway for signals that alert the controller as to their operational status, be it full on, or off, or at some intermediate speed. In existing homes, other wireless methods of communication may be used. One such system, but by no means the only one, utilizes a protocol known as X10, which system includes associated hardware devices and a defined X10 communications language. There are many X10 compatible devices on the market. Common uses include control of house lighting and home security functions. The communications protocol, limited to simple, low speed communications, allows compatible devices to talk to one another using the existing home electrical wiring. Because it uses the home's existing electrical wires, installation is quite simple. Other higher bandwidth alternative can be used including KNX, INSTEON, BACnet, and ONWorks.

[0026] According to ASHRAE Standard 62.2-2007, a mechanical exhaust system, or supply system or combination thereof should be capable of providing whole building ventilation with outdoor air each hour at a specified rate, according to the equation:

$$Q_{fan}=0.01A_{floor}+7.5(n_{br}+1)$$

Where

[0027] Q_{fan}=fan flow rate in cubic feet per minute (cfm)

A_{floor}=floor area in square feet (ft^2)

N_{br}=number of bedrooms; not to be less than one

[0028] In one embodiment of the invention, the RIVEC can be used in conjunction with a Heat Recovery Ventilator (HRV) system as an adjunct to the whole-house fan. Such HRV systems make mechanical ventilation more cost effective by reclaiming energy from exhaust airflows. They do so by heat exchange, to heat cool incoming fresh air, or cool hot incoming fresh air, in this way recapturing 60 to 80 percent of the conditioned air temperatures that would otherwise be lost upon venting. When used with a whole-house fan, the HRV system can be included as an additional exogenous system to be monitored by the RIVEC controller, and according to the embedded logic of the controller, cause a shut down, or slow down of the whole-house fan when the HRV system is running. In another embodiment the HRV itself can serve as the whole-house fan.

[0029] It is to be appreciated that the controller of this invention can also be used in conjunction with existing "economizer" units as well, such economizers typically used at night during the summer months to bring in cool outside air to help maintain cooler indoor temperatures during the day. It can also be programmed to operate with Central Fan Integrated Supply (CFIS) systems which uses the existing central forced air system fan (even when there is no demand for heating or cooling) to pull air in from the outside (often through a separate ventilation air intake duct) and circulate it within the house. In such a typical set up, a motorized ventilation damper is used, the damper open only during ventilation-only mode, to limit the potential for over-ventilation during heating and/or cooling, in order to save the energy of unnecessarily conditioning extra outside air. All of these auxiliary approaches to home ventilation are well known in the art, and do not constitute a separate part of this invention. However, if used in place of a whole-house fan, such as in the case of a CFIS system, operation can be controlled by the controller of this invention in a manner similar to that of the whole-house fan.

[0030] FIG. **2** depicts the electronic set up of the whole-house ventilation system **200**. At the heart of the system is the RIVEC controller **220**. The RIVEC controller **220**, which comprises a CPU, including control algorithms **221** (which will be discussed later in more detail), along with its supporting electronic elements, is electronically connected to fan sensors **202**, **204**, and **206**, and **207** (which may for example be for an economizer) which sensors detect whether or not fans **102**, **104** and **106** (etc.) are on, off, or running at some intermediate speed. This information is sent to controller **220**, via any of the previously mentioned protocols, in one embodiment being the X10 protocol, wherein signals are sent through the existing home electrical wiring. Controller **220** is also provided with its own clock timer **208**, and independent power supply **209**. The on-off status of whole-house ventilation fan **214** is controlled by whole-house fan switch **212**, which in turn is activated to the on or off state depending upon signals received from controller **220**. The whole-house ventilation van may also be equipped with a variable fan speed controller, in the case where the fan is capable of operation at various speeds. During a period of time during which the whole-house fan **214** is programmed to be on, if any of the fan operation sensors detect that their associated ventilation fan is turned on, then a signal is sent to the RIVEC controller **220** through I/O port **217**, and a command issued via I/O **217** to whole-house fan switch **212** to shut off or reduce the speed of whole-house fan **214**.

[0031] Home specific operational variables to be inputted into the control program of the RIVEC is accomplished via I/O interface **218**, which in one embodiment can be linked either by wire or wirelessly to a personal computer. While the RIVEC unit can be installed with a preprogrammed algorithm, given the many variables that can affect ventilation requirements for a given house incorporating a RIVEC system, the capability through I/O **218** is provided to change to the default settings in the field or at the point of use (which can be one in the same).

[0032] An exemplary screen shot of a GUI which can be used to program the RIVEC is depicted in FIG. **3**. Therein, as shown in the screen shot, one can (among other things) select the default program. Customizing data to be entered include the floor area of the house, the volume of the home, the number of bedrooms, the target ACH flow, along with the listing of ventilation locations, including supply and exhaust flows, if known. Entry of other information such as the presence of an economizer is shown in the I/O along with an entry window for recording its air flow capacity. Other entry windows allow for additional adjustments to the operational algorithm, which will now be described in connection with FIG. **4**.

[0033] Embedded logic in the controller allows it to make the decision to turn the whole-house mechanical ventilation fan on or off, or to an intermediate speed, the decision made at each discrete time interval, which in one embodiment can be set to every five minutes. The following set of actions is performed at each time interval, be it at every five minutes, ten minutes, or longer interval such as every hour.

[0034] Determine current mechanical ventilation rate: the controller monitors the status of the whole-house mechanical system and all exogenous mechanical ventilation systems.

[0035] Estimate current Indoor Air Quality: the relative exposure, R, and relative dose d are calculated. These values are then used in the decision making process of the control algorithm.

[0036] Modify whole-house mechanical ventilation: Based on the imbedded and programmed logic of the control algorithm, the whole-house mechanical ventilation is turned on or off for the next time interval.

[0037] The control algorithms of control program **221** (which may be implemented in software, firmware or a combination of both) are programmed to keep the dose d at or below 1, but allow the whole-house mechanical ventilation system to be turned off during a defined peak period. To do this each day in the embodiment of the invention illustrated in the figure, the day is broken up into four periods (box **303**). There is a (4 hour) peak period where the whole-house system is "off" (box **312**). There is a pre-peak and a post-peak shoulder period (4 hours each), and then a 12 hour base period. Each period has its own control logic including allowable levels of relative dose and relative exposure. These levels are set through a combination of engineering judgment and results of simulations and field testing.

[0038] For the base period: the Minimum Total Mechanical Ventilation is set at A (the target ACH—air change per hour), the Maximum Total Mechanical Ventilation is set to: unlimited. The algorithm turns on the whole-house ventilation fan (box **310**) if d is greater than 1 or R is greater than 0.8 (box **304**)]. The algorithm turns off the whole-house ventilation (**312**) if d is less than 1 and R is less than 0.8.

[0039] For the pre-peak shoulder period: The minimum whole-house mechanical ventilation is set to zero. If the ventilation system has variable capacity, the maximum whole-house mechanical ventilation is set at: 1.25 A. The algorithm is set to turn on whole-house ventilation (box **310**) if R is greater than 1 (box **305**), but not if the then current mechanical ventilation rate total is at least 1.25 A (box **308**). The algorithm will turn off whole-house ventilation fan (box **312**) if R is less than 1 (box **305**) and d is less than 1 (box **306**).

[0040] For the Peak Period: Minimum whole-house mechanical ventilation is set to zero, maximum whole-house mechanical ventilation set to zero. The algorithm is programmed to always turn off the whole-house ventilation fan (box **312**).

[0041] For the Post-Peak Shoulder Period: The minimum whole-house mechanical ventilation is set to zero. If the ventilation system has variable capacity, maximum whole-house mechanical ventilation is set to 1.25 A. The algorithm is set to turn on whole-house ventilation fan (box **310**): if d is greater than 1, or R is greater than 1 (box **307**), but not if the then current mechanical ventilation total is already at least 1.25 A (box **309**). The program algorithm is set to turn off whole-house ventilation fan: if d is less than 1, and R is less than 1 (box **307**) or current mechanical ventilation total is at least 1.25 A (box **309**).

[0042] To program the controller, step **218** of FIG. **2**, the user will usually start by clicking the "Select Defaults" button (see FIG. **3**). This will fill in the windows which define winter and summer months and peak hours. It also assigns three bedrooms to the house with a default area of 3,500 ft^2 and a volume of 30,800 ft^3. From this it calculates the ASHRAE 62.2 constant ventilation requirement, in this case 0.15ACH (also shown in units of CFM). The user can then modify the number of bedrooms, floor area, and house volume and then click the "Cal. ACH" button to calculate the ASHRAE 62.2 ventilation rate for their house. The user can replace this target ventilation rate to a value of their own choosing if they so desire.

[0043] The pull down menu "RIVEC Device Type" defaults to RIVEC control of the whole-house fan. Other active selections are "Always ON" and "Always OFF". The other ventilation control types listed have the same control logic as the "Exhaust Fan" but are names of other common ventilation devices.

[0044] The names of the various ventilation devices, their X10 address, and flow rates can now be set. These can also be changed during RIVEC operation and will take effect when the device is next used. A sensor is used (usually a clamp-on current sensor) to detect when other ventilating fans are on. The summer and winter seasons and peak and shoulder times can be changed. Controller step time and serial communications port to the X10 controller can also be adjusted as well. After the user has completed filing in the information, then click the "init" button. This will start up communications with the X10 interface, start logging data, and start the RIVEC control.

[0045] With reference now to FIG. **5**, a plot of relative exposure (R) vs. relative dose (d) is shown over a two day period, the plot exemplary as to the operation of the ventilation system employing a RIVEC fan. As can be seen from this plot, when the fan is off, the relative exposure increased above 1, and then began to decrease as soon as the RIVEC whole-house fan was turned on. When other house exhaust or supply fans were turned on, such as in the bathroom or the kitchen, the RIVEC whole-house fan turned off, and then cycled back on again staying on for extended periods of time. All the while, the relative dose remained near 1. To be noted in this exemplary test of the RIVEC system illustrated in FIG. **5**, the controller was programmed to perform calculations of R and d every 10 minutes to determine if the fan should be on or off in order to maintain the relative dose as near to 1 as possible.

[0046] By way of summary, in using the RIVEC controller it is possible to successfully control ventilation while still maintaining acceptable indoor air quality. Due to the "smart" nature of the device, implementation of the RIVEC approach can lead to run times of but 30-70% of normal full time operation. Substantially higher savings may further be realized if home occupants use equipment like dryers, exhaust or supply fans, or economizers to a degree higher than is assumed in standard calculations. Existing homes may be retrofitted with the RIVEC technology and can show improved Indoor Air Quality (IAQ) and/or ventilation energy savings.

[0047] From time to time in describing the operation of the whole-house fan, reference has been made to periods where the whole-house fan is either on or off. It is to be appreciated that for whole-house fans capable of being operated at various speeds, when reference has been made to the "on" state, such contemplates an "on" state which can be full on, or at some intermediate speed. Whether or not the whole-house fan is to be operated at an intermediate speed will depend upon what other home exhaust or supply fans are on at the time, and at what speed those fans might be running, where they too may be capable of operating at more than one speed. Other variations in the operation of the whole-house fan are possible, and any such variations are considered to be within the scope of this invention.

[0048] This invention has been described herein in considerable detail to provide those skilled in the art with information relevant to apply the novel principles and to construct and use such specialized components as are required. It is to be understood that the invention can be carried out by different equipment, materials and devices, and that various modifications, both as to the equipment and operating procedures, can be accomplished without departing from the scope of the invention itself.

We claim:

1. A system for controlling the ventilation of a house, said system including:

a) a whole-house fan

b) one or more other home supply or exhaust fans

c) a controller for regulating the on-off time of the whole-house fan, said controller including a central processing unit, a bios, a clock, and memory, said memory including programmable software for both calculating the relative exposure and relative dose within the building, and instructions based on the calculated relative exposure and relative dose to either turn the whole-house fan on or off; and,

d) communication links with the one or more other home exhaust or supply fans, such that a signal is sent from each of the one or more other home exhaust or supply fans to the controller, indicating the operating status of the fan, such as whether or not it is on or off, or operating an some intermediate speed, and a set of instructions within the controller which either turns the whole-house fan on or off, or set it to some intermediate speed, in response to the signals from the other home exhaust or supply fans.

2. The system of claim **1**, in which the set of instructions within the controller which either turn the whole-house fan on or off, or sets it to some intermediate speed, in response to the signals from the other home exhaust or supply fans is programmed to turn the whole-house fan off, or set it to some intermediate speed, when any one of the other home exhaust or supply fans is operating.

3. The system of claim **2** further including an economizer.

4. The system of claim **2** further including a heat recovery ventilation system.

5. The system of claim **1** further including a control algorithm implemented in software residing within the controller, which algorithm includes a programmed schedule during at least one segment of which, the whole-house fan is in an "always off" condition.

6. The system of claim **5** wherein said algorithm is programmed such that the "always off" condition occurs during the peak energy demand period is summer months for cooling, or in winter months for heating.

7. The system of claim **5** further including means for programming the controller algorithm from a separate electronic device, which device can be accessed by a user to set programmable variables, including when the whole-house fan will be in the "always off" condition.

8. A system for controlling ventilation within a structure including:

a) a main whole-house ventilation control fan, including an on-off switch or variable fan speed controller, said fan located within said structure;

b) one or more supply or exhaust fans located within said structure, each of said fans having an on-off switch, or variable fan speed controller;

c) a central controller in communication with the said switches or speed controller of said main whole-house ventilation fan and said one or more supply or exhaust fans; and,

d) a software program associated with said central controller, which software program includes a set of electronic instructions which provides among other things for the monitoring of the status of the one or more supply or exhaust fan switches or speed controllers, such that if said one or more of said supply or exhaust fans are operating, an electronic instruction is sent to the on-off switch or variable fan speed controller of the main whole-house ventilation control fan to turn it off or to some reduced speed.

9. The system of claim **8** wherein the main ventilation control fan, one or more exhaust or supply fans, and the central controller are in wired communication with each other.

10. The system of claim **8** wherein said wired communication is achieved employing an X10 protocol, or equivalent.

11. The system of claim **8** wherein the main ventilation control fan, one or more exhaust or supply fans and the central controller are in wireless communication with each other.

12. The system of claim **8** wherein additional instructions control the operating status of the main whole-house ventilation fan based on the time of day.

13. The system of claim **8** wherein instructions contained within the said software program are used to calculate a relative dose and a relative exposure function at set intervals during the day, the calculated relative dose and relative exposure for that time of day then compared with a preset value for these same variables at that same time of day, whereby based on said comparison an instruction is issued to the on-off switch or variable fan speed controller of the main whole-house ventilation fan to be on, off or set to an intermediate speed.

* * * * *