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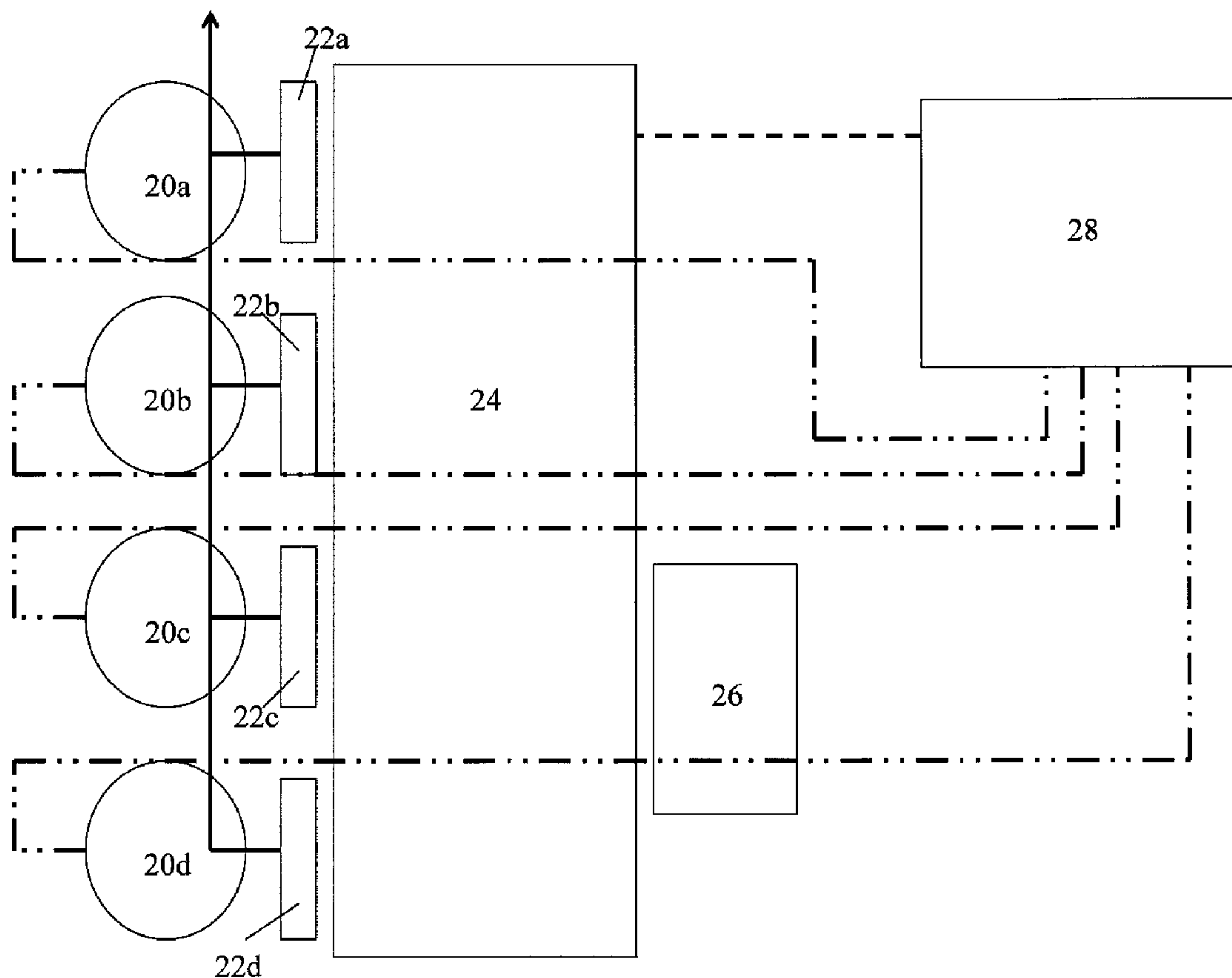
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(54) Titre : SYSTEME DE COMMANDE DE VENTILATEURS

(54) Title: FAN CONTROL SYSTEM



(57) Abrégé/Abstract:

There is described a method for controlling an exhaust system having at least two fans, a plenum chamber interconnecting the at least two fans, and a bypass air damper in the plenum chamber to allow bypass air to flow therethrough, the method comprising:

(57) **Abrégé(suite)/Abstract(continued):**

monitoring pressure in the plenum chamber of the system; detecting a variation of the pressure beyond a predetermined range; and regulating operation of the exhaust system in response to the pressure variation in order to return the pressure to within the predetermined range.

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ABSTRACT

There is described a method for controlling an exhaust system having at least two fans, a plenum chamber interconnecting the at least two fans, and a bypass air damper in the plenum chamber to allow bypass air to flow therethrough, the method comprising: monitoring pressure in the plenum chamber of the system; detecting a variation of the pressure beyond a predetermined range; and regulating operation of the exhaust system in response to the pressure variation in order to return the pressure to within the predetermined range.

FAN CONTROL SYSTEM**CROSS-REFERENCE TO RELATED APPLICATIONS**

This is the first application filed for the present invention.

5 TECHNICAL FIELD

The present invention relates to the field of ventilation fans, and more particularly, to control systems for industrial ventilation fans.

BACKGROUND OF THE INVENTION

- 10 Industrial and Laboratory exhaust systems may have at least one active fan and a standby fan. The standby fan is used whenever the active fan fails. In many cases, multiple fans are used as a more cost efficient way of providing the air flow requirements of the active fan. A standby fan can be
15 activated whenever one of the other fans fail.

Under-use of a fan can lead to premature bearing failure. Having a standby fan inactive for an extended period of time can lead to bearing and drive damage due to stagnant conditions.

- 20 In addition, large quantities of energy are wasted by having all fans running continuously in an environment with varying demand. For example, a large laboratory may need the system to run at a capacity of 50000 cubic feet per minute (CFM) during the day, while requiring only 30000 CFM
25 at night. Bypass dampers, in plenums, are used to bypass all extra air.

Therefore, there is a need to provide a more cost efficient system.

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SUMMARY OF THE INVENTION

It is an object of this invention to overcome the drawbacks of existing systems.

In accordance with a first broad aspect of the present invention, there is provided a method for controlling an exhaust system having at least two fans, a plenum chamber interconnecting the at least two fans, and an air damper in the plenum chamber to allow bypass air to flow therethrough, the method comprising: monitoring pressure in the plenum chamber of the system; detecting a variation of the pressure beyond a predetermined range; and regulating operation of the exhaust system in response to the pressure variation in order to return the pressure to within the predetermined range.

Regulating operation of the fans includes such functions as energizing and/or de-energizing a single or multiple fans and modulating the bypass air damper to regulate the air pressure in the plenum chamber.

In accordance with a second broad aspect of the present invention, there is provided an exhaust system assembly comprising: at least two fans; a plenum chamber having an air damper at one end, the plenum chamber interconnecting the at least two fans and having a pressure sensor therein for sensing and detecting pressure; and a control module receiving the pressure detected in the plenum chamber and adapted to regulate operation of the at least two fans when the pressure has varied beyond a predetermined range in order to restore the pressure to within the range.

The control module is connected via a pressure sensor to the plenum chamber where the pressure is sensed. The pressure measurements are used by the control module to

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determine whether a fan must be energized or de-energized and controls the bypass air damper.

In accordance with a third broad aspect of the present invention, there is provided in a computer network enabling
5 communication between a plurality of computers, a method comprising: providing at least one sensing device in a fan exhaust system; monitoring at least one parameter of the system using the at least one sensing device; comparing the at least one parameter to a predetermined tolerance level;
10 and sending an alarm signal through the network to a remote computer when the at least one parameter does not meet the predetermined tolerance level.

The sensing device can be a pressure sensor for the plenum chamber connecting multiple fans, a vibration transducer
15 for the vibration of an individual fan, or any other parameter used to monitor the proper functioning of the system. The alarm signal is sent in the form of an email message to a remote computer, a light is lit, or equipment is disconnected.

20 **BRIEF DESCRIPTION OF THE DRAWINGS**

Further features and advantages of the present invention will become apparent from the following detailed description, taken in combination with the appended drawings, in which:

25 Fig. 1 is a block diagram of the exhaust system illustrating the plumbing of the system in accordance with a preferred embodiment of the present invention;

Fig. 2 is a block diagram of the exhaust system illustrating the wiring of the system in accordance with a
30 preferred embodiment of the present invention; and

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It will be noted that throughout the appended drawings, like features are identified by like reference numerals.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The wiring diagram of figure 1 illustrates a system including four fans 20a, 20b, 20c, 20d, one of the four 20d being a standby fan. Should any of the active fans 20a, 20b, 20c fail, the standby fan 20d is activated. It should be understood that the system of the present invention can be used with a system having two fans or more. Each fan 20a, 20b, 20c, 20d has its own isolation air damper 22a, 22b, 22c, 22d, which is used to shut off air flow. When the fans are stopped, the isolation air dampers 22a, 22b, 22c, 22d are typically set in the fully opened or fully closed positions. An isolation air damper is supplied with a full blade seal which provides a minimum amount of leakage when the damper is in the closed position. Isolation air dampers without seals are also possible.

A plenum chamber 24 interconnects all the fans 20a..20d via the isolation dampers 22a..22d. Negative static pressure is maintained in the plenum chamber 24 at all times when fans are on. The pressure within the plenum chamber is monitored as a control parameter for the system. If the pressure varies above or below a given range, this is an indication that the system must be stabilized by modulating the damper 26 or energizing/de-energizing a fan. An air damper, in this case a bypass air damper 26, is on the plenum chamber 24 to allow air to enter the plenum chamber 24. The bypass air damper 26 can be adjusted to control the amount of bypass air.

A control module 28 is connected to the plenum chamber 24 and to each fan 20a..20d via pressure taps, as shown in

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figure 1. This is used to determine the status of the fans 20a..20d and the pressure of the plenum chamber 24. The control module 28 is also connected by wired connection to the bypass air damper 26 and the isolation dampers 22a..22d, either wirelessly or through wired connections, as shown in figure 2. Preferably, a 2-10VDC control signal is used to control the dampers. The control module 28 is connected to the fans 20a..20d through a starter.

According to one embodiment of the present invention, the system turns on a standby fan while simultaneously turning off one of the active running fans, while maintaining constant pressure in the plenum chamber 24. In addition, the system rotates the fans which are being operated. Energy is saved by running only the number of fans needed to maintain the preset system pressure. The system will shut off or add fans as needed. On a four fan system, the controller will, if necessary, operate only one fan to preserve energy. During that period, only 33% of power is used. The system can operate the system at 33%, 66%, 100%, and 133% by using one, two, three, or four fans, respectively.

For example, using a four fan system designed to operate three fans continuously and one standby fan at a total of 60000 cubic feet per minute (CFM) and 5" water-column (w.c.), each fan would use a 30 horsepower motor. Each motor at the current price of electricity can consume approximately \$20000/year if they operate around the clock. Each fan could be selected with a 20000 CFM capacity. If the system demand changes to 30000 CFM, the control module 28 will de-energize one fan and use only two fans to keep the bypassed air to a minimum. An energy saving of 33% is then achieved.

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Assuming a situation where the system CFM may vary from 10000 CFM to 60000, the control module 28 would use one fan on the low end and three fans at the high end. On the low end, 66% of energy can be saved as opposed to a regular system that would bypass all that energy through bypass dampers.

Through the use of a microprocessor, fans running are monitored for the number of hours of operation. A fan is de-energized after a set number of hours of operation and a standby fan is energized. The de-energized fan then becomes the standby fan. During this process, the microprocessor monitors the plenum chamber pressure and adjusts the bypass damper. The microprocessor also adjusts the rate that the isolation damper opens on the energized fan and closes on the de-energized fan in order to maintain a constant plenum chamber pressure.

The microprocessor monitors the operating fans for possible failures. If a fan fails, it will be shutdown and the next available fan will be energized. Energy saving is achieved through monitoring the amount of bypass air. When too much air is being bypassed, the control module 28 will de-energize a fan.

In a preferred embodiment, the control module 28 allows for three modes of operation: "AUTO", "OFF", and "MANUAL". In "AUTO" mode, the control module 28 checks its internal programming to determine which fan is the current active fan and closes the appropriate contact for that fan. This contact activates the fan activation relay which in turn provides a closed contact to activate the fan. The appropriate isolation damper is opened by the control module 28 through the appropriate analog (or digital) output. Once the determined switching day/time has passed,

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the control module 28 will change the status of its digital outputs. The contact that was closed will open, and the contact that was open becomes closed. With this action, the fan that was the active fan prior to the contact change becomes the standby fan and vice-versa. The fan that was the standby fan prior to the switch goes through the same starting sequence as described above. The fan that was the active fan prior to the switch is shut down and the associated isolation damper is closed. The individual isolation damper actions precede the associated fan shutdowns in order to keep the vacuum in the plenum chamber.

In "OFF" mode, none of the fan start relays are activated, so the fans cannot receive a start contact. Note that fans switched to "OFF" while the system start contact is engaged will result in a fan failure alarm when called upon to operated in "AUTO" mode.

In "MANUAL" mode, the fan (as selected) is activated, and the isolation damper is opened. The control outputs are bypassed and a constant signal is sent to the isolation damper to open it. Pressure switch verification of the pressure change is also not used in "MANUAL" mode.

The system is constantly monitoring the plenum chamber 24 pressure with a pressure transmitter. A pressure signal is fed to the control module 28 which issues a control signal to the bypass damper to maintain the assigned/adjustable set point. If the negative static pressure needed cannot be maintained by one fan, the control module 28 will activate a second fan to help maintain the plenum chamber vacuum. Alternatively, the control module 28 will initiate de-energizing the fans.

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A fan's alarm light is activated upon failure. A control panel will have a light that will be turned on to signal the failure. Substantially simultaneously, the appropriate relay is activated and a dry contact is closed to provide a fan-specific dry contact alarm. This alarm condition is maintained in the control module 28 until the alarm is reset either by dry contact or by a local push button.

Another parameter of the operating fans that can be monitored is vibration. All fans generate some vibration. It's only when vibration reaches a certain amplitude that it may cause damage to the fan. Vibration may be an indicator of some problem with a mechanism, or it may be a cause of other problems. High vibration can create heat which can break down lubricants in the bearings and, in addition, may cause metal fatigue in the bearings. Excessive vibration can cause fasteners to loosen or can cause fatigue failure of structurally loaded components. A device such as a vibration transducer may be used to sense vibratory motion and convert it into a signal for the purpose of measurement. When the measurement no longer corresponds to a vibration tolerance in accordance with a specification requirement, an alarm signal is activated to indicate that there may be a problem. A fan that vibrates excessively may have some type of mechanical failure and may be shut down. Other parameters, such as heat and rotations per minute (RPMs) of the fans can also be sensed and used as a control parameter for the system

The control module 28 of the present invention may be connected to a computer network, allowing information to be sent to other computers. In a preferred embodiment, email messages are generated and sent upon any type of change that would occur in the system. For example, if the system

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were to adjust to a reduction in demand (by de-energizing a fan, for example), an email message would be generated and sent to a system operator to advise him of the change. Alternatively, messages may be sent only in the case of a
5 problem, such as a fan failure or an increased vibration measurement. Such alarms would also appear on a typical LED control panel to allow an operator on-site to immediately see if there were a problem with the system.

In yet another embodiment, a remote user could access the
10 system through his computer, either through the internet or a special application installed on the computer. This would work in a similar way as the remote access of a work computer from home. Remote control software can be used to allow a user at a remote site to have control of a desktop
15 computer via modem or the Internet. The remote control software is installed at both ends, and both users are controlling the local machine and viewing the same screen display simultaneously. A remote access server provides access to remote users via analog modem or ISDN
20 connections. Including dial-up protocols and access control (authentication), it may be a regular file server with remote access software or a proprietary system, for example, Shiva's LANRover. The modems may be internal or external to the device.

25 The embodiments of the invention described above are intended to be exemplary only. The scope of the invention is therefore intended to be limited solely by the scope of the appended claims.

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I/WE CLAIM:

1. A method for controlling an exhaust system having at least two fans, a plenum chamber interconnecting said at least two fans, and a bypass air damper in said plenum chamber to allow bypass air to flow therethrough, the method comprising:

monitoring pressure in said plenum chamber of said system;

detecting a variation of said pressure beyond a predetermined range; and

regulating operation of said exhaust system in response to said pressure variation in order to return said pressure to within said predetermined range.

2. A method as claimed in claim 1, wherein said regulating comprises energizing one of said at least two fans.

3. A method as claimed in claim 1, wherein said regulating comprises de-energizing one of said at least two fans.

4. A method as claimed in claim 3, wherein said de-energizing comprises timing closing of an isolation air damper associated with said fan with said de-energizing of said fan to minimize an overall pressure drop in said plenum chamber.

5. A method as claimed in claim 1, wherein said regulating comprises modulating said bypass air damper to aid in returning said pressure to within said predetermined range.

6. A method as claimed in claim 1, wherein said regulating comprises monitoring a standby fan for time of inactivity,

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and replacing an active fan with said standby fan after a predetermined time of inactivity.

7. A method as claimed in claim 6, wherein said replacing a fan comprises timing opening and closing of an isolation damper associated with said fan with energizing and de-energizing said fan to minimize an overall pressure drop in said plenum chamber.

8. An exhaust system assembly comprising:

at least two fans;

a plenum chamber having a bypass air damper therein for bypassing air, said plenum chamber interconnecting said at least two fans and having a pressure sensor therein for sensing and detecting a pressure; and

a control module receiving said pressure detected in said plenum chamber and adapted to regulate operation of said at least two fans when said pressure has varied beyond a predetermined range in order to restore said pressure to within said range.

9. An exhaust system as claimed in claim 8, wherein said control module is adapted to energize and de-energize individual fans in response to said pressure variation.

10. An exhaust system as claimed in claim 9, wherein said control module times opening and closing of an isolation damper associated with said fan with energizing and de-energizing of said fan to minimize an overall pressure drop in said plenum chamber.

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11. An exhaust system as claimed in claim 8, wherein said control module modulates said bypass air damper to aid in returning said pressure to within said predetermined range.

12. An exhaust system as claimed in claim 8, wherein said control module monitors a standby fan for hours of inactivity, and replaces an active fan with said standby fan after a predetermined time of inactivity.

13. An exhaust system as claimed in claim 12, wherein said control module times opening and closing of an isolation damper associated with said fan with energizing and de-energizing of said fan to minimize an overall pressure drop in said plenum chamber.

14. In a computer network enabling communication between a plurality of computers, a method comprising:

 providing at least one sensing device in a fan exhaust system;

 monitoring at least one parameter of said system using said at least one sensing device;

 comparing said at least one parameter to a predetermined tolerance level; and

 sending an alarm signal through said network to a remote computer when said at least one parameter does not meet said predetermined tolerance level.

15. A method as claimed in claim 14, wherein said alarm signal is an email message.

16. A method as claimed in claim 14, wherein said at least one sensing device is a vibration transducer, and said at least one parameter is vibration of a fan.

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17. A method as claimed in claim 14, wherein said at least one sensing device is a pressure sensor, and said at least one parameter is pressure.

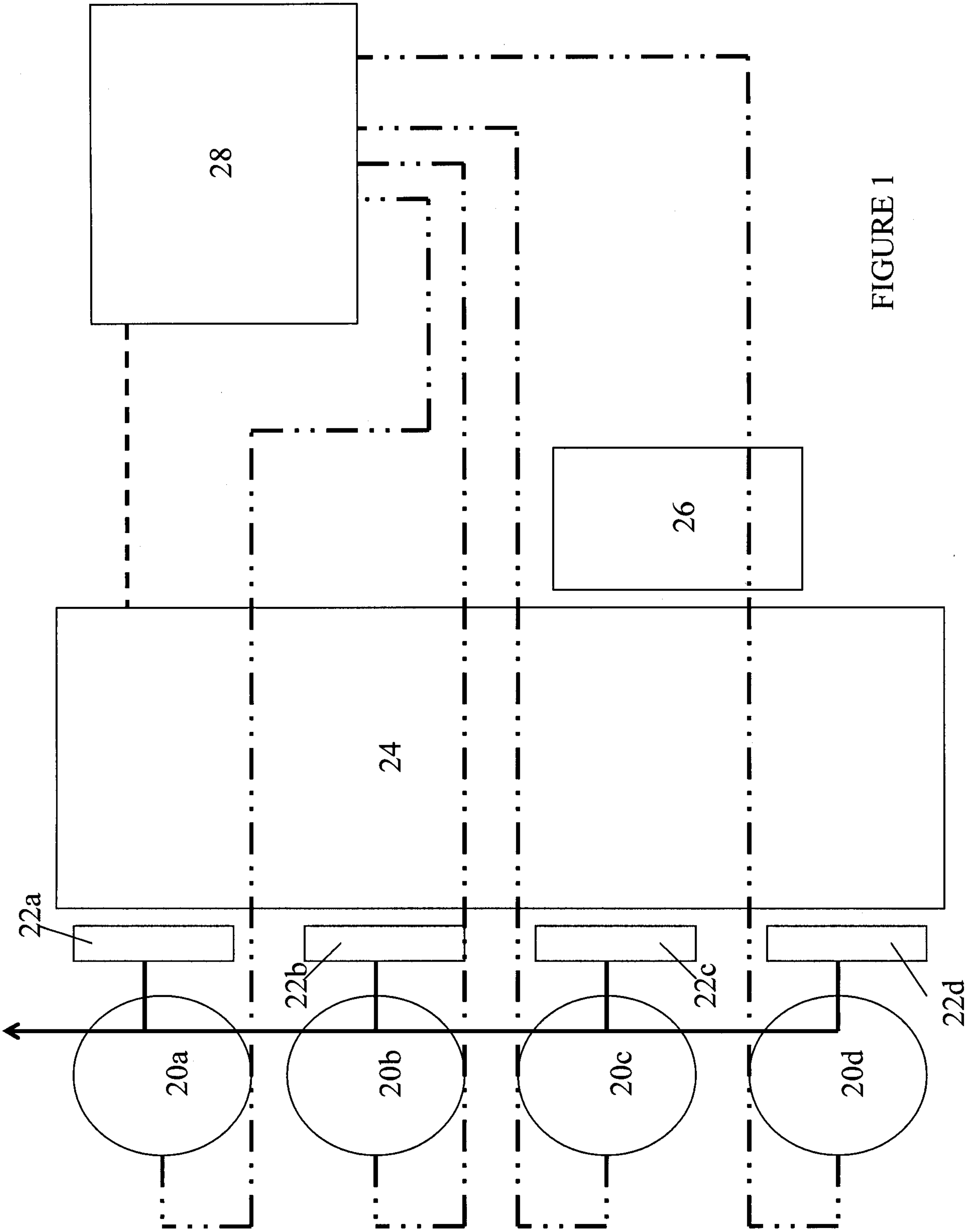


FIGURE 1

