

Controls for Ventilation and Exhaust Ducts and Fans

Field of the Invention

- 5 This invention relates to controls for ventilation and exhaust ducts and fans and preferably, through not exclusively, relates to such an apparatus for use in offices, commercial kitchens, factories, warehouses, retail centres, production facilities, car parks, cooling tower fans, or the like.

10 Background of the Invention

- Exhaust apparatus for fumes and/or smoke are normally used in commercial kitchens, factories, production facilities, car parks, cooling tower fans or the like, to exhaust fumes and/or smoke and/or gasses caused by the cooking or production
15 process, or vehicle exhausts. Some exhaust systems may have a hood above the stove or production facility, and ducting to connect the hood to the outside atmosphere. One or more fans are built into the ducting or the hood to force the fumes and/or smoke through the ducting. Filters may be used to remove the principal contaminants from the fumes and/or smoke.

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- The fan or fans are normally controlled by a control panel. If a hood is used, it may be on the front of the hood. The fan may be multi-speed with corresponding speed controls on the control panel. This means the fans may not be on when required, may be on when not required or may be operated at a speed in excess of that
25 required, or may be operated at a speed less than that required. Such a situation can lead to ineffective or inefficient fume and/or smoke extraction, and/or excess use of the fan and therefore increased power consumption. Increased power consumption leads to increased energy costs. For example, in many commercial kitchens exhaust fans are operated at full speed from the beginning of food
30 preparation until the last dish is cleaned. Also, in car parks they operate continually at full speed even when there is no vehicle movement in operation. Such a level of use is very wasteful of energy and increases operational costs.

- There have been proposed exhaust systems that monitor the ambient temperature
35 in the kitchen. Such systems do not operate in the presence of noxious gasses or fumes, or when the carbon dioxide and/or carbon monoxide level increases and the oxygen level decreases in the ambient air. Also, there is a tendency for the

ducting to act as a conduit for fire if the premises are on fire, or for contaminants in the ducting to catch fire. Ducting for exhaust systems does not normally deal with such problems and can enhance the fire by the fan(s) being on, and the ducting being open to the outside atmosphere.

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Also, ventilation systems for supplying air to zoned structures such as offices, warehouses and retail centres rely on fire detectors adjacent the zone boundary. At the zone boundary there are dampers in the duct. Upon the fire detector operating, the damper is operated to reduce the risk of fire spread. But by then the fire is close to penetrating the boundary. Also, each damper operates independently and there is no structured approach to use and operation of the dampers, and duct fans, for prevention of the spread of fire. Often the only source of air to fuel the fire is the ventilation duct. Therefore, closing the duct and braking the fan to a complete stop as early as possible can slow the fire considerably by removing the source of oxygen.

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Summary of the Invention

In accordance with a first preferred aspect there is provided a fan assembly for placement in ducting of a ventilation or exhaust system for an environmental space, the fan assembly comprising:

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- (a) a motor having an output shaft;
- (b) a fan mounted on the output shaft; and
- (c) a brake for operation on the motor

25 wherein

(d) the brake is operable for stopping operation of the motor upon a detection of a prescribed situation in one or more of: the environmental space, and the ducting.

In accordance with a second preferred aspect there is provided a valve assembly for placement in ducting of a ventilation or exhaust system, the valve assembly comprising:

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- (a) a valve member for placement in the ducting for movement between a first position where the ducting is substantially open; and a second position where the valve member substantially closes the exhaust ducting;
- (b) the valve member being adapted to move from the first position to the second position in response to at least detection of a prescribed situation. The

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valve member may be mounted on a spindle for movement therewith between the first and second positions; the spindle being for operative connection to a drive motor for movement of the spindle for causing the valve member to move between the first and second positions.

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The prescribed situation may be the detecting of the presence of at least one: heat, fire, smoke, fumes, gas, and obnoxious fumes. The gas may be one or more of: a cooking gas, carbon monoxide, and carbon dioxide.

- 10 The valve member may be sized and shaped to substantially accord to an interior size and shape of the exhaust ducting.

In accordance with a third preferred aspect there is provided a ventilation or exhaust system comprising:

- 15 (a) ducting;
 (b) the fan assembly described above;
 (c) the valve assembly described above; and
 (d) at least one detector for detecting a prescribed situation and for controlling the operation of:
- 20 (i) the brake of the fan assembly, and
 (ii) the valve assembly

in response to the detecting.

- 25 The valve assembly may be located near an outlet end of the ducting or at a boundary of zones of the environmental space. The exhaust apparatus may further comprise a hood, the hood having a control panel. The control panel may comprise a reset control for resetting the at least one detector, releasing the brake of the fan assembly, and moving the valve member to the first position. The exhaust apparatus may further comprise at least one sensor for controlling the operation of
- 30 the fan assembly. The at least one sensor may be at least one of: a time sensor, a gas sensor, and at least one heat sensor. The at least one sensor may be arranged in groups. There may be a plurality of sensors, a plurality of groups, and a plurality of sensors in each group. The number of sensors, or number of groups of sensors, activated may determine the speed of operation of the fan. For a time
- 35 sensor, the time stage may determine the speed of operation of the fan.

In accordance with a fourth preferred aspect there is provided a ventilation or exhaust system comprising:

- (a) a fan assembly as described above; and
- (b) a plurality of sensors for automatically controlling the operation of the fan assembly by controlling the operational speed of the fan assembly in accordance with the number, location or nature of sensors that are activated.

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The system may further comprise:

- (c) a master on control for overriding the time sensor;
- (d) a master off control for overriding the time sensor; and
- (e) time controls for setting the first and second preset times.

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Brief Description of the Drawings

In order that the present invention may be fully understood and readily put into practical effect, there shall now be described by way of non-limitative example only preferred embodiments of the present invention, the description being with reference to the accompanying illustrative drawings.

In the drawings:

20 Figure 1 is a front perspective view of a preferred embodiment;
 Figure 2 is a vertical cross-sectional view of the embodiment of Figure 1;
 Figure 3 is an enlarged view of one embodiment the fan assembly of Figure 2;
 Figure 4 is block diagram of an alternative embodiment for the fan assembly;
 Figure 5 is an enlarged view of the duct valve of Figure 2 when in the open position;
 25 Figure 6 is an enlarged view of the duct valve of Figure 2 in the closed position;
 Figure 7 is a vertical cross-sectional view of an alternative duct valve in the open position;
 Figure 8 is a view corresponding to Figure 7 in the closed position;
 30 Figure 9 is an enlarged view of the part of the stove and hood of Figure 2 illustrating the sensor arrangement;
 Figure 10 is a block diagram of a first sensor array;
 Figure 11 is a flow chart for the operation of the embodiment of Figure 10;
 Figure 12 is a flow chart for the operation of the embodiment of Figure 10 with timing sensors, and
 35 Figure 13 is an illustration of a zone system for fire and other control.

Detailed Description of the Preferred Embodiments

To refer to Figures 1 and 2, there is illustrated a commercial stove 10 with an exhaust hood 12. Ducting 14 connects the exhaust hood 12 to the outside atmosphere 16. Although a stove 10 is shown, it could be any commercial or industrial equipment that produces or uses smoke and/or fumes and/or noxious gasses, a car park for removing vehicle exhaust fumes, and so forth.

The stove 10 has hobs 18 for use in the cooking of food, and are or more ovens 20 also used in the cooking of food.

The exhaust hood 12 has a control panel 22 for controlling the operation of the exhaust hood 12, including the operation of a fan assembly 24. Although a single fan assembly 24 is shown, there may be two or more fan assemblies. The fan assembly 24 may be of any suitable form or nature. Preferably, the fan assembly 24 is multiple speed.

Also in ducting 14 is a valve 26 that is shown in the open position in Figure 2, and which is adjacent the outlet end 28 of the ducting 14. The outlet end 28 is in the outside and is therefore outside the premises in which stove 10, hood 12 and ducting 14 are located. The outlet end 28 may have a weather cap 30, if required or desired. Valve 26 may be at any location in ducting 14. There may be more than one valve 26 in ducting 14. If ducting 14 is zones, there may be a valve 26 for each zone.

One form of the fan assembly 24 is shown in more detail in Figure 3. The fan assembly 24 may have a shroud 32. The shroud 32 may be spaced from ducting 14, or may be a relatively sealing fit in ducting 14. Non-rotatably mounted within shroud 32 is a drive motor 34 with an output shaft 36. Mounted on output shaft 36 is a fan 38. Motor 34 and fan may be within the shroud 32. Motor 34 is powered by an electric supply cable 40 for rotating shaft 36 and thus fan 38.

Mounted for acting on shaft 36 is a brake 42. Brake 42 is secured to the motor 34 and/or shroud 32 so that it does not rotate relative thereto. Shaft 42 rotates relative to brake 42.

When a prescribed situation such as, for examples, smoke, fumes or heat above a preset density or level is detected in ducting 14 by one or more of smoke, fume or heat detectors 44, 46, and if the motor 34 is on, the motor 34 is immediately switched off and brake 42 applied so that the motor 34 and shaft 36, and thus fan 38, will stop rotating in the shortest possible time. This prevents or stops air flow in ducting 14 due to fan assembly 24. Furthermore, as the air is moving in ducting 14 the air will have momentum. By use of the brake 42, the fan 38 is held stationary. As such, the fan 38 becomes a damper on the movements of air within ducting 14 and this air movement ceases far more speedily. If brake 42 is not applied, the shaft 36 and thus fan 38 would continue to rotate at a decreasing rate, the rate of decrease depending on function within motor 34, the inertia of the fan 38 and the momentum of the air flow in ducting 14 over fan assembly 24. Further, by use of brake 42 the generation of a back EMF by motor 34 is minimized.

The motor 34 and brake 42 are operatively connected to detectors 44, 46 by a wiring loom 48. The detectors 44, 46 may have the same, or different, preset smoke, fume or heat density or other levels. The motor 34 and brake 42 may also be connected to a fire alarm system, so that upon the fire alarm being activated, motor 34 is switched off and brake 42 applied.

An alternative is shown in Figure 4 where in place of the physical brake 42 there is a variable speed drive 43 for the motor 34 to enable motor 34 to have a number of speeds of operation. The variable speed drive 34 includes an electric brake component that operates electrically to stop motor 34. The variable speed drive 43 may be at the motor 34, or may be remote from the motor 34.

Also operatively connected to smoke fume or heat detectors 44, 46 by cable loom 48 is a duct valve 26 located in the ducting 14. The valve 26 may be anywhere in the ducting 14. As shown, it is adjacent the outer end 28 of ducting 14. There may be more than one valve 26 in ducting 14. If ducting 14 is in zones, there may be a valve 26 for each zone, preferably at the boundary of each zone.

The valve 26 is shown in the open position in Figures 2 and 5, and in the closed position in Figure 6. Upon either or both of the smoke detectors 44, 46 operating as described above, a step motor 50 operates to rotate a spindle 52 by 90° so that a valve member 54 is also rotated by 90° from the open position (Figures 2 and 5) to the closed position (Figure 6). Valve member 54 is mounted on spindle 52 to

rotate therewith. The valve member may almost, or substantially, seal the ducting 14 to create static pressure within the ducting 14, and thus to prevent the passage to the outlet end 28 of smoke, fumes or the like.

- 5 The valve member 54 will be sized and shaped to substantially accord to the internal size and shape of the ducting 14. Thus, if ducting 14 is of a circular cross-sectional shape, the valve member 54 will be circular (as shown) and of substantially the same radius. If the ducting 14 is of a square cross-sectional shape, the valve member 54 will also be square and of substantially the same side
10 length.

In this way, upon an excessive level of smoke or fumes in ducting 14 being detected by either or both detectors 44, 46, valve 26 operates to close the outlet end 28 of the ducting 14; and motor 34 is switched off and brake 42 or 43 applied
15 to prevent rotation of fan 38. This prevents, or minimizes, movement of the smoke or fumes within the ducting 14, and can prevent contamination of the outside atmosphere 16 if the smoke or fumes are of a polluting or toxic nature.

As shown in Figure 13, there may be two ducts 14 and 214 for supplying or
20 exhausting air to or from outlets 80 and 280 in a zone 82 of a building. Air supply may be conditioned air. The zone 82 is defined by zone boundary walls 84. Duct valves 86 and 286 are located in ducts 14, 214 respectively. A number of sensors and detectors 44 are located in zone 82 and/or ducts 14, 214 for detecting a prescribed situation in zone 82 and/or ducts 14, 214. The prescribed situation may
25 be the presence of one or more of: smoke, fumes, gas, heat, noxious fumes, and fire. The gas may be of any form including a cooking gas, carbon dioxide and a carbon monoxide. Valves 14, 214 operate as described above if any one of the sensors or detectors 44 is activated. This isolates zone 82 as early as possible so that any fire in zone 82 is starved of oxygen and will thus spread at a slower rate.
30 Similarly, valves 86, 286 may also be linked to and operated by the building fire alarm to prevent the spread of smoke or fumes even if the prescribed situation is not in zone 82.

The control panel 22 may include a "reset" button or switch 56 if required or desired
35 to enable the valve 26 to return to the open position (Figures 2 and 4), for brake 42 to be released and motor 34 switched on, and for resetting the detectors 44, 46.

Figures 7 and 8 show an alternative form of valve 26. Here, the valve member 55 comprises a number of portions 57 hingedly connected together and being biased to the closed position. A stop 59 holds them in the open position against the bias. An electromagnetic motor 51 is used to release the stop 59 to close the duct 14, and to subsequently reopen the duct 14.

In Figures 9 and 10, there is shown a number of possible sensor arrangement for enabling the automatic operative of the fan assembly 24.

In Figure 9, there are three possible sensors 58, 60, 62 operatively connected to fan assembly 24 by wiring loom 48 and control box 68 that contains all necessary control functionality (including relays, and so forth) for the valve assembly 26, fan assembly 24, control panel 22, and the sensors/detectors 44, 46, 58 60 and 62.

Sensor 58 is one or more sensors for heat or temperature, but preferably heat, and located at, on or adjacent hobs 18 so that upon one or more of the hobs 18 being operated to generate heat for cooking, the sensor 58 will operate to switch on fan assembly 24. Upon the heat ceasing, sensor 58 will operate to switch off the fan assembly 24. This may cause repeated, short cycles of operation. As the largest consumption of electricity by fan assembly 24 is at start-up, although this system is effective it may not be electrically efficient. However, this may be applicable for car parks where a combination of heat from engines and exhausts or exhaust fumes may be detected. Also, or alternatively, a time-based system may be utilized to cover peak operational periods.

Senor 60 is somewhat similar to sensor(s) 58 but is located in the hood 12 so that it detects heat from hobs 18. This may reduce the number of sensors required, but may suffer the same problem.

Sensor 62 is a time sensor. With commercial kitchens, and many industrial processors, the period of peak operation is known. For example, a restaurant that is open for lunch from midday to 3pm will have the kitchen preparing foods by cooking from about 11.00am, and will be cooking until about 2.00pm. Therefore, the fan assembly 24 needs to operate from 11.00am to 2.00pm only. Therefore, time sensor 60 will automatically switch on the fan assembly 24 at 11.00am, and automatically switch if off at 2.00pm. The control panel 22 may contain time adjusting knobs 64 for adjusting the on and off times. Within the time period 11.00

am to 2.00 pm, the operating speed of the fan assembly 24 may vary. As shown in Figure 12, at the beginning of operation the fan 28 may be at a first preset speed in the range 25% to 75%, preferably 50%; at a second stage in the timing at a second preset speed in the range 75% to 100%, preferably 80%; and at a third stage at a third speed being full speed.

A further sensor 74 may be provided for sensing a prescribed situation in the interior or environmental space (such as zone 82). The prescribed situation may be the presence of one or more of: smoke, fumes, gas, heat, noxious fumes, and fire. The gas may be of any form including a cooking gas, carbon dioxide and a carbon monoxide.

The control panel 22 may also have a master on switch 66 for manually switching on the fan assembly 24 irrespective of the time or temperature, and a master off switch 66 for manually switching off the fan assembly 24 irrespective of the time or temperature.

Two or more of the sensors 58, 60, 62 may be provided and may be connected in series so that the fan assembly 24 will only operate when all the sensors are active; or in parallel so that the fan assembly will operate when any one or more of the sensors is active.

Figure 10 shows multiple sensors 58 on hobs 18, each hob having a pot support 64. Here the smallest hob 66 has one sensor 58; the small, intermediate hob 68 has two sensors; the two larger, intermediate hob 70 has two sensors 58; and the largest hob 72 has four sensors 58. However, each hob 66, 68, 70 and 72 may have the same number of sensors 58, if required.

As is shown in Figure 11, the fan 28 is preset to start at a predetermined speed when first operational. That may be in the range of 25% to 75%, preferably 50%. When a sensor 58 is activated it determines if one or more sensors 58 have been activated. The sensors 58 may be arranged in groups, if desired. If one sensor 58, or one group of sensors 58, is activated, the fan speed is increased to a second predetermined speed that may be in the range 60% to 80%, preferably 70%. If a second sensor 58, or a second group of sensors 58, is activated the fan speed is increased to a third predetermined speed in the range 75% to 95%, preferably 85%. If all sensors 58, or all groups of sensors 58, are activated, the fan 28 is

increased to full speed. The three-speed operation may be two-speed, four-speed, five-speed, or a continuous speed, if required or desired.

5 In this way the operation of the fan assembly 24 can be controlled in an automatic manner based on the number, nature and location of sensors activates to thus reduce electricity consumption, but still allowing manual override if required or desired. This is applicable in commercial kitchens, car parks, cooling tower fans, production facilities, factories, warehouses, retail centres, offices, or the like.

10 Whilst there has been described in the foregoing description preferred embodiments of the present invention, it will be understood by those skilled in the technology concerned that many variations or modifications in details of design or construction may be made without departing from the present invention.

THE CLAIMS

1. A fan assembly for placement in ducting of a ventilation or exhaust system for an environment space, the fan assembly comprising;
 - 5 (a) a motor having an output shaft;
 - (b) a fan mounted on the output shaft; and
 - (c) a brake mounted for operation on the motor;
 wherein
 - (d) the brake is operable for stopping rotation of the motor upon a
 - 10 detection of a prescribed situation one or more of: the environmental space, and the ducting.
2. A fan assembly as claimed in claim 1, wherein the motor and fan are within a shroud.
- 15 3. A fan assembly as claimed in claim 1 or claim 2, wherein the brake comprises a variable speed drive.
4. A fan assembly as claimed in any one of claims 1 to 3, wherein the
 - 20 prescribed situation may be the presence of one or more of: smoke, fumes, gas, heat, noxious fumes, and fire; and the gas included a cooking gas, carbon dioxide or carbon monoxide.
5. A valve assembly for placement in ducting of a ventilation or exhaust
 - 25 system, the valve assembly comprising:
 - (a) a valve member for placement in the ducting for movement between a first position where the ducting is substantially open, and a second position where the ducting is substantially closed;
 - (b) the valve member being adapted to move from the first position to
 - 30 the second position in response to at least one detection of a prescribed situation.
6. A valve assembly as claimed in claim 5, wherein the valve member is sized and shaped to substantially accord to an interior size and shape of the exhaust ducting.
- 35 7. A valve assembly as claimed in claim 5 or claim 6, wherein the prescribed situation may be the presence of one or more of: smoke, fumes, gas, heat, noxious

fumes, and fire; and the gas includes a cooking gas, carbon dioxide or carbon monoxide.

8. A ventilation or exhaust system comprising:
 - 5 (a) ducting;
 - (b) the fan assembly of any one of claims 1 to 4;
 - (c) the valve assembly of any one of claims 5 to 7 claim 5 or claim 6;
 - (d) at least one detector for detecting a prescribed situation, the
 10 detector being for controlling the operation of the brake of the fan assembly, and
 the valve assembly, in response to the detecting.
9. A system as claimed in claim 8, wherein the valve assembly is located
 near an outlet end of the exhaust ducting.
- 15 10. A system as claimed in claim 8 or claim 9 further comprising a control
 panel comprising a reset control for resetting the at least one detector, releasing
 the brake of the fan assembly, and moving the valve member to the first position.
- 20 11. An system as claimed in any one of claims 8 to 10 further comprising at
 least one sensor for controlling the operation of the fan assembly.
- 25 12. A system as claimed in claim 11, wherein the at least one sensor is at least
 one selected from the group consisting of: at least one time sensor, at least one
 heat sensor, at least one temperature sensor, at least one gas sensor, at least one
 fumes sensor.
13. A system as claimed in any one of claims 8 to 12, wherein there are a
 plurality of sensors arranged in groups.
- 30 14. A system as claimed in claim 13, wherein at least one group of the groups
 of sensors comprises more than one sensor.
15. A system as claimed in any one of claims 8 to 14, wherein a number of
 sensors activated determines the fan assembly operational speed.

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16. A system as claimed in any one of claims 8 to 15, wherein a stage in a time sensor determines a stage in a time sensor determines the fan assembly operational speed.

- 5 17. A ventilation or exhaust apparatus comprising:
- (a) a fan assembly as claimed in any one of claims 1 to 4; and
 - (b) a plurality of sensor for automatically controlling the operation of the fan assembly by controlling the operational speed of the fan assembly in accordance with the number, location or nature of sensors that are activated.

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18. Apparatus as claimed in claim 17, wherein the plurality of sensors is at least two selected from the group consisting of: at least one time sensor, at least one heat sensor, at least one temperature sensor, at least one gas sensor, and at least one fumes sensor.

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19. Apparatus as claimed in claim 17 or claim 18 further comprising at least one of:

- (a) a master on control for overriding the time sensor;
- (b) a master off control for overriding the time sensor; and
- 20 (c) time controls for setting a plurality of preset times for the operation of the time sensor.