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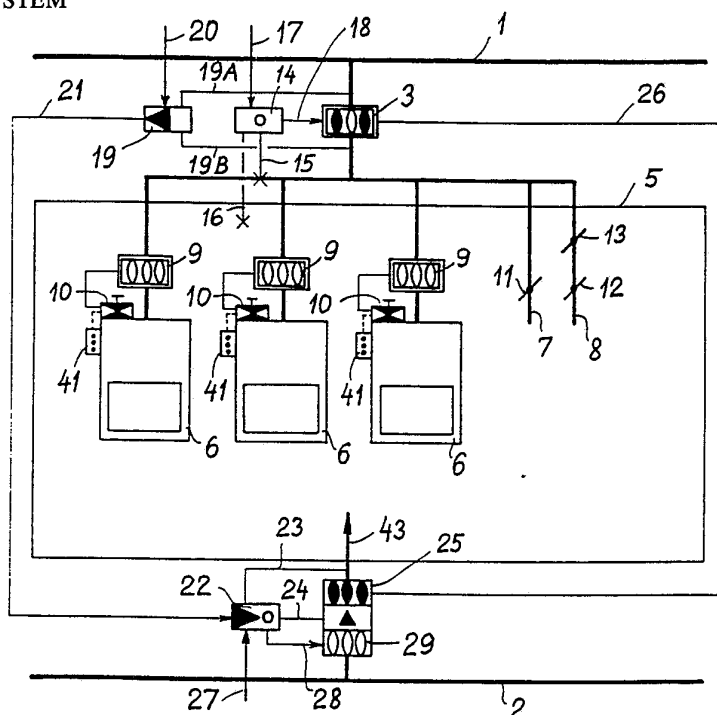
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2631/90 2 November 1990 (02.11.90) DK(71) Applicant (for all designated States except US): NETAVENT
A/S [DK/DK]; Rolighedsvej 53, DK-3500 Værløse
(DK).

(72) Inventor; and

(75) Inventor/Applicant (for US only): CHRISTENSEN, Jørn
[DK/DK]; Nørrevænget 35, DK-3500 Værløse (DK).(74) Agent: LEHMANN & REE A/S; Grundtvigsvej 37, DK-
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(54) Title: VENTILATION SYSTEM



(57) Abstract

In an exhaust system for fume hoods (6) and other exhaust demanding sites comprising an exhaust source (1) connected to the exhaust sites and an air injection source (2) connected to the room accommodating the exhaust sites, a first damper (3) is inserted between the exhaust source and an exhaust duct (4) to which the exhaust sites are connected. The damper is controlled by a first regulator (14) maintaining the pressure constant in the exhaust duct (4). A second identical damper (25) is inserted between the air injection source (2) and the room (5), and both dampers (3, 25) are controlled in such a manner that their openings are always equal. A third regulating damper (29) is inserted in series with the second damper (25) and is responsive to the difference between the pressure drops over the first and second dampers.

+ DESIGNATIONS OF "SU"

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Ventilation system

The present invention relates to a ventilation system comprising an air injection source and an air exhaust source which are connected to rooms or zones to be ventilated, in which a first damper is inserted between the exhaust source and an exhaust duct which is connected to the room(s) or zone(s), and a second damper is inserted between the air injection source and an air injection duct which is connected to the room(s) or zone(s).

In ventilation systems of various types, such as air conditioning systems and exhaust systems in work premises, staff rooms, laboratories, etc., injection and exhaust of approximately equally large but varying volumes of air are required in order to maintain the air balance in the rooms or "zones" which may comprise several rooms, hoods, cabinets, cupboards, etc.

Thus, in air conditioning systems air having a desired temperature is injected through adjustable air injection fittings, the volume of air being controlled by room temperature regulators responsive to the need for air, which most often means the need for cooling. In a prior art air conditioning system a common pressure-controlled air injection duct provides the individual air injection fittings with air, and air is exhausted from the individual rooms through a non-pressure-controlled duct. In case of small volumes of air, accurate control of the volume of exhaust air in the individual rooms is often not necessary. However, by means of uniformly controlled dampers in the injection and in the exhaust it is possible to throttle the total volumes of injection and exhaust air in such a manner that the volume of exhaust air becomes almost equal to the volume of injection air. On the other hand, an accurate control of the volume of air with either overpressure, underpressure or air balance cannot be obtained with the prior art system.

In laboratories and other rooms where working processes require air exhaust from fume hoods and from other confined work sites in the room and optionally a general exhaust from the room, it is important for safety reasons to be able to control the air velocity in the exhaust and the pressure conditions or the air balance in the room.

As very considerable volumes of air may be needed for the exhaust and as the air is taken from the room, there is a need for an air injection into the room which substantially corresponds to the exhaust in order to maintain the air balance mentioned above, as
5 undesirably high overpressures or underpressures may result in heavy draft nuisances in the adjoining rooms, corridors, elevator shafts etc, and make it difficult to open and close doors and windows. However, in certain situations it may be desirable to work with a slight overpressure or underpressure in the room.

10

The volumes of required exhaust air vary very strongly depending on the work processes performed in the fume hoods or in the laboratory and, therefore, there is of course a need for regulating the total volumes of exhaust air and injection air within a very wide range
15 and simultaneously.

In case of only a single exhaust site, e.g. a fume hood, a connected exhaust ventilator and an air injection ventilator may be directly controlled from the hood by means of door position sensors or by
20 potentiometers regulated by the door (or sash), the potentiometer gradually or continuously regulating the respective ventilators responsive to the door opening. Such sensors may also be used to shift the regulating dampers in the exhaust and in the injection between several positions.

25

However, in case of several fume hoods and/or other exhaust sites with a common exhaust source, the above mentioned solution is not applicable. The volume of exhaust air at the individual sites may then be regulated by means of e.g. adjustable dampers, but this
30 partly results in that the pressure drop available at a given exhaust site will vary depending on the consumption of air at the other sites, and partly that at times where there is a high total consumption of air, the dampers will have to absorb the corresponding very high pressure drop at exhaust sites having a
35 small consumption of air at the time in question. In practice, the dampers are usually not capable of this and it would also result in i.a. great noise problems.

To avoid a leakage of poisonous fumes etc. from fume hoods or local

exhausts, the air velocity should not be allowed to become too low, when the door of the hood is opened or when other exhaust sites are used. Vice versa, a too high air velocity will also be unacceptable, when the door of the hood is partially closed or when other exhaust sites are stopped. Thus, the various fume hoods or local exhausts or other exhaust sites in the room should not be allowed to influence one another even in case of very large variations in the total volume of exhaust air required.

The regulation of the volumes of exhaust and injection air might be based on a measurement of the air pressure in the room(s), but this is not practically feasible due to the particularly small pressure differences between the room or rooms and the ambient air, in particular in case a door or a window is opened.

By measuring the total volume of air in the exhaust it is possible to correctly adjust the volumes of injection air and thereby to obtain the above mentioned air balance in the room. Measurement of air volume per time unit (m^3/h) is ordinarily carried out by measuring the pressure drop across measuring orifices. An example thereof is disclosed in EP-A1 040086. As the pressure drop across a measuring orifice is proportional to the square root of the air volume per time unit, and as very large volumes of air and variations in volumes of air are involved in the use of e.g. fume hoods and other exhausts as mentioned above, e.g. ranging from a very small value, when the door of the hood is almost closed, to e.g. a value twenty times as high, when the door is opened to the working position, the measuring orifice is unsuitable for providing merely fairly correct measuring values for the entire variation area of the pressure drop as required. Thus, the same restriction in the use is involved as in case of regulating dampers, and if they were to be used over a regulation range as large as required, it would result in highly unacceptable losses of energy when a large volume of air is needed.

WO-A 90/08293 discloses an air conditioning system in which adjustable air inlet dampers and air outlet dampers are controlled by means of a computer according to preset control programmes based on i.a. pressure and temperature measurements, damper position

signals and air resistance coefficients. Apart from the fact that measuring sensors in air ducts ordinarily do not function correctly for longer periods of time as a result of i.a. soiling, the prior art system requires complicated electronics, just as it is complicated to operate and, therefore, easily becomes subject to errors and malfunctions.

It is the object of the present invention to provide a ventilation system of the type mentioned above which is capable of fulfilling the above mentioned needs while avoiding the drawbacks associated with the prior art, and according to the invention this is obtained by the fact that the first and second dampers are identical, that one damper is controlled by means of a first regulator which is arranged to maintain the pressure substantially constant in the duct connected to the damper in question, that the two dampers are controlled in such a manner that their openings are always equal, and that a third damper is inserted in series with the other of the two dampers and is controlled responsive to the difference between the pressure drops over the one or the other dampers.

Thus, as identical regulation dampers which always assume the same degree of opening are used on the exhaust side and on the air injection side, the air injection/exhaust can readily be caused to follow the exhaust/injection to the desired degree, as the third damper then only needs to regulate on the difference between the two pressure drops, which difference is set to a value of zero or different from zero depending on which air balance state is desired in the room. By maintaining a constant pressure in the exhaust duct it is furthermore possible to directly connect several exhaust sites, fume hoods, local exhausts and basic exhausts to the exhaust duct without causing them to influence each other. Furthermore, the invention results in that it becomes possible to operate with relatively small pressure drops over the individual dampers, and consequently they are capable of performing an accurate regulation within their normal working field.

In an embodiment of the ventilation system for air conditioning in which the injection air is supplied to injection fittings which are controlled by room regulators, a pressure regulator may according to

the invention regulate the second damper in a manner known per se so that the pressure in the injection duct is maintained substantially constant.

5 In an embodiment of the ventilation system for exhaust from fume hoods and other exhaust demanding sites, according to the invention the fume hood(s) and the exhaust demanding sites are connected to the exhaust duct, a pressure regulator regulates the first damper in such a manner that the pressure in the exhaust duct is maintained
10 substantially constant, and the air injection duct is connected to the room in which the fume hood(s) and the exhaust demanding sites are located.

An expedient embodiment of the ventilation system according to the
15 invention is characterized in that a pressure transmitter is inserted over the first damper to measure the pressure drop over this damper and hence the volume of exhaust air in the exhaust duct and the volume of injection air in the air injection duct, respectively, at a given opening of the damper, a second pressure
20 regulator is inserted over the other and the third dampers, which second regulator is connected to the pressure transmitter and arranged so as to partly measure the pressure drop over the other damper and hence the volume of injection air and the volume of exhaust air, respectively, at a given opening of the damper and
25 partly to regulate the opening of the third damper accordingly and responsive to the signal from the pressure transmitter. This construction is advantageous in that in addition to performing the regulation the dampers may also be used as measuring orifices due to the relatively limited but varying pressure drops over the dampers.

30 The second regulator may be manually adjustable according to the invention so that the ratio of the volumes of exhaust air and of injection air can be adjusted, thereby making it possible to select between a completely neutral air balance or an overpressure or an
35 underpressure in the room.

In a particularly advantageous embodiment according to the invention the dampers are pneumatic, and the pneumatic connections of the first and the second dampers are coupled together. In this manner,

it is ensured in a very simple way that the openings of the dampers are always completely equal.

5 According to the invention each fume hood may be connected to the exhaust duct via an adjustable damper which is controlled by a regulator having one air velocity sensor mounted in an opening in the hood. As the system is capable of operating with a relatively limited but constant pressure in the exhaust duct, the damper can handle the varying needs for air without difficulties depending on
10 the degree of the opening of the door. The air velocity sensor senses the front velocity in the opening irrespective of the location of the sensor and irrespective of whether the door opening happens to be partly blocked by the laboratory assistant or for any other reason. Thus, the desired front velocity in the opening of the
15 hood is always secured by means of the regulator which may be adjustable. As mentioned above the influence from other exhaust sites is eliminated as each fume hood constitutes an independent regulation circuit.

20 In order to obtain a rapid and independent verification of the function of the exhaust, an additional air velocity sensor may be disposed in a second opening in the hood, which sensor is connected to an electric monitoring circuit which is arranged to emit a visible and/or audible signal indicating the air velocity.

25 According to the invention a light panel in the form of a semaphore with green, yellow and red lights may be coupled to the monitoring circuit and be arranged to indicate the magnitude of the air velocity. As a result, the laboratory staff is alerted in a well
30 known and safe manner in case of an emergency.

In a further embodiment of the exhaust system according to the invention a three-way valve, which is inserted in the compressed air supply for the pneumatic damper before the fume hood, is connected
35 to the electric monitoring circuit and arranged to be shifted to a position which relieves the pressure from the damper so as to allow it to open to a maximum when the air velocity sensed by the additional sensor drops below a certain value. The particular advantage of the pneumatic damper, viz. that it opens to a maximum

position by itself in case of malfunction in the air supply, is thereby utilized. Furthermore, the monitoring system is used at the same time as an active security system in case the regulation system fails.

5

In order to ensure that the monitoring system always produces a correct indication of the air velocity into the hood, the additional air velocity sensor in an embodiment of the system according to the invention is directional, the sensing element of the air velocity
10 sensor being shielded towards the interior of the hood by a plate which prevents an outward air flow from affecting the sensor. Such an outward air flow may occur in case of a hot process in the hood without sufficient air exhaust.

15 The invention will now be explained in further detail with reference to the drawings wherein

Fig. 1 shows an embodiment of an air conditioning system according to the invention,

20

Fig. 2 a diagram of an embodiment of an air exhaust and injection system according to the invention for a room with several fume hoods and other exhaust sites, and

25 Fig. 3 a fume hood with schematically indicated regulating and monitoring systems according to the invention.

In the drawings Fig. 1 shows a room or a zone 55 comprising several rooms in which the air is to be conditioned. From an injection
30 source 51 in the form of an air injection main duct connected to a air injection ventilator, air is directed through a pneumatic damper 56 to an injection duct 57 which is common for all injection sites 60 in the zone 55. The injection sites, which may be in the form of motorized air injection fittings 60 as shown, are regulated by room
35 temperature regulators 61 responsive to the need for air. In modern, highly insulated, air-tight buildings injection air having a temperature below the ambient temperature is ordinarily used in order to obtain a necessary cooling.

An exhaust source 52 in the form of an exhaust main duct is connected to an exhaust duct 54 via pneumatic dampers 53,59, the exhaust duct exhausting air from the zone 55 through the exhaust sites 62.

5

A duct pressure regulator 58 which as shown measures the pressure in the duct 57 and in the zone 55 is supplied with compressed air through a conduit 63 and controls the damper 56 via a compressed air connection 64 responsive to the pressures measured so as always to maintain a substantially constant but adjustable pressure in the air injection duct 57.

In addition to regulating the pressure in the duct 57, the damper 56 is also used as a measuring orifice, as a pressure transmitter 19 measures the pressure drop over the damper 56 via hoses 19A and 19B. The pressure transmitter 19 is supplied with compressed air via a conduit 20 and emits an output signal via a conduit 21 responsive to the pressure difference measured over the damper 56.

The signal on the conduit 21 is transmitted to a second pressure regulator 22 which by means of measuring hoses 23 and 24 measures the pressure drop over the pneumatic damper 53 which is completely identical with the damper 56 on the injection side and which is controlled by the regulator 58 in the same manner as will appear from Fig. 1. In other words, the openings of the two dampers are always precisely equal.

The regulator 22 which is supplied with compressed air through a conduit 27 is arranged to control an additional pneumatic damper 59 via a compressed air connection 28 responsive to the difference between the measured pressure drops over the combined measuring orifice/dampers 53 and 56. As the openings thereof are always equal as mentioned above, the injected and exhausted volumes of air will be equally large, if the pressure drops over them are equal. The damper 59 inserted between the exhaust main duct 52 and the damper 53, therefore, ensures by air balance in the zone 55 that exactly the same volume of air is exhausted through the damper 53 as is totally injected through all the air injection fittings 60. The pressure regulator 22 may be adjustable so as to allow an

underpressure or overpressure to be maintained in the zone 55 by exhausting more or less air, respectively, than is injected.

5 The diagram in Fig. 2 shows an exhaust source 1 in the form of a main duct connected to an exhaust ventilator (not shown), the main duct optionally forming part of a larger air conditioning system in a building. A corresponding air injection source 2 which is connected to an injection ventilator (not shown) is shown as an injection main duct.

10 An exhaust duct 4 is connected to the main duct 2 via a pneumatic damper 3. The exhaust duct 4 is common for all exhaust sites in a room 5. Thus, Fig. 2 shows three fume hoods 6, a basic exhaust site 7 and a local exhaust 8 which are all connected to the duct 4. It
15 will be understood that there may be any number of the different exhaust sites.

The fume hoods 6 are connected to the common exhaust duct 4 via a pneumatic damper 9 which is controlled by a regulator 10 on each
20 hood as further explained below. The basic exhaust 7 and the local exhaust 8 are coupled to the exhaust duct 4 via a simple on-off damper 11 and 12, respectively. The Figure further shows a pre-adjustment damper 13 in connection with the local exhaust to adjust the volume of air therefore once and for all.

25 In a similar manner as Fig. 1, Fig. 2 furthermore shows a duct pressure regulator 14 which as shown measures the pressure in the duct 4 and in the room via the connection hoses 15 and 16, respectively. The regulator 14 is supplied with compressed air via a
30 conduit 17 and controls the damper 3 via a compressed air connection 18 responsive to the measured pressures. The regulator is arranged in such a manner as always to maintain a constant, adjustable pressure in the exhaust duct 4.

35 In addition to regulating the pressure in the duct 4, the damper 3 is also used as a measuring orifice, a pressure transmitter 19 measuring the pressure drop over the damper 3 by hoses 19A and 19B. The pressure transmitter 19 is supplied with compressed air via a conduit 20 and emits an output signal via a conduit 21 responsive to

the pressure difference measured over the damper 3.

5 The signal on the conduit 21 is transmitted to a second pressure regulator 22 which via measuring hoses 23 and 24 measures the pressure drop over a pneumatic damper 25 which is completely identical with the damper 3 on the exhaust side and is connected to said damper via a compressed air hose 26 in such a manner that the openings of the two dampers are always precisely equal. From the damper 25 the injection air is directed into the room 5 through an
10 injection duct 43.

The regulator 22, which is supplied with compressed air via a conduit 27, is arranged to control an additional pneumatic damper 29 via a compressed air connection 28 responsive to the difference
15 between the measured pressure drops over the combined measuring orifice/dampers 3 and 25. As the openings of these dampers are always equal as mentioned above, the injected and exhausted volumes of air will be equally large, if the pressure drop over them are equal. The damper 29 inserted between the exhaust main duct 2 and
20 the damper 25 ensures by air balance in the zone 5 that exactly the same volume of air is supplied to the damper 25 as is totally exhausted from all connected exhaust sites 6,7 and 8. The pressure regulator 22 may be adjustable so as to allow an underpressure or overpressure to be maintained in the room 55 by supplying more or
25 less air, respectively, than is exhausted.

Fig. 3 shows a fume hood 6 with a regulation system and a monitoring system. The above mentioned pneumatic damper and the appertaining regulator are indicated at 9 and 10. The opening 30 of the hood is
30 shown partly closed by a door 31 or sash. The air velocity present in the door opening in connection with exhaust through the damper 9 is also present in openings at other places of the hood. Thus, a pneumatic air velocity sensor 32 disposed in an opening 33 in the upper side of the hood is shown. This sensor is connected to the
35 regulator 10 which directs compressed air from an air conduit 34 to the damper via a control conduit 35 to control the damper responsive to the measured air velocity so that a constant value is always maintained which though may be adjusted by the regulator 10.

The monitoring system shown in Fig. 3 comprises an air velocity sensor 37 located in a bore 36 in the upper side of the hood, said air velocity sensor having an electric sensor element 38 which is shielded in direction towards the interior of the hood by a plate 39 so as to prevent it from being influenced by any outward directed air flow in case of a failure of the exhaust system. This sensor 37 which as the sensor 32 may be located at other places on the hood measures as the sensor 32 and completely independently of the latter sensor the air velocity in the door opening 30 irrespective of the size of the opening of the hood and irrespective of whether the opening is covered more or less by the laboratory assistant or in any other way.

The sensor 37 is connected to an electric monitoring circuit 40 which responsive to the air velocity measured in the hood delivers electric signals both to a light and sound indicator 41 located on the hood 6 and to a three-way valve 42 inserted in the air conduit 35 to the regulating damper 9, the valve shifting position from the position shown in the drawing on receipt of a signal from the circuit 40 into another position, in which the conduit 35 to the damper 9 is connected to the atmosphere so that the damper obtains its maximum opening position in order to immediately obtain a maximum exhaust. The signal for rapid opening of the damper is emitted by the circuit 40 when the air velocity drops below a preset value, where there may be danger of a leak from the hood.

The light and sound indicator 41 is arranged as a semaphore with green, yellow and red lights, where the green light(s) is(are) on when the air velocity has a correct, safe value. If the velocity drops, the yellow and red lights will gradually be lit as an indication of dangerously low air velocities.

As an example, an air velocity in the door opening of a fume hood of about 0.5 m/sec. is considered to be suitable, and the yellow and red lights are then lit at velocities of 0.4 and 0.2 m/sec. The sound signal may be released at the velocity where either the yellow or the red light is lit, and the three-way valve may be shifted at one of these velocities.

Thus, it will be understood that the independent regulating and monitoring systems result in a very high degree of safety in the laboratory work as the exhaust velocity at all exhaust sites can be maintained constant irrespective of what is going on at the other exhaust sites. It is noted that no regulating damper is required for the basic exhaust 7 and the local exhaust 8, as the volume of exhaust air is constant due to the constant pressure in the common exhaust duct 4.

It is noted that whereas the door position sensors in some of the prior art fume hoods are located in the front opening, the front opening of the present fume hood is kept completely clear, as the said air velocity sensors are located on the upper side of the hood or on the side walls. It is further noted that the pneumatic dampers used have a neat linear characteristic as opposed to e.g. pivot dampers or other mechanical dampers which require movable pull rods or the like, and which besides suffer from the drawback that they are relatively easily blocked. Furthermore, the pneumatic dampers are particularly safe as they automatically open completely in case of failure of the air supply or in case the control air vanishes from the system for any other reason.

It is further noted that sensors are only used on an incoming air flow, whereas there are no sensors in the exhaust air flow which may contain aggressive vapours. Finally, it is added that the entire exhaust and air injection system with the described regulation of the volumes of exhaust and injection air is completely independent of whether doors or windows of the room are opened or closed, as it is always ensured that the volume of injection air exactly corresponds to the volume of exhaust air.

P a t e n t C l a i m s

1. A ventilation system comprising an air injection source (2,51) and an air exhaust source (1,52) which are connected to rooms or zones (5,6,7,8,55,62) to be ventilated, in which a first damper (3,53) is inserted between the exhaust source (1,52) and an exhaust duct (4,54) which is connected to the room(s) or zone(s) (5,6,7,8,55,62) and a second damper (25,56) which is inserted between the air injection source (2,51) and an injection duct (43,57) which is connected to the room(s) or zone(s) (5,6,7,8,55,62), characterized in that the first (3,53) and second dampers (25,56) are identical, that one damper (3,56) is controlled by means of a first regulator (14,58) which is arranged to maintain the pressure substantially constant in the duct (4,57) connected to the damper (3,56) in question, that the two dampers (3,25,53,56) are controlled in such a manner that their openings are always equal and that a third damper (29,59) is inserted in series with the other (25,53) of said two dampers and is controlled responsive to the difference between the pressure drops over said one (3,56) and said other dampers (25,53).

2. A ventilation system according to claim 1 for air conditioning in which the injection air is supplied to injection fittings (60) which are controlled by room regulators (61), characterized in that a pressure regulator (58) regulates the second damper (56) in a manner so as to maintain the pressure in the air injection duct (57) substantially constant.

3. A ventilation system according to claim 1 for exhaust from fume hoods (6) and other exhaust demanding sites (7,8), characterized in that the fume hood(s) (6) and the exhaust demanding sites (7,8) are connected to the exhaust duct (4), that a pressure regulator (14) regulates the first damper (3) in a manner so as to maintain the pressure in the exhaust duct (4) substantially constant, and that the air injection duct (43) is connected to the room (5) in which the fume hood(s) (6) and the exhaust demanding sites (7,8) are located.

4. A ventilation system according to claims 1, 2 or 3,

characterized in that a pressure transmitter (19) is inserted over said one damper (3,56) to measure the pressure drop over said damper and hence the volume of exhaust air in the exhaust duct (4) and the volume of injection air in the air injection duct (57), respectively, at a given opening of the damper, and that a second pressure regulator (22) is inserted over said other and said third dampers (25,29,53,59), which second regulator (22) is coupled to the pressure transmitter (19) and arranged to partly measure the pressure drop over said other damper (25,53) and hence the volume of injection air and the volume of exhaust air, respectively, at a given opening of the damper and partly to regulate the opening of the third damper (29,59) accordingly and responsive to the signal from the pressure transmitter (19).

5. A ventilation system according to claim 4, characterized in that the second regulator (22) is manually adjustable in a manner which allows the ratio of the volumes of exhaust air and of injection air to be adjusted.

6. A ventilation system according to any of the preceding claims, characterized in that the dampers (3,9,25,29,53,56,59) are pneumatic and that the compressed air connections of said first and second dampers (3,25,53,56) are coupled together.

7. A ventilation system according to any of the claims 3-5, characterized in that each fume hood (6) is connected to the exhaust duct (4) via an adjustable damper (9) which is controlled by a regulator (10) having an air velocity sensor (32) mounted in an opening (33) in the hood.

8. A ventilation system according to any of the claims 3-7, characterized in that an additional air velocity sensor (37) is disposed in a second opening (36) in the hood, which sensor is coupled to an electric monitoring circuit (40) which is arranged to emit a visible and/or audible signal indicating the air velocity.

9. A ventilation system according to claim 8, characterized in that a light panel (41) in the form of a semaphore with green, yellow and red lights is coupled to the monitoring circuit

(40) and is arranged to indicate the magnitude of the air velocity.

10. A ventilation system according to claim 7,8 or 9, c h a r a c -
t e r i z e d in that a three-way valve (42) inserted in the
5 compressed air supply (35) for the pneumatic damper (9) is connected
to the electric monitoring circuit (40) and is arranged to be
shifted to a position which relieves the pressure from the damper
(9) so as to allow it to open to a maximum when the air velocity
sensed by the additional sensor (37) drops below a preset value.

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11. A ventilation system according to claim 8,9 or 10, c h a r -
a c t e r i z e d in that the additional air velocity sensor (37)
is directional, the sensing element (38) of the sensor being
shielded towards the interior of the hood by a plate (39) which
15 prevents a outward air flow from affecting the sensor.

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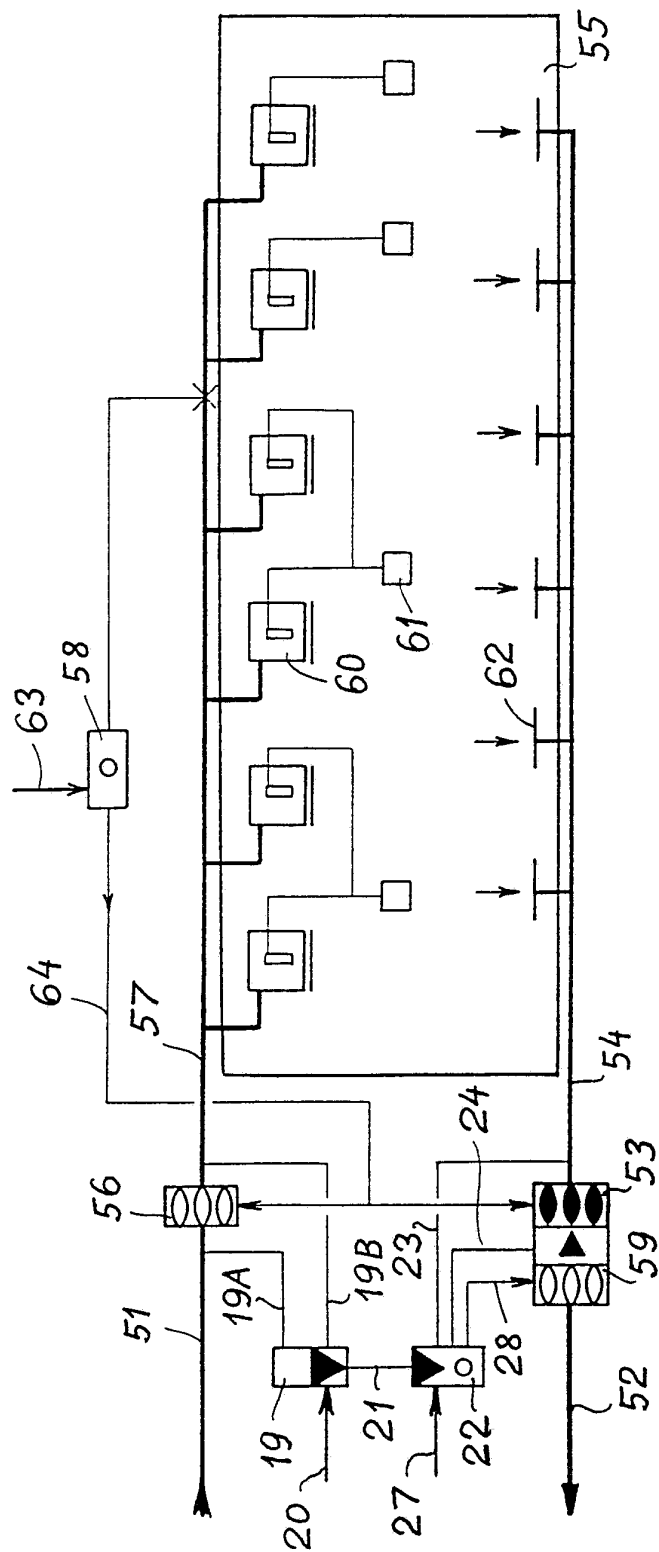


FIG. 1

2/3

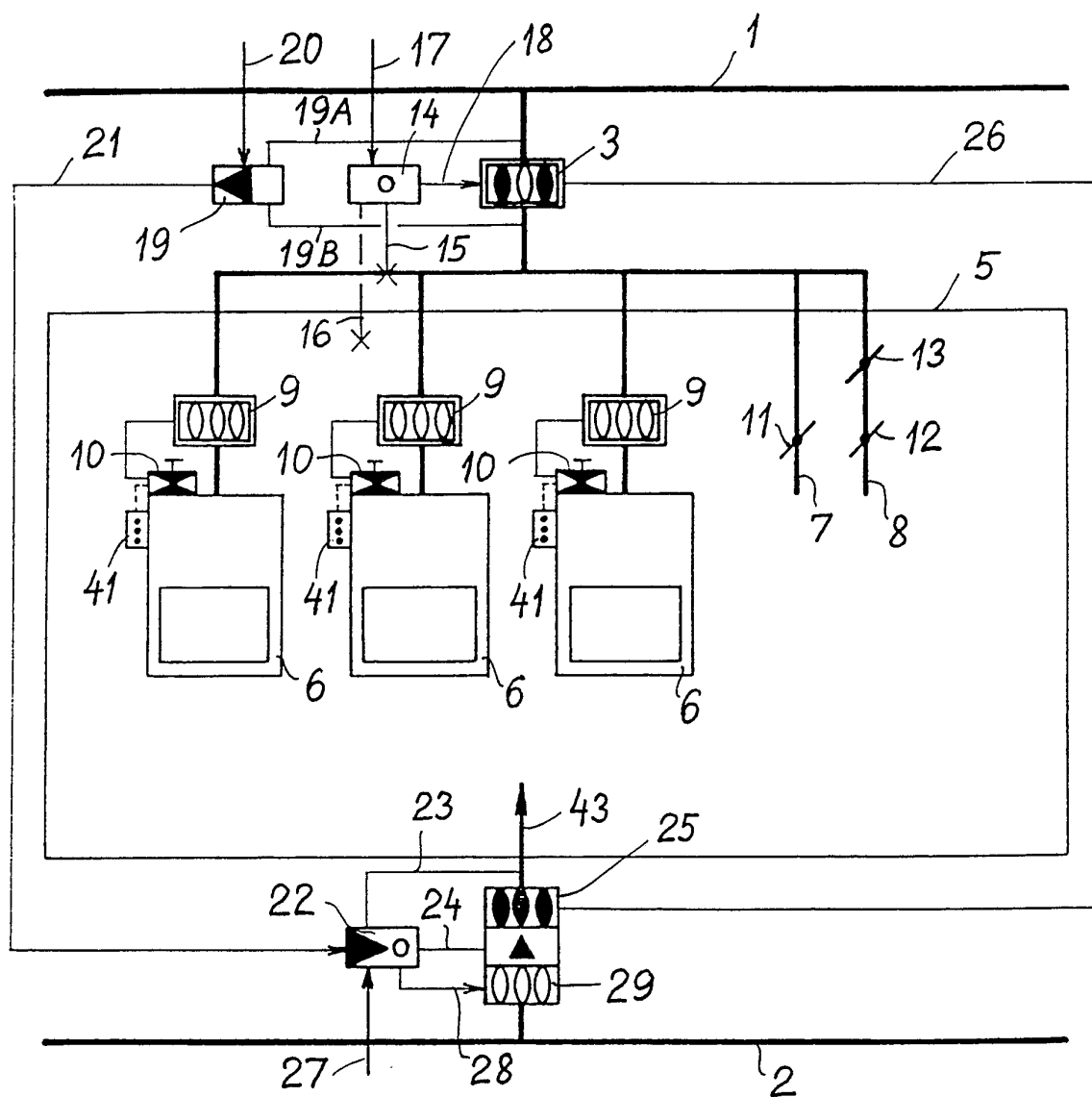


FIG. 2

3/3

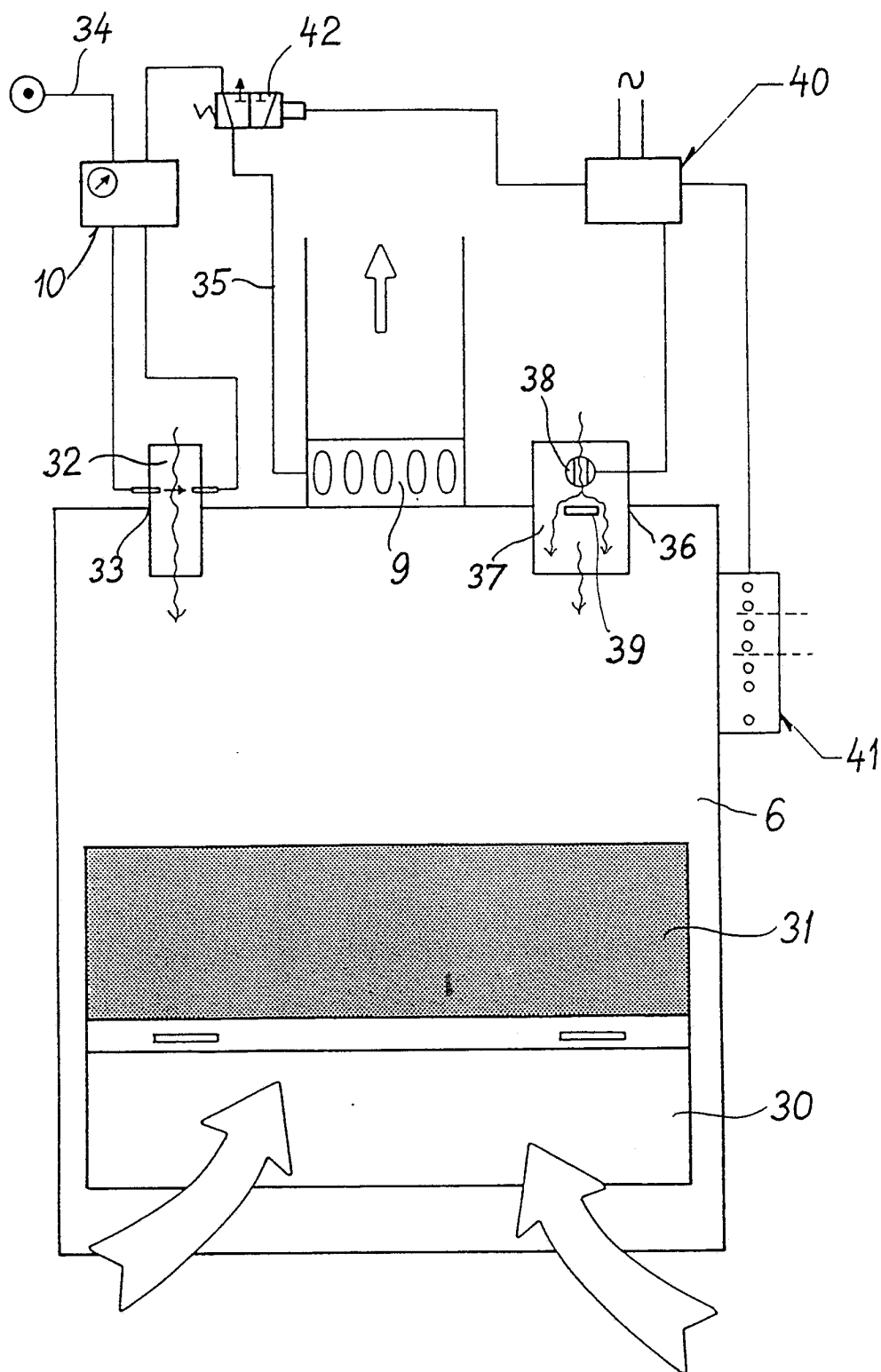
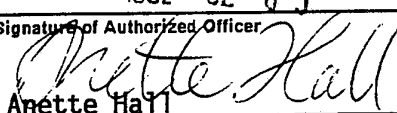
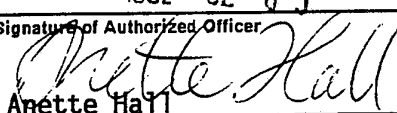
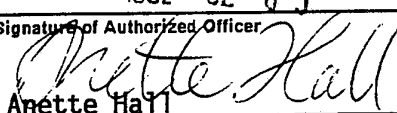


FIG. 3

SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International Application No PCT/DK 91/00328

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: F 24 F 11/04, B 08 B 15/02														
II. FIELDS SEARCHED Minimum Documentation Searched⁷ <table style="width: 100%; border: none;"> <tr> <td style="width: 25%; border: none;">Classification System</td> <td style="border: none;">Classification Symbols</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">IPC5</td> <td style="border: 1px solid black; padding: 5px;">F 24 F; B 08 B</td> </tr> </table> Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched⁸ SE,DK,FI,NO classes as above			Classification System	Classification Symbols	IPC5	F 24 F; B 08 B								
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IPC5	F 24 F; B 08 B													
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Category *</th> <th style="width: 70%;">Citation of Document,¹¹ with indication, where appropriate, of the relevant passages¹²</th> <th style="width: 20%;">Relevant to Claim No.¹³</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>US, A, 4497242 (MOYER) 5 February 1985, see the whole document ---</td> <td></td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>WO, A1, 8101455 (THE COMMONWEALTH OF AUSTRALIA) 28 May 1981, see the whole document ---</td> <td></td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>GB, A, 2136560 (A.C. PLASTIC INDUSTRIES LIMITED) 19 September 1984, see the whole document -----</td> <td></td> </tr> </tbody> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	A	US, A, 4497242 (MOYER) 5 February 1985, see the whole document ---		A	WO, A1, 8101455 (THE COMMONWEALTH OF AUSTRALIA) 28 May 1981, see the whole document ---		A	GB, A, 2136560 (A.C. PLASTIC INDUSTRIES LIMITED) 19 September 1984, see the whole document -----	
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A	GB, A, 2136560 (A.C. PLASTIC INDUSTRIES LIMITED) 19 September 1984, see the whole document -----													
* Special categories of cited documents:¹⁰ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family														
IV. CERTIFICATION <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none;">Date of the Actual Completion of the International Search</td> <td style="width: 50%; border: none;">Date of Mailing of this International Search Report</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">3rd February 1992</td> <td style="border: 1px solid black; padding: 5px;">1992 -02- 05</td> </tr> <tr> <td style="border: none;">International Searching Authority</td> <td style="border: none;">Signature of Authorized Officer</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px; text-align: center;">SWEDISH PATENT OFFICE</td> <td style="border: 1px solid black; padding: 5px; text-align: center;">  Anette Hall </td> </tr> </table>			Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	3rd February 1992	1992 -02- 05	International Searching Authority	Signature of Authorized Officer	SWEDISH PATENT OFFICE	 Anette Hall				
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International Searching Authority	Signature of Authorized Officer													
SWEDISH PATENT OFFICE	 Anette Hall													

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. PCT/DK 91/00328**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 30/11/91. The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4497242	85-02-05	CA-A- 1180590	85-01-08
WO-A1- 8101455	81-05-28	AU-B- 550053	86-02-27
		CA-A- 1161140	84-01-24
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		US-A- 4485729	84-12-04
		AU-D- 6482480	81-06-03
GB-A- 2136560	84-09-19	DE-A- 3408507	84-09-13