



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) Publication number:

0 290 702 B1

(12)

EUROPEAN PATENT SPECIFICATION

(43) Date of publication of patent specification: **13.11.91** (51) Int. Cl.⁵: **F24F 3/16, F24F 3/14**

(21) Application number: **87420127.0**

(22) Date of filing: **14.05.87**

(54) **Air conditioning unit.**

(43) Date of publication of application:
17.11.88 Bulletin 88/46

(45) Publication of the grant of the patent:
13.11.91 Bulletin 91/46

(84) Designated Contracting States:
AT CH DE ES FR GB IT LI SE

(56) References cited:
US-A- 1 749 763
US-A- 3 975 995
US-A- 4 608 066
US-A- 4 667 580

KLIMAAT BEHEERSING, vol. 12, no. 10, October 1983, pages 303-306, Zeist, NL; E. WELZL: "Klimaatbeheersing van moderne operatieruimten"

(73) Proprietor: **CLESTRA HAUSERMAN, S.A.**
56 rue Jean Giraudoux
F-67200 Strasbourg-Koenigshoffen(FR)

(72) Inventor: **Wetzel, Lawrence E.**
3590 Watervale Road
Manlius, NY 13104(US)

(74) Representative: **Laurent, Michel et al**
Cabinet LAURENT et CHARRAS, 20, rue Louis
Chirpaz B.P. 32
F-69131 Ecully Cedex(FR)

EP 0 290 702 B1

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

Description

Background of the Invention

This invention relates generally to controlled environment chambers, and has particular reference to an improved construction for a clean room module air conditioning unit.

With the growth of high technology industries, the need for contamination free work areas has greatly increased. This has led to the development of completely enclosed work areas, known as clean rooms, in which the environment is closely controlled to rid the ambient air of contaminants. Hereofore, most clean rooms have been built on site and this had led to inefficiencies and other problems.

More recently, modular type clean rooms have been developed wherein the principal components of the room are prefabricated at the factory and then are assembled on site. The modular constructions are more efficient and have fewer problems than the completely on site constructions but some problems do remain. An example of a modular type clean room is disclosed in U.S. Patent No. 4,409,889, issued October 18, 1983 to M. L. Burleson. A prefabricated knockdown clean room is disclosed in U.S. Patent No. 4,267,769, issued May 19, 1981 to G.B. Davis et al.

It has also been described in US-A-1,749,763 an unit in which by-pass air and make-up air are mixed and fed to an air conditioning elements. Nevertheless, it does not feed the by-pass air to an inlet of a fan or blower, but to a chamber following the blower. Thus, there is no attempt to maintain a constant volume air flow through the air conditioning elements. Furthermore, there is not attempt to automatically control the make-up air damper.

Other patents noted in a preliminary search are U.S. Patent Nos. 2,559,654 ; 3,505,989 ; 3,601,031 ; 3,766,844 ; 4,044,772 and 4,202,676.

SUMMARY OF THE INVENTION

The present invention provides a self-supporting, self-contained air conditioning unit according to claim 1, connected with a clean-room module having all of the equipment necessary for maintaining the temperature, humidity and pressurization that are required for the work space within the room. This air conditioning unit can be easily incorporated in the module as a whole.

An important feature of this unit, not found in any of the prior art cited above, is the provision of two independent air system or paths whereby only a portion of the recirculating air need to be conditioned as will be explained in greater detail hereinafter. This original feature of the air con-

ditioning unit saves energy and gives better operating control.

The invention also relates to a clean room module combining a self-contained conditioning unit disclosed above. This conditioning unit may be a component of the entire unit or separated for other uses. This clean room module is factory built rather than built on site, and then precise quality control can be achieved and each module can be thoroughly tested before shipment. This obviously is advantageous to the end user who can avoid the problems and inefficiencies of a field erected, one-of-a kind clean room.

An important feature of the invention, not found in any of the prior art cited above, is the provision in the module of its own sealed base unit. This base unit permits the module to be moved or relocated without having to be disassembled and also insures that the module will have a completely sealed sump area beneath its floor. Obtaining such a sealed area or plenum is difficult when the clean room is constructed or assembled on site.

An important object of this invention therefore is to provide a modular clean room, which will be a self-contained unit, with all the mechanical equipment necessary to control the air temperature, humidity, pressurization and cleanliness inside the space provided.

Another object of this invention is to provide a mobile modular clean room the base unit of which will include casters that can be cranked up and down to enable the invention to be rolled into position and set into place.

Another object of this invention is provide a modular clean room which will be so designed as to meet or exceed the U.S.A. Federal Standard 290B for a Class 100 Clean room. This means that there can be no more than 100 particles 0.5 microns in size and no more than four particles 2.0 microns in size per cubic foot (i.e. per 0.028 cubic metre).

A further object of this invention is to provide a modular clean room which will be so designed as to have its return floor plenum sealed underneath and epoxy coated to contain any chemical spills through the unit's perforated raised tiles.

Another object of this invention is to provide a modular clean room that can be moved or relocated as a complete unit, it only being necessary to disconnect electric, water and drain lines.

Other objects are to provide a mobile modular clean room, which is simple in design, inexpensive to manufacture, rugged in construction, easy to use and efficient in operation.

Yet another object of this invention is to provide modular clean rooms which can be joined to one another to form a multiple unit clean room with a minimum of labor and without extensive or com-

plex modifications.

It is still another object of this invention to provide such modular clean rooms whose air conditioning units can be connected together in a master/slave configuration to ensure uniform pressure, temperature, and humidity conditions in a multiple unit clean room.

These and other objects, will be readily evident upon a study of the following specification and the accompanying drawings, wherein :

Brief Description of the Drawings

Fig. 1 is a perspective view of the present invention, shown partly broken away ;
 Fig. 2 is a diagrammatic end elevational view, taken from the right end of Fig. 1
 Fig. 3 is an end elevational view of the opposite end of Fig. 1 ;
 Fig. 4 is a fragmentary rear elevational view of Fig. 1, shown partly broken away.
 Fig. 5 is similar to Fig. 2, but is modified to include access or inspection covers;
 Fig. 6 is a front elevational view of Fig. 1;
 Fig. 7 is a perspective view of a modified form of the invention, shown partly broken away;
 Fig. 8 is a perspective view somewhat similar to Fig. 7, illustrating the side walls and the top partly broken away;
 Fig. 9 is a perspective view of another modified form of the invention, illustrating a stand-alone air conditioner, which is optional;
 Fig. 10 is a fragmentary perspective view of a further modified form of the invention, illustrating a composite grouping thereof;
 Fig. 11 is a schematic drawing illustrating the arrangement and operation of the air conditioning unit;
 Fig. 12 is a perspective view, partly in ghost and partly cut away, of a group of modules of this invention configured in a master/slave arrangement; and
 Fig. 13 is a sectional partial view of a corner post, side panel and end panel of the module of this invention.

Description of the Preferred Embodiments

Having reference now to the drawings, and with particular reference to Figs. 1-4, the clean room module of the invention is essentially comprised of a base unit 15, a ceiling unit 16, a front wall 17, a side wall 18 and a back wall 20, Fig. 6, which abuts the inside panel or back wall of the air conditioning unit indicated generally at 21. An access door 22 is provided in the front wall 17 and, if desired, the side wall 18 can be provided with windows 24, Figs. 1 and 6. The other side wall of the module can be

formed by a panel shown fragmentarily at 25 in Fig. 1; however, if this side of the module is connected to a like module to provide a larger work space, the side will be left open for communication between the two as shown in Fig. 7.

The base unit 15, Figs. 1-4, comprises a sheet metal bottom 26 and four sheet metal side walls 27 that are welded together to form a sealed box-like receptacle that serves as an air and water tight sump area. The module floor is comprised of perforated tiles 28, Fig. 1, that are spaced above the bottom 26 of the base unit and supported by transversely extending steel strips 30 that are in turn supported by truss-like members 31. Because the base unit is self-contained with its own sealed bottom and side walls, the complete module can be moved or relocated as required. To increase the mobility of the module, the base unit can be provided with casters 32 that can be raised or lowered by conventional crank means (not shown).

The ceiling unit 16, like the base unit 15 has a hollow chamber or plenum, the unit including a top panel 34 to which are secured four depending side panels 35 in an airtight manner. A filter block 36 is spaced below the top panel 34 as best shown in Fig. 8 whereby a plenum chamber 37 is formed between the block and panel. The ceiling unit is entirely supported by four columns, one in each corner, such a column being shown at 38 in Figs. 1, 7 and 8. With this construction, the side walls are not load bearing and can be removed as necessary when connecting two or more modules together.

As indicated in Fig. 1, the interior of the module or work space may be provided with a sink 40, storage cabinets 41 or any other needed equipment.

The air conditioning unit 21, Figs. 1, 2, 4 and 9, is an upstanding, self-contained unit which abuts the back wall 20 of the module interior. The top of the air conditioning unit is in communication with the ceiling unit plenum chamber 37 and the bottom of the unit is in communication with the interior of the base unit 15 as will be described in more detail hereinafter. A shelf 42 in the air conditioning unit supports recirculating fans 44 which are driven by a motor 45. These fans direct the recirculating air into the ceiling unit plenum 37 as shown by arrow 46, Fig. 4.

The air conditioning components are located below the shelf 42 and comprise a compressor 47, a condenser 48 and the make-up air components 49 including a make-up air fan 50, a reheat coil 51 and a DX coil 52, all to be described in more detail below. Also located in this area of the air conditioning unit are a humidifier 54, the power supply 55 and a controls recorder 56. Between the components just listed and the back wall of the air conditioning unit there is an enclosed vertical air duct

57, Fig. 4, through which return air from the base unit sump is drawn upwardly by the fans 44 as indicated by the arrows 58. The air duct is also in communication with the make-up air components 49 as indicated by the arrows 60.

The exposed side of the air conditioning unit 21 is normally closed by a wall or panel 61 shown in Figs. 7 and 9 and fragmentarily in Figs. 1 and 2. This wall has a smaller removable panel 62 that permits access to the air conditioning components. Alternatively, the air conditioning unit can be provided with hinged, louvered access doors 64 as shown in Fig. 5.

Reference is now made to Fig. 11 which is a schematic drawing that illustrates the operation of the air conditioning unit 21 and its relationship to the remainder of the clean room module. As indicated in Figs. 1, 2 and 3, the air conditioning components are all actually located within the confines of the unit. In operation, the recirculating air is continuously blown through the interior of the clean room module by the fans 44, the air entering the ceiling unit plenum 37 and then passing down through the filter block 36 into the room. Because the air is under positive static pressure, it flows downwardly through the room in a vertical laminar flow. At the bottom of the room, the air passes through the floor tiles 28 and into the sump area of the base unit 15. From thence the air flows through an opening 65, Fig. 11, into the return air duct 57 which directs the air upwardly to the intake side of the fans 44. Before entering the fans, the air passes through recirculation prefilters 66.

As the air passes through the return air duct 57, a portion of it is drawn into the air conditioning system where it is combined with a certain amount of make-up air which, because of room exhaust and leakage, is needed to maintain room pressurization. This combined air flow is then blown through cooling and reheating coils by a make-up air fan. The conditioned air is then reinjected into the recirculating air stream.

The portion of the recirculating air that is drawn into the air conditioning system passes through a spring loaded, weighted backdraft damper 67 into a by-pass air conduit 68 that takes it to the make-up air fan 50. The make-up air enters the system through a conduit 70, passes through a prefilter 71, damper 81 and then is drawn into the fan 50 where it is combined with the by-pass air. The combined air flow is blown by the fan through the DX coil 52, the latter being a cooling coil that removes moisture from the make-up air. As shown in Fig. 11, the DX coil 52 is connected to the compressor 47 and condenser 48 through a suction throttling valve 72 and expansion valve 74, respectively, the operation of all of these and other commercially available components being well known.

The combined air flow that passes through the DX coil 52 is thereafter blown in part through the reheat coil 51 and in part through by-pass dampers 75 on the coil depending on the temperature of the air, the control settings, etc. From the coil 51 and dampers 75, the conditioned, combined air flows into a conduit 76 that takes it back into the return air duct 57 just upstream of the prefilters 66 as shown, the conditioned air being injected into the recirculating air stream at this point.

The temperature in the clean room is controlled by the temperature of the air leaving the air conditioning system, just described. To this end, a dry bulb sensor 77, Fig. 11, is located in the return air duct 57, and this sensor transmits a signal to the controller 56 which signal is in proportion to the return air (room) temperature. This signal is analyzed by the controller with respect to the set point and the controller sends an output signal to a control element 78 on the by-pass dampers 75. By regulating the amount of conditioned air going through or bypassing the reheat coil 51, the leaving air temperature of the conditioned air flow is varied to meet the controller's set point condition.

The humidity in the clean air room is maintained by regulating the amount of moisture taken out of or added to the combined air stream. Thus, a sensor 79 located in the leaving air stream of the DX coil 52 sends a signal to the controller 56 which modulates the suction throttling valve 72 in the refrigeration lines to maintain setpoint. This setpoint is selected as the upper limit of the room dewpoint at saturated air conditions, i.e. so that dry bulb approximately equals wet bulb and dewpoint. The setpoint will control the refrigeration system to maintain maximum leaving air temperature and therefore the maximum amount of moisture in the air.

The steam generating humidifier 54, Fig. 11 adds moisture to the recirculating air stream thereby controlling the minimum level of humidity. Humidity sensor 80, through controller 56, controls humidifier 54 to add the proper amount of moisture for maintaining set point conditions. The range between minimum and maximum is termed the humidity tolerance. A relatively wide tolerance conserves energy because it allows the clean room humidity to float without refrigeration or steam energy. Closer tolerances require more energy. For a very close tolerance, the refrigeration must be set up to subcool the air slightly below the design dewpoint and then the steam humidifier 54 must continuously add moisture to hold the tolerance.

The pressurization in the clean air room is maintained by controlling the amount of make-up air that is drawn into the make-up air fan 50, Fig. 11, of the air conditioning unit. This air, as noted above, combines with a certain amount of bypass

air from the recirculating air stream to maintain a constant air flow through the DX refrigeration coil 52. This prevents frosting of the coil and loss of efficiency.

The amount of make-up air is regulated by a damper 81 that can be either manually or automatically controlled. A sensor 82 located in the clean air room immediately below the filter block 36 sends a pneumatic signal to a pressure gauge (not shown) located in the air conditioning unit and continuously indicates the room static pressure. The damper 81 can be manually set to any pressure. If automatic operation is desired, the pneumatic signal is also sent to the controller 56 which then automatically controls the make-up air damper 81 to hold set point by means of a damper motor 84.

The controller 56 is preferably an electronic unit that senses not only the room static pressure, but also the rate of change of the room static pressure. The controller 56 includes a continuously variable adjuster to move the make-up damper 81 in accordance with both the detected differential static pressure and the detected rate of change of static pressure. With this system, the differential pressure between inside and outside air is easily maintained within ± 0.02 inches (± 0.51 cm) of water of the set point, typically ± 0.10 inches (± 0.25 cm) WC.

Referring now to Figs. 7 and 8, these drawings illustrate how two clean room modules can be joined to form a double unit having twice the work space of a single unit. The Fig. 7 module is, except for its base unit 15a, essentially like the module of Figs. 1-4 having a ceiling unit 16a, a front wall 17a, a side wall 18a and a back wall 20a abutting the air conditioning unit 21a. The Fig. 8 module is in effect a mirror image of the Fig. 7 module so that the open back sides of the modules can be brought into registering engagement with each other to double the area of the work space.

As shown in Figs. 7 and 8, the base units 15a and 15b of the mating modules are recessed at 85 and 86 respectively so that the modules can be "wrapped around" existing floor mounted fixtures or vibration isolated equipment such as electron beam units. Stated another way, an existing floor mounted fixture can be received in the space defined by the base unit recesses 85 and 86 which recesses can be shaped as required to fit around the particular fixture. With respect to Figs. 7 and 8, it should also be noted that in this kind of arrangement one module can be a master and the other module a slave meaning that the latter does not have its own air conditioning unit but receives its conditioned air from the master.

Fig. 9 illustrates the air conditioning unit as a free standing, independent unit 21c that can be

utilized for other types of clean rooms or the like. The unit 21c includes a discharge duct 87, or the discharge duct may optionally be located at 88. Likewise, the return air duct may be located at 90 with knockout 91 being provided for an alternative return air connection. Knockout 92 is provided for supply air to adjacent units.

Fig. 10 illustrates a multiple module arrangement in which twelve clean room modules are connected together to form a relatively large clean room area. The drawing also illustrates the versatility of the modules since it shows the different ways in which they can be joined with one another. The multiple arrangement includes at least one access door 94 which may open into a gowning room 95. Windows 96 are provided as necessary, and for convenience one or more passthroughs 97 can also be provided.

Fig. 12 illustrates a multiple clean room assembly formed of three adjacent modules disposed side by side, with the central module functioning as master and the adjacent modules serving in a slave capacity. One of these modules (identified with double-primed reference numbers) is shown only in ghost lines so as to minimize drawing clutter. Here, the modules are joined with their air conditioning units 21, 21' and 21'' adjacent one another. The central module air conditioning unit is of dual coil configuration, with two DX coils 52, two reheat coils 51, two by-pass dampers 75, and two make-up air control dampers 81 defining two parallel air conditioning paths. These are both controlled by a single controller 56. The output side of the by-pass dampers 75 and reheat coils 51 feeds the conditioned air into a generally wedge-shaped distribution chamber 98 that connects through an opening 99 at a central part of the air conditioning module into the return air conduit 57 where it flows through the prefilters 66 and thence into the main recirculating fans 44 which feed the recirculated air into the ceiling unit plenum 35. The wedge-shaped distribution chamber 98 also feeds the treated air through corresponding wedge-shaped openings (corresponding to knock-out 92), to the distribution chambers of the slave modules through corresponding wedge-shaped knock-out openings 92' and 92''. In this configuration only the central module air conditioning unit 21 (shown with cover removed) is used to dehumidify, cool, reheat, and control the pressure for all three modules. All three modules employ their own recirculating air systems to maintain the laminar vertical clean air flow in each module but the central or master module air conditioner 21 supplies the treated, temperature, humidity, and pressure controlled air to the main recirculating fans of all three modules. The control 56 of the central master air conditioner 21 only is functional.

In this arrangement the side wall panels 18 or 25 are removed from the central or master module, and one side wall panel 18 or 25 is removed from each of the slave modules, so that they can be joined. Gaskets disposed along the corner columns 38 and at the base and ceiling units 15,16 compress together to form a seal when the modules are connected. Bolts or other fasteners can be passed between abutting side walls of adjacent ceiling and base units of the master and slave modules to connect the modules together. The slave module air conditioning unit 21' here is shown as a standard module with doors in place. A slave module does not contain any of the air treatment and make-up elements, but is provided with only the recirculating fans 44 and associated ducts and filters.

The rigid side and front walls are removably connected to the corner columns 38 as generally shown in horizontal cross section in Fig. 13. Here the side wall panels 18 or 25 and the front panel 17 are each formed of a rigid panel and a surrounding mounting frame formed of an extruded aluminum "h"-shaped channel member 100. The panel 25 or 18 itself fits into a channel 101 defined between two flanges 102 and abuts a gasket 103 to form a sealed entity. An outer flange 104 then projects around the periphery of the column 38, and is fastened against the column 38 with a gasket 106 compressed between the channel 100- and the column 38. These elements are easily fastened together with machine screws 108. The top edge and bottom edge of the panels 25, 18 and 17 are fastened to the module base unit 15 and ceiling unit 16 in similar fashion.

When two or more modules are to be combined, it is a simple matter to unscrew the facing panels and join the modules together with the panels removed. Because the panels are not load bearing, the modules maintain their structural integrity when one or more panels are removed, so the modules can be moved together on their casters, with their panels removed, to facilitate their combination.

The air conditioning circuit including the make-up air fan 50, the DX Coil 52, the reheat coil 51 and the by-pass damper 75 and return duct 98 or conduit 76 handles a constant volume of air per unit time, the volume being the sum of bypass air 68 plus make-up air 70. This volume constitutes only a fraction of the total recirculated air, typically, between 5% and 20%. Because only a small part of the total circulated air passes through this loop, the DX coil 52 can cool at full capacity for more efficient operation; the coil 52 need not be held at the much higher room interior dry bulb temperature but can be much cooler. Another benefit of the partial recirculation of the air is the ability to hold room temperature (typically ± 0.1 to ± 0.4 degrees F -i.e. ± 0.06 to ± 0.22 degrees C), even with the

DX coil temperature variance ranging ± 2.0 degrees - ± 1.1 degree C -or more.

Preferably, the reheat coil 51 receives its heat from the heat absorbed in the DX coil 52. This avoids the need for a separate electric heater.

The modular clean room of this invention has the advantage of being factory assembled, pre-packaged and pre-tested. The modular unit can be simply connected to electric, water, and drain and turned on ready for use. If there is any residual dust, it will purge out in a short interval of time. Field certification is usually unnecessary, depending on local regulations, because the built-in air conditioning is pre-tested and factory certified. Modules constructed according to this invention have been found to exceed federal quality standard 209B for a class 100 and better clean room, and have consistently met class 10 standard (i.e., less than ten particles of $1/2$ micron diameter per cubic foot (0.028 cubic metre), with no particles larger than five microns).

Temperature is maintained within ± 0.1 degree F (± 0.05 degree C), humidity maintained within 2.0% relative humidity, and pressure maintained within ± 0.02 inches (± 0.051 cm) of water column of the desired set point.

Also, because the clean rooms are transportable and modular, and not field-assembled, they can be treated as capital expenditures by the purchaser, and are ideal for lease arrangements.

Claims

1. A self-supporting, self-contained air conditioning unit (21) connected with a clean room module or the like, and in which :
 - a first fan (44) blows recirculating air into a room or area of the module ;
 - a return air duct (57) defining a first circulating path has an intake port (65) for receiving the recirculating air after it has passed through the room and in which the duct (57) delivers air to the first fan (44), such that the room to be air conditioned and the return air duct define a first air circuit for the air conditioning unit ;
 - a second fan (50) delivers ambient make-up air to the first fan (44) ;
 - and a bypass (67,68) coacts with the return air duct in advance of the first fan (44) and diverts a portion of the air passing therethrough into the second fan (50), the second fan (50) being disposed in an enclosure (49) of the air conditioning unit (21) that contains a cooling coil (52) and a reheat coil (51) in the outflow of the second fan for treating the air from

- the second fan (50), such that the second fan (50) mixes the make-up air and the air diverted from the duct (57) and blows the combined air through the cooling and reheat coils (51,52) ;
- and an outlet port (76) for delivering the treated air back to the return air duct (57) for combining with the recirculating air passing therethrough, with the bypass, the second fan enclosure (49), and the outlet port (76) defining a second air circuit for the air conditioning unit and said second air circuit with said bypass (67,68) defining a second circulating path, characterized in that the second circulating path (49, 67,68 76) operates at a constant volume flow of about five to twenty percent of the air flow formed of the sum of the diverted and make-up air flows, through the first circuit (58), and a controller that includes an air pressure sensor (82) in communication with said room or area controls a make-up air damper (81) in accordance with the air pressure within said room or area so as to maintain said room or area at a substantially constant pressure.
2. An air conditioning unit as defined in claim 1, further characterized in that the return air duct (57) is substantially vertically disposed, the first fan (44) being located adjacent the upper end of the duct and the duct intake port (65) being located adjacent the lower end of the duct (57) so that the return air through the intake (68) flows upwardly from the port (65) to the fan (44).
 3. An air conditioning unit as defined in claim 2, further characterized in that a prefilter (66) is disposed in the duct (57) adjacent the upstream side of the first fan (44).
 4. An air conditioning unit as defined in claim 2 further characterized in that a diverter (67) for diverting a portion of the duct air to the second fan (50) via said intake (68) is located adjacent the lower end of the duct (57), said diverter being automatically controllable.
 5. An air conditioning unit as defined in claim 3, wherein the outlet port (76) connects with the duct (57) adjacent the upstream side of the prefilter (66).
 6. An air conditioning unit as defined in claim 1, wherein the make-up air is introduced in the second circulating path (49,67,68,76) via an inlet (70) coupled to the intake (68).
 7. A clean room module comprising in combination a self-contained, unitary base unit (15) that includes a floor (28), bottom and side walls (18,20) that define a sump chamber (15) beneath the floor (28), vertical side walls (27) mounted on and supported by the base unit (15), an upstanding self-contained air conditioning unit (21) as defined in one of claims 1 to 6, connected to the base unit (15) adjacent one side wall of the clean room module, a ceiling unit (16) engaging upper edges of said side walls, support members (38) supporting said ceiling unit independently of said side walls, the ceiling unit (16) having filter material (36) therein and a plenum chamber (37) above the filter material (36), with the floor, walls, and ceiling unit together defining an enclosed clean room, the ceiling unit plenum chamber and the base unit sump chamber being in communication with the air conditioning unit, characterized in that said first circulating path (57) of said air conditioning unit (21) extends from said base unit sump chamber (15) to said ceiling unit plenum chamber (35), so that the air conditioning unit (21) circulates filtered air at a constant predetermined pressure in a downward laminar flow through the enclosed clean room area.
 8. A clean room module as defined in claim 7 further characterized in that said distribution duct includes a distribution channel (98,99) extending laterally and having a port (92) disposed in at least one side wall of the air conditioning unit (21), the port (92) serving for coupling by a corresponding port (92' or 92'') to a distribution channel of an air conditioning unit (21' or 21'') of an adjacent connected clean room module for supplying the treated air from the first-mentioned clean room module to the first circulating path of the second-mentioned clean room module, so that the first-mentioned module functions as a master and the second-mentioned module acts as a slave unit receiving treated air only from the air conditioning unit (21) of the first-mentioned module.
 9. A clean room module as defined in claim 7, further characterized in that said second circulating path (49,50, 51, 52 - Fig. 12) is disposed to one side of the air conditioning unit (21), and the latter includes a third circulating path disposed to the other side thereof, and having an automatically controllable diverter (67), a blower (50) having an input coupled to

the diverter, a make-up air inlet (70) coupled to the intake of the blower and including a controllable make-up damper (81), an air conditioning element (52) following said blower (50), and conduit connecting the air conditioning element (52) to said distribution, said sensor (82) controlling the make-up damper (81) of the third circulating path as well as the make-up damper (81) of the second circulating path.

Revendications

1. Unité de climatisation autonome et indépendante (21) reliée à un module pour salles blanches ou similaires, dans laquelle :

- un premier ventilateur (44) souffle de l'air recirculé dans une pièce ou une aire du module ;
- une canalisation pour le retour d'air (57), définit un premier trajet de circulation comportant une prise d'entrée (65) destinée à recevoir l'air recirculé après son passage dans la pièce, et dans lequel la canalisation (57) délivre de l'air au premier ventilateur (44) de telle sorte que la pièce devant être climatisée et la canalisation de retour d'air définissent un premier circuit de l'air pour l'unité de climatisation ;
- un second ventilateur (50) délivre de l'air ambiant d'appoint au premier ventilateur (44) ;
- et une dérivation (67,68) interagit avec la canalisation de retour d'air en amont du premier ventilateur (44) et dérive une partie de l'air passant au travers au niveau du second ventilateur (50), ce second ventilateur (50) étant disposé dans une enceinte (49) de l'unité de climatisation (21) et comprend un organe de refroidissement (52) et un organe de chauffage (51) situé au niveau de la sortie du flux du second ventilateur pour traiter l'air issu dudit second ventilateur (50), de telle sorte que le second ventilateur (50) mélange l'air d'appoint et l'air dévié de la canalisation (57) et souffle l'air ainsi combiné à travers les organes de refroidissement et de chauffage (51,52) ;
- et un point de sortie (76) pour délivrer l'air traité en retour à la canalisation de retour d'air (57) pour le mélanger avec l'air recirculé la traversant, l'enceinte du second ventilateur (49) et l'orifice de sortie (76) définissant un second circuit d'air pour l'unité de climatisation, ledit second circuit d'air et ladite dérivation (67,68)

définissant le second trajet de circulation, caractérisé en ce que le second trajet de circulation (49,67,68,76) opère à flux volumique constant d'environ 5 à 20 % du flux d'air formé par la somme des flux dérivés et d'appoint, à travers le premier circuit (58), et en ce qu'un contrôleur comprenant un capteur de pression d'air (82) en communication avec ladite pièce ou aire contrôle une soupape d'air d'appoint en liaison avec la pression d'air dans ladite pièce ou aire afin de maintenir ladite pièce ou aire à une pression relativement constante.

2. Unité de climatisation selon la revendication 1, caractérisée en ce que la canalisation de retour d'air (57) est disposée essentiellement verticalement, le premier ventilateur (44) étant disposé de manière adjacente à l'extrémité supérieure de ladite canalisation, et la prise d'entrée (65) étant localisé au voisinage de l'extrémité inférieure de ladite canalisation (57), de telle sorte que l'air en retour au travers du piquage (68) s'écoule vers le haut à partir du point (65) jusqu'au ventilateur (44).
3. Unité de climatisation selon la revendication 2, caractérisée en ce qu'un pré-filtre (66) est disposé dans la canalisation (57) au voisinage de la face amont du premier ventilateur (44)
4. Unité de climatisation selon la revendication 2, caractérisée en ce qu'une dérivation (67) pour dériver une partie de l'air de la canalisation au niveau du second ventilateur (50) par l'intermédiaire d'un piquage (68) est localisée au voisinage de l'extrémité inférieure de la canalisation (67), ladite dérivation étant contrôlable automatiquement.
5. Unité de climatisation selon la revendication 3, caractérisée en ce que l'orifice de sortie (76) est relié avec la canalisation (57) au voisinage de la face amont du pré-filtre (66).
6. Unité de climatisation selon la revendication 1, caractérisée en ce que l'air d'appoint est introduit dans le second trajet de circulation (49, 67,68,76) par un orifice (70) couplé au piquage (68).
7. Module pour salle blanche comprenant en combinaison une unité de base unitaire autonome (15) incluant un plancher (28), des cloisons de fond et latérales (18,20) définissant une chambre de fond sous le plancher (28), des cloisons latérales et verticales (27) mon-

tées et supportées par une unité de base (15), une unité de climatisation autonome (21) verticale définie selon l'une des revendications 1 à 6, reliée à l'unité de base (15) au voisinage de l'une des cloisons latérales ou du module pour salle blanche, une unité de plafond (16) reliée aux portes supérieures desdites cloisons latérales, des éléments de support (38) supportant ladite unité de plafond indépendamment desdites cloisons latérales, et l'unité de plafond (16) présentant des matériaux filtrants (36) et une chambre pleine (37) au dessus du matériau filtrant (36), définissant avec le plancher, les cloisons et l'unité de plafond, une enceinte pour salle blanche, la chambre pleine de l'unité de plafond et la chambre de fond de l'unité de base étant en communication avec l'unité de climatisation, caractérisé en ce que ledit premier trajet de circulation (57) de ladite unité de climatisation (21) s'étend de ladite chambre de fond de l'unité de base (15) à ladite chambre pleine de l'unité de plafond (35), de telle sorte que l'unité de climatisation (21) entraîne en circulation de l'air filtré à une pression constante prédéterminée, selon un flux laminaire descendant à travers ladite enceinte de salle blanche.

8. Module pour salle blanche selon la revendication 7, caractérisé en ce que ladite canalisation de distribution comprend des canaux de distribution (98,99) s'étendant latéralement et présentant un orifice (92) disposé au moins sur l'une des cloisons latérales de l'unité de climatisation (21), l'orifice (92) servant au couplage avec un orifice correspondant (92' ou 92'') d'un canal de distribution d'une unité de climatisation (21' ou 21''), d'un module pour salle blanche relié de manière adjacente pour délivrer de l'air traité dudit premier module pour salle blanche au premier trajet de circulation du second module pour salle blanche, de telle sorte que le premier module fonctionne comme maître et le second module agit comme esclave, recevant de l'air traité seulement de l'unité de climatisation dudit premier module.

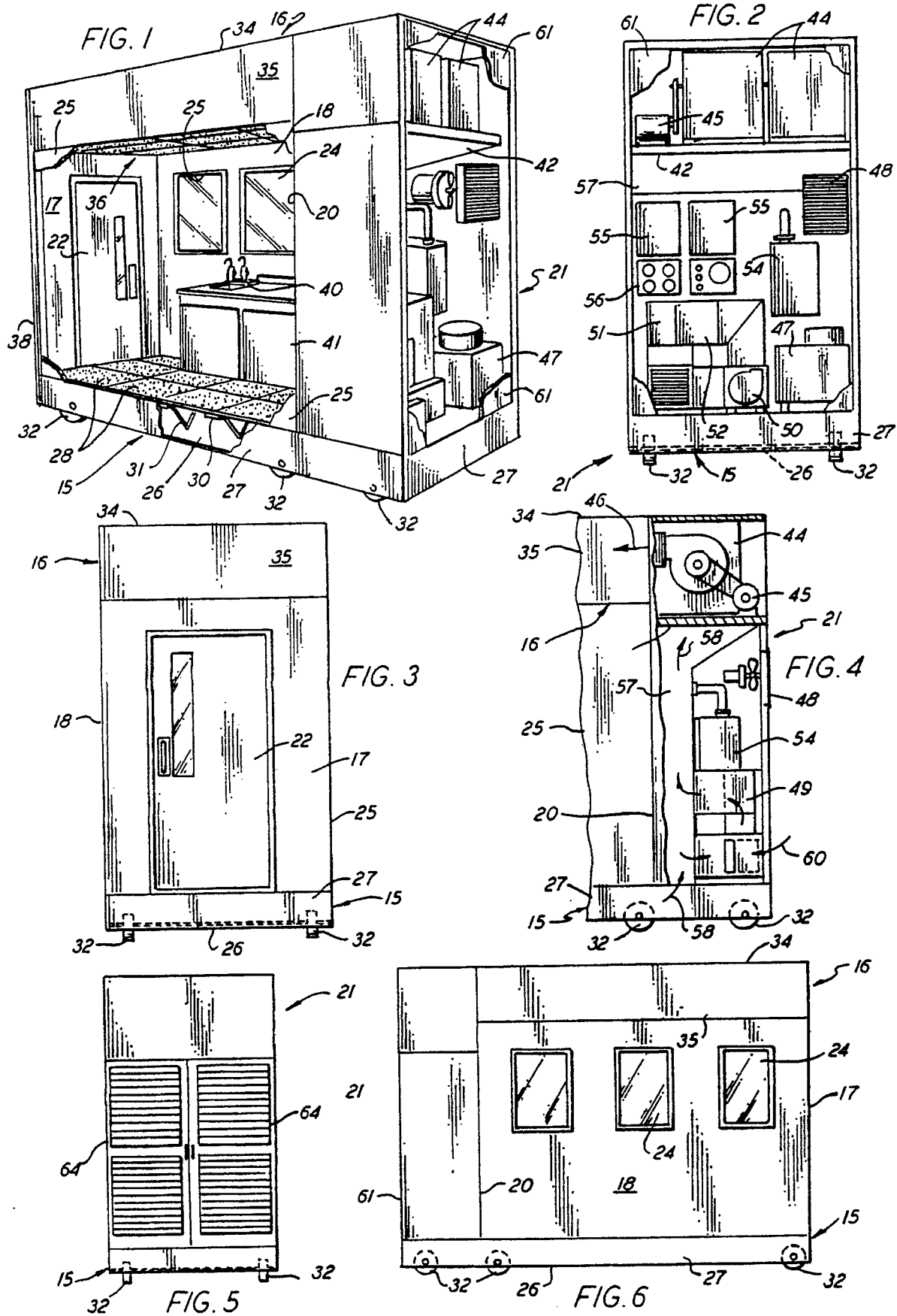
9. Module pour salle blanche selon la revendication 7, caractérisé en ce que ledit second trajet de circulation (49,50,51,52 - Figure 12) est disposé sur l'une des faces de l'unité de climatisation (21), et en ce que cette dernière comprend un troisième trajet de circulation disposé de l'autre côté, et présentant une dérivation automatiquement contrôlable (67), un ventilateur (50) présentant une entrée couplée à la dérivation, une entrée d'air d'appoint (70) couplée à l'entrée du ventilateur et incluant une

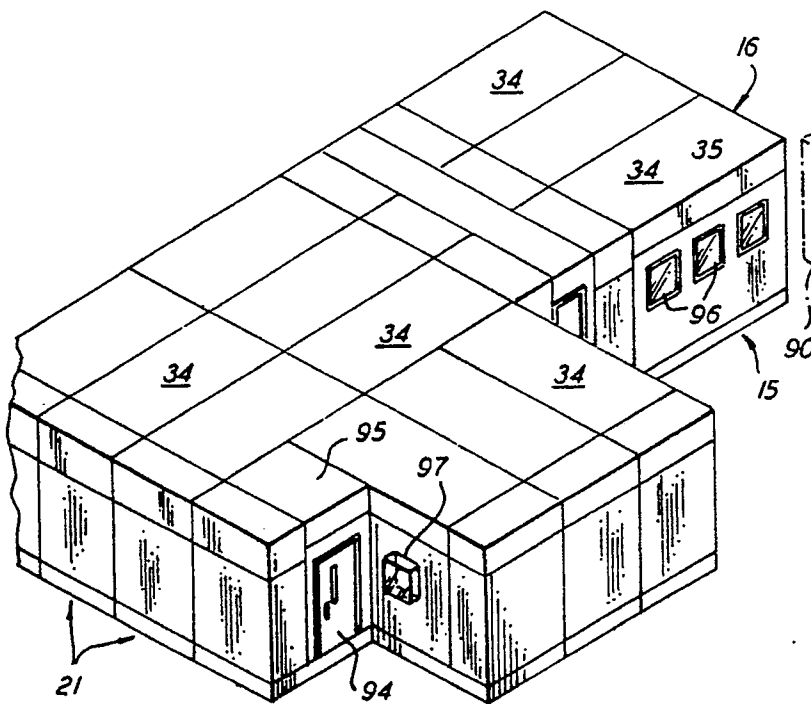
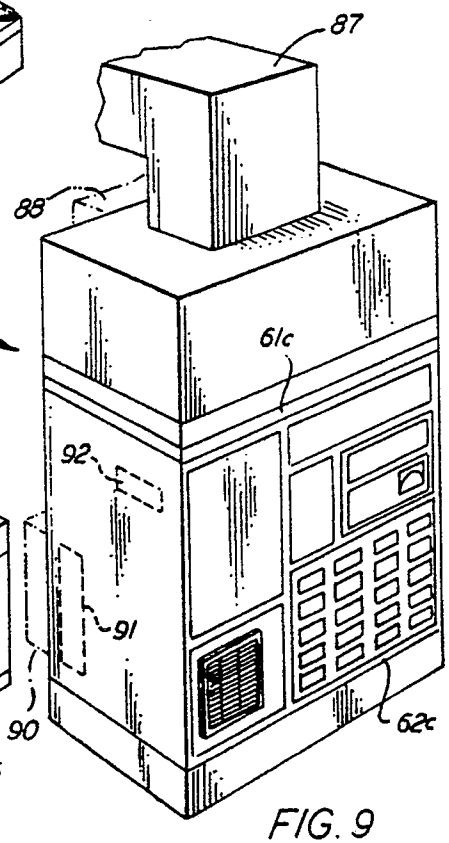
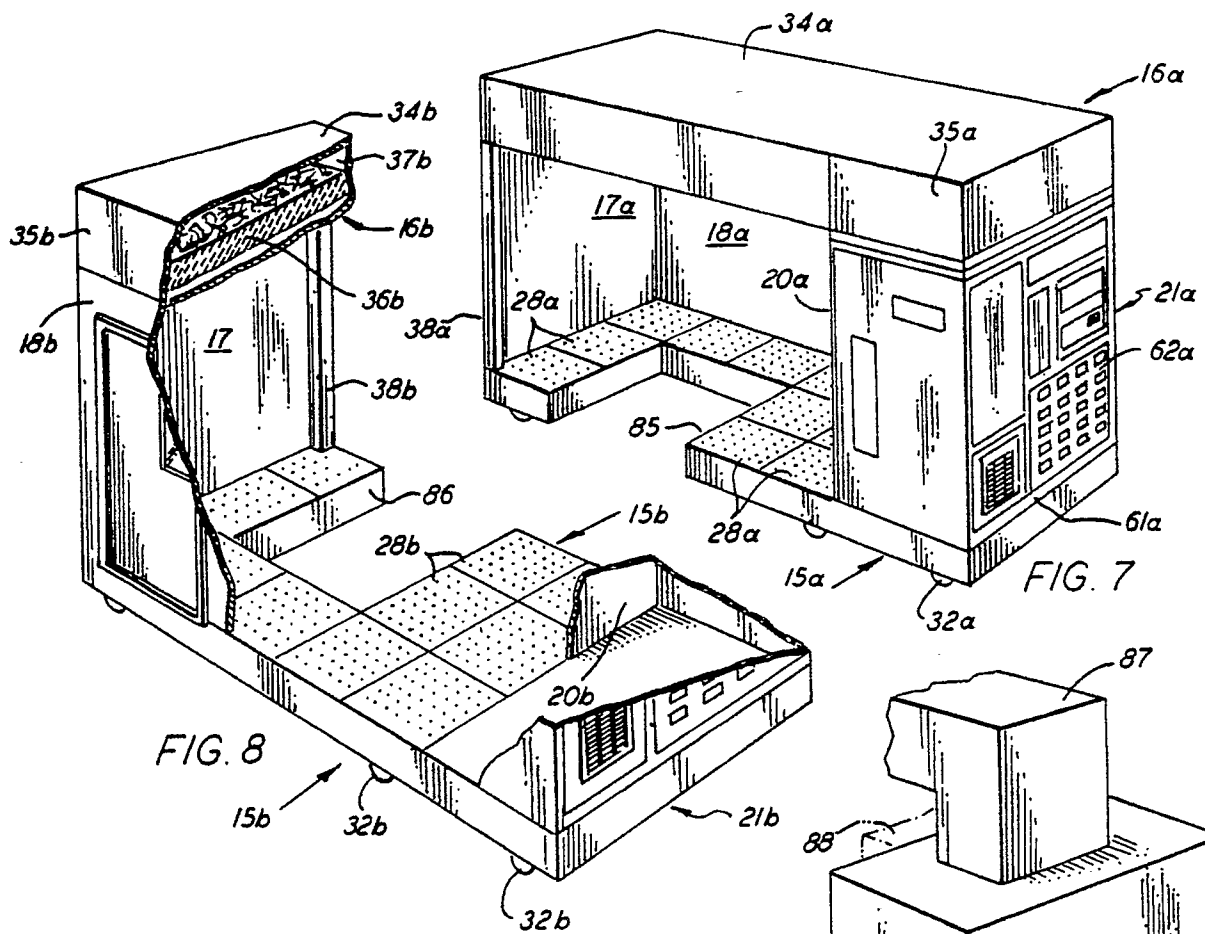
soupape d'appoint contrôlable (81), un élément de conditionnement d'air (52) situé après le ventilateur (50) et des conduits connectant l'élément de conditionnement d'air (52) audit distributeur, ledit capteur (82) contrôlant la soupape d'appoint (81) du troisième trajet de circulation de même que la soupape d'appoint (81) du deuxième trajet de circulation.

10 Patentansprüche

1. Selbständige, in sich geschlossene Klimaanlage (21), die mit einem Reinraum-Modul oder dergleichen verbunden ist, in der:
 - ein erstes Gebläse (44) umlaufende Luft in einen Raum oder eine Zone des Moduls bläst;
 - ein Rückströmkanal (57), der einen ersten Zirkulationsweg bildet, eine Eintrittsöffnung (65) aufweist zur Aufnahme der umlaufenden Luft, nachdem diese den Raum durchlaufen hat, wobei der Kanal (57) dem ersten Gebläse (44) Luft zuführt, so daß der zu klimatisierende Raum und der Rückströmkanal einen ersten Luftkreislauf der Klimaanlage bilden;
 - ein zweites Gebläse (50) dem ersten Gebläse (44) Umgebungs-Frischluft zuführt;
 - ein Bypass (67,68) vor dem ersten Gebläse (44) mit dem Rückströmkanal zusammenwirkt und einen Teil der diesen durchlaufenden Luft abzweigt in das zweite Gebläse (50), welches in einem Gehäuse (49) der Klimaanlage (21) angeordnet ist, das im Austritt des zweiten Gebläses einen Luftkühler (52) und einen Lufterhitzer (51) enthält zur Behandlung der Luft aus dem zweiten Gebläse (50), derart, daß das zweite Gebläse (50) die Frischluft und die aus dem Kanal (57) abgezweigte Luft mischt und die Luftmischung durch den Luftkühler und den Lufterhitzer (51,52) bläst;
 - einen Auslaßkanal (76) zur Rückführung der behandelten Luft in den Rückströmkanal (57) zur Mischung mit der dort umlaufenden Luft, wobei der Bypass, das Gehäuse (49) des zweiten Gebläses und der Auslaßkanal (76) einen zweiten Luftkreislauf der Klimaanlage definieren, welcher mit dem Bypass (67,68) einen zweiten Zirkulationsweg bildet, dadurch gekennzeichnet, daß der zweite Zirkulationsweg (49,67,68,76) mit einem konstanten Volumenstrom von etwa 5 bis 20% des aus der Summe des verzweigten und des Frischluft-Stroms gebildeten Gesamtluftstroms durch den ersten

- Kreislauf (58) arbeitet und daß eine Regeleinrichtung, die einen mit dem Raum oder der Zone in Verbindung stehenden Drucksensor (82) aufweist, eine Frischluftdrossel (81) entsprechend dem Luftdruck in dem Raum oder der Zone regelt, so daß in dem Raum oder der Zone ein im wesentlichen konstanter Druck aufrechterhalten wird.
2. Klimaanlage nach Anspruch 1, dadurch gekennzeichnet, daß der Rückströmkanal (57) im wesentlichen vertikal angeordnet ist, wobei das erste Gebläse (44) an das obere Ende des Kanals angrenzt und die Eintrittsöffnung (65) am unteren Ende des Kanals (57) angeordnet ist, so daß die Rückluft von der Eintrittsöffnung (65) aufwärts zu dem Gebläse (44) strömt.
 3. Klimaanlage nach Anspruch 2, dadurch gekennzeichnet, daß in dem Kanal (57) auf der Anströmseite des ersten Gebläses (44) ein Vorfilter (66) angeordnet ist.
 4. Klimaanlage nach Anspruch 2, dadurch gekennzeichnet, daß eine Abzweigvorrichtung (67) zum Abzweigen eines Teils der Kanalluft über die Zuleitung (68) zum zweiten Gebläse (50) am unteren Ende des Kanals (57) angeordnet ist, wobei die Abzweigvorrichtung (67) automatisch regelbar ist.
 5. Klimaanlage nach Anspruch 3, dadurch gekennzeichnet, daß der Auslaßkanal (76) auf der Anströmseite des Vorfilters (66) mit dem Kanal (57) verbunden ist.
 6. Klimaanlage nach Anspruch 1, dadurch gekennzeichnet, daß die Frischluft über einen mit der Zuleitung (68) gekoppelten Einlaß (70) in den zweiten Zirkulationsweg eingeleitet wird.
 7. Reinraum-Modul, bestehend aus der Kombination eines selbständigen, einheitlichen Basisbauteils (15), welches einen Boden (28) und Rück- und Seitenwände (18,20) aufweist, die unter dem Boden (28) eine Sumpfkammer (15) bilden; vertikaler Seitenwände (27), die auf dem Basisbauteil (15) befestigt und von diesem getragen sind; einer aufrechtstehenden, in sich geschlossenen Klimaanlage (21) nach einem der Ansprüche 1 bis 6, die an einer Seitenwand des Reinraum-Moduls mit dem Basisbauteil (15) verbunden ist; eines die oberen Ränder der Seitenwände umgreifenden Deckenbauteils (16) und Stützen (38), die das Deckenbauteil unabhängig von den Seitenwänden tragen, wobei sich in dem Deckenbauteil (16) Filtermaterial (36) und über dem Filtermaterial (36) eine Luftkammer (37) befindet und der Boden, die Wände und das Deckenbauteil einen geschlossenen Reinraum bilden, dessen Luftkammer im Deckenbauteil und Sumpfkammer im Basisbauteil mit der Klimaanlage in Verbindung stehen, dadurch gekennzeichnet, daß der erste Zirkulationsweg (57) der Klimaanlage (21) sich von der Sumpfkammer (15) im Basisbauteil bis zur Luftkammer (37) im Deckenbauteil erstreckt, so daß die Klimaanlage (21) gefilterte Luft mit konstantem vorbestimmtem Druck in abwärtsgerichteter, laminarer Strömung durch den geschlossenen Reinraum zirkulieren läßt.
 8. Reinraum-Modul nach Anspruch 7, dadurch gekennzeichnet, daß die Verteilerleitung einen querverlaufenden Verteilerkanal (98,99) mit mindestens einem in einer Seitenwand der Klimaanlage (21) angeordneten Durchlaß (92) aufweist, wobei der Durchlaß (92) zum Anschluß eines korrespondierenden Durchlasses (92' oder 92'') zu einem Verteilerkanal einer Klimaanlage (21' oder 21'') von einem angrenzend angeschlossenen Reinraum-Modul dient, für die Zufuhr der behandelten Luft des erstgenannten Reinraum-Moduls zum ersten Zirkulationsweg des zweitgenannten Reinraum-Moduls, so daß der erstgenannte Modul als Haupteinheit und der zweitgenannte Modul als Nebeneinheit wirkt, welche die behandelte Luft nur von der Klimaanlage (21) des erstgenannten Moduls erhält.
 9. Reinraum-Modul nach Anspruch 7, dadurch gekennzeichnet, daß der zweite Zirkulationsweg (49, 50, 51, 52 - Fig.12) auf einer Seite der Klimaanlage (21) angeordnet ist und daß diese einen dritten Zirkulationsweg auf ihrer anderen Seite aufweist mit einer automatisch regelbaren Abzweigvorrichtung (67), einem Gebläse (50), dessen Eintritt mit der Abzweigvorrichtung verbunden ist, einem mit dem Eintritt des Gebläses verbundenen und eine regelbare Frischluftdrossel (81) enthaltenden Frischlufteinlaß (70), einem dem Gebläse (50) nachgeordneten Klimatisierungselement (52) und einer das Klimatisierungselement (52) an die Verteilerleitung anschließenden Leitung, wobei der erwähnte Drucksensor (82) die Frischluftdrossel (81) des dritten Zirkulationsweges sowie die Frischluftdrossel (81) des zweiten Zirkulationsweges regelt.





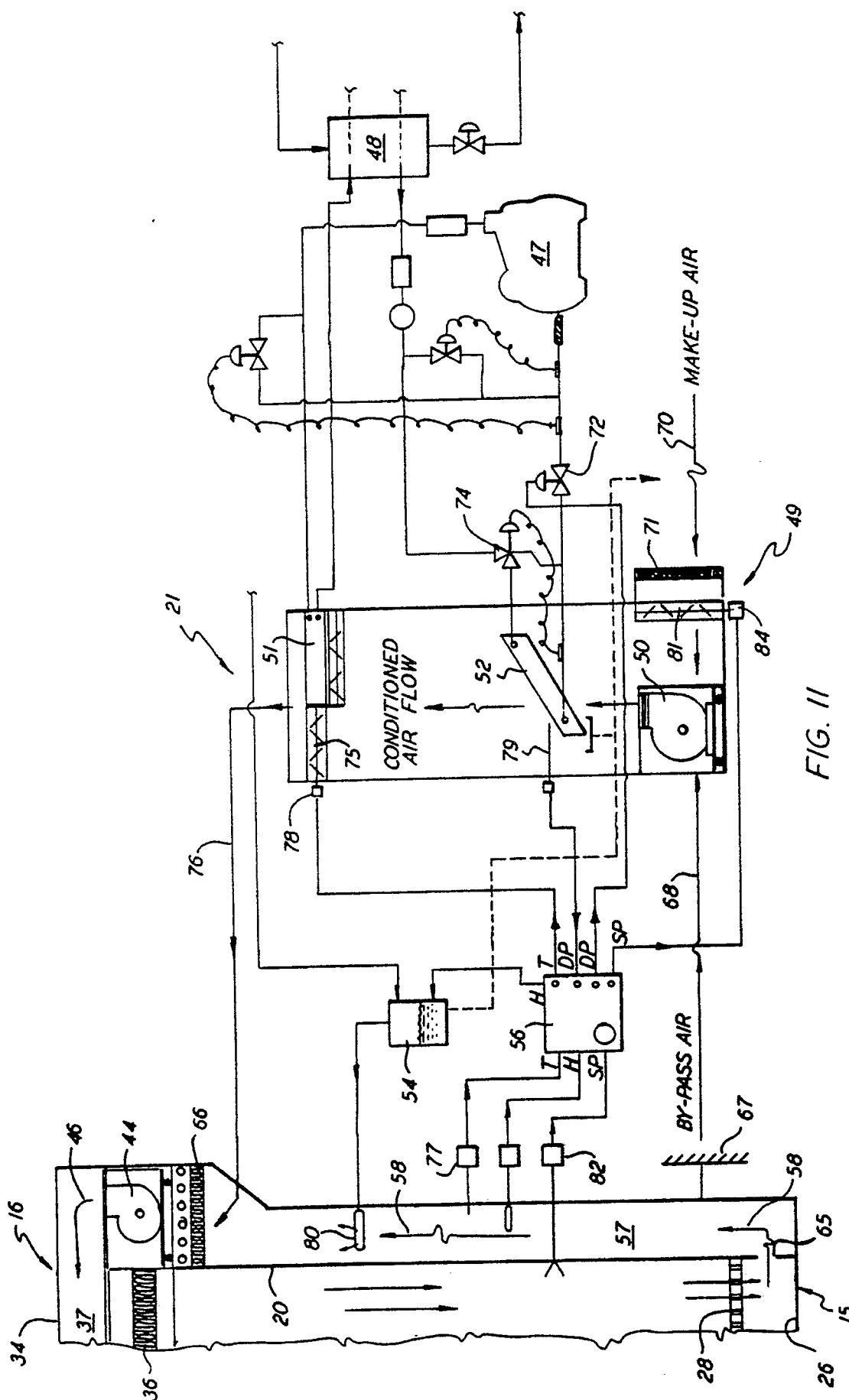


FIG. 11

