

[54] BIOHAZARD SAFETY CABINET

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[57] ABSTRACT

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[51] Int. Cl. A47b 81/00, A61b 19/82, B01i 9/02
[58] Field of Search 312/209, 236; 98/41 SV, 98/41 R

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A biological safety cabinet, including a hood structure defining a work chamber, at the bottom of which is a work surface, the cabinet being provided at its front wall with an access opening therein adjacent the work surface, and with means for creating an air flow through said chamber from top to bottom, which air may become contaminated by materials disposed in said chamber, air discharged from said chamber passing through a decontaminating filter disposed below the plane of said work surface, blower means arranged to withdraw decontaminated air passing through said filter and discharge the same in duct means operative to conduct such air to a chamber disposed above said work chamber, from which it is discharged into the latter at the top thereof. Means are also provided for readily effecting in a simple manner decontamination of the filter; for increasing the access opening in the work chamber to accommodate relatively large equipment; with control means, responsive to the size or closure of the access opening, for varying the operation of the blower; and indicating means for ascertaining operating conditions during normal or decontaminating functions. Means is also provided for effecting a relatively uniform distribution of air discharged into the top of said work chamber.

10 Claims, 8 Drawing Figures

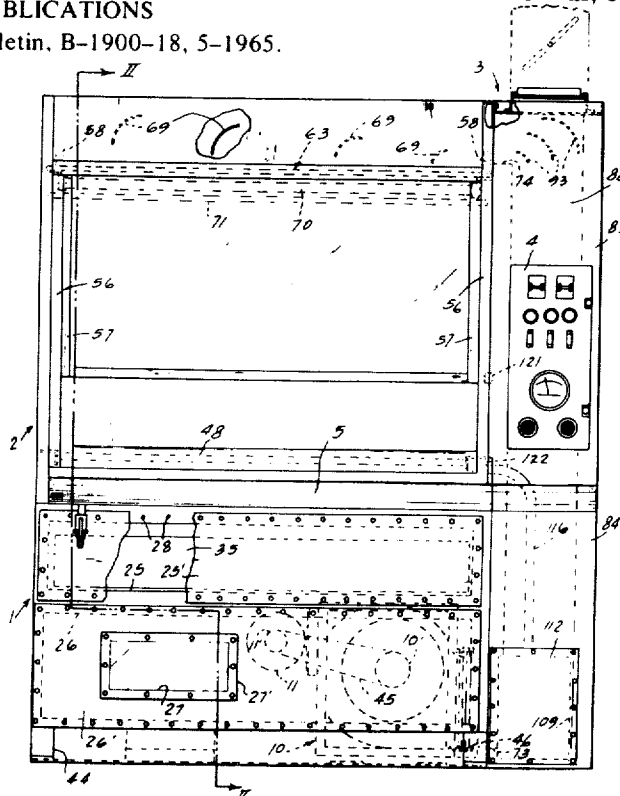


Fig. 1

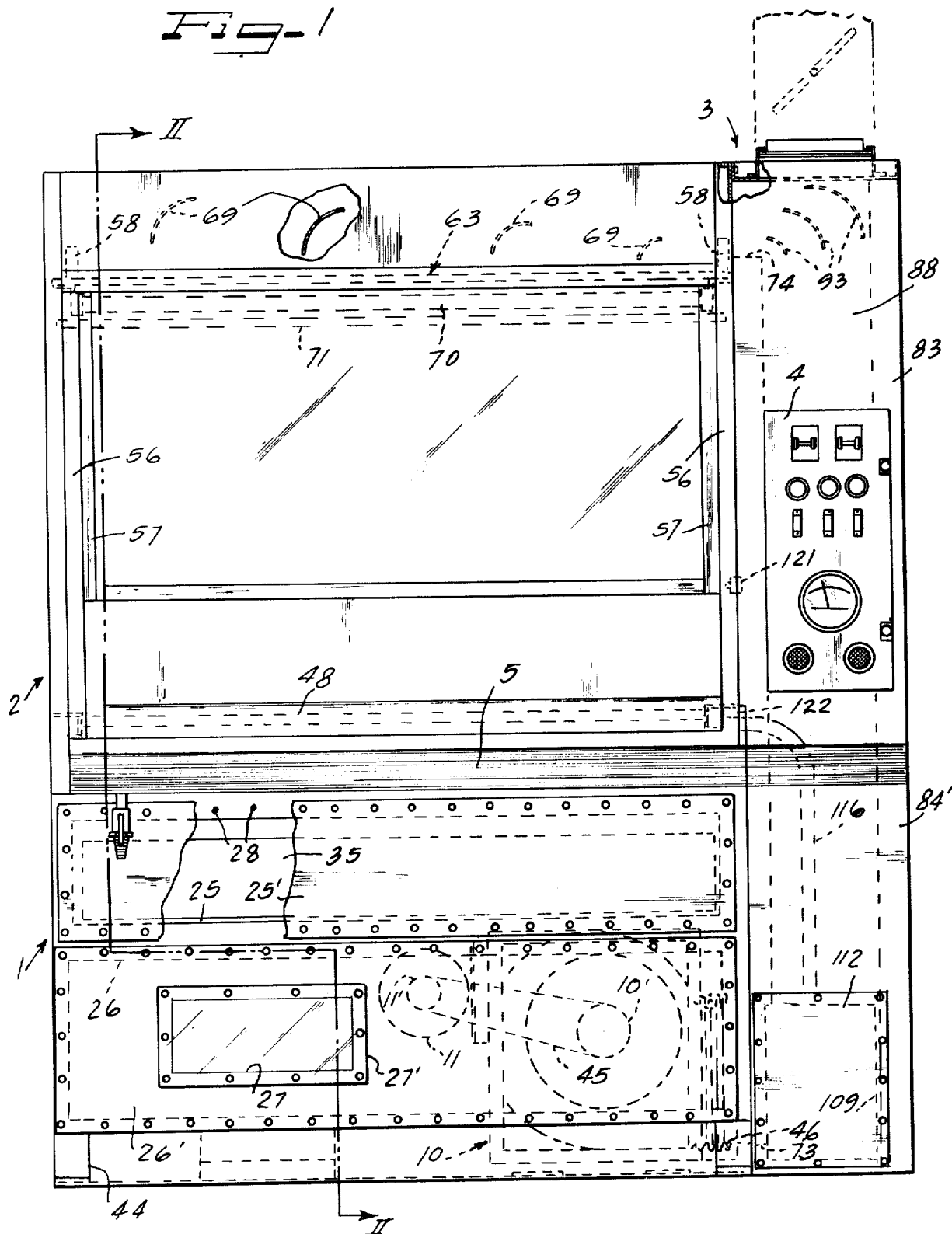
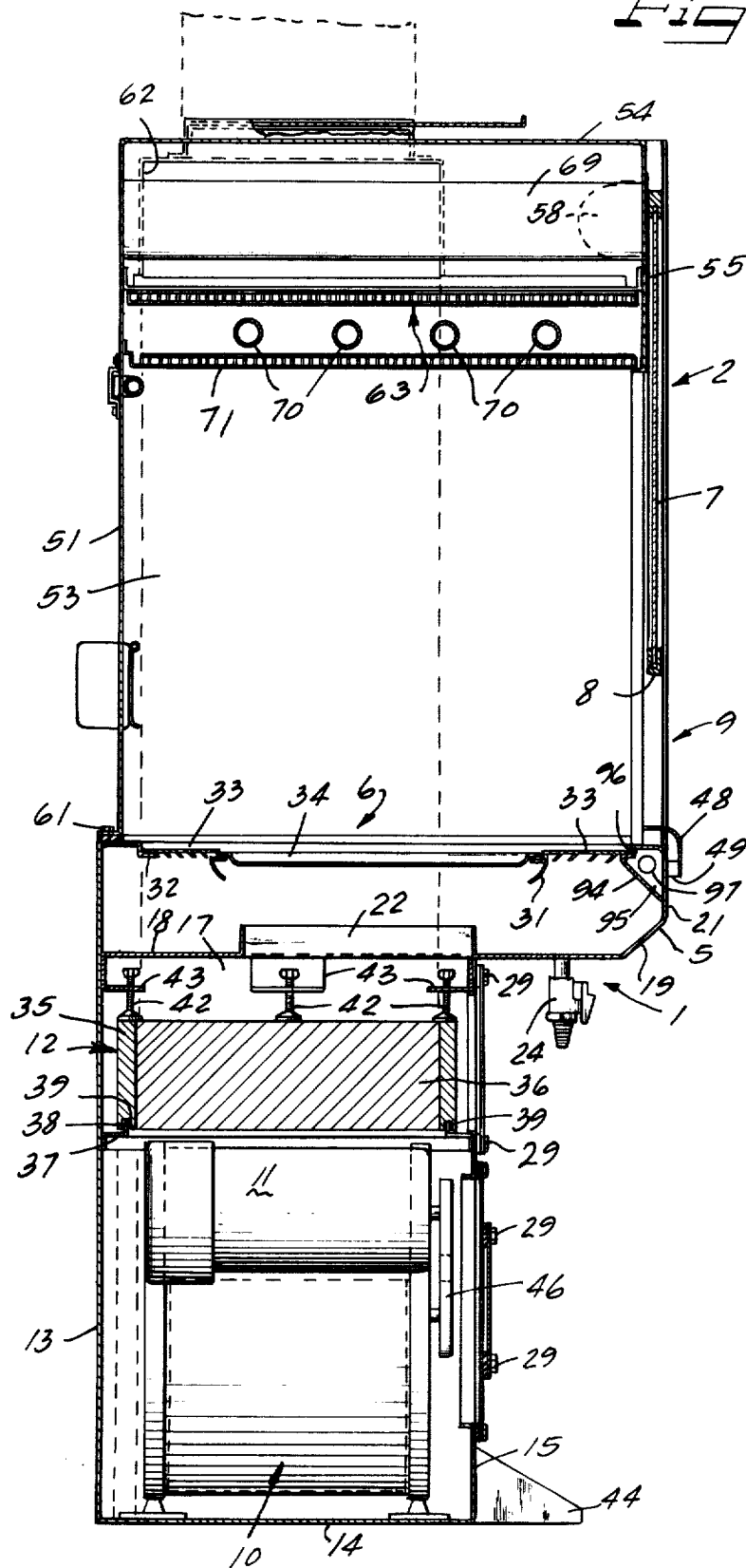


Fig. 2



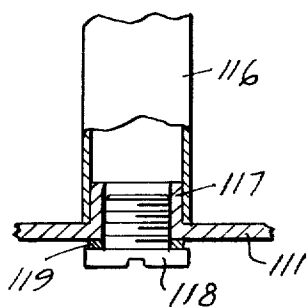
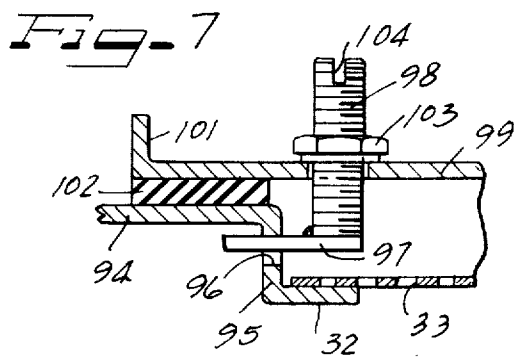
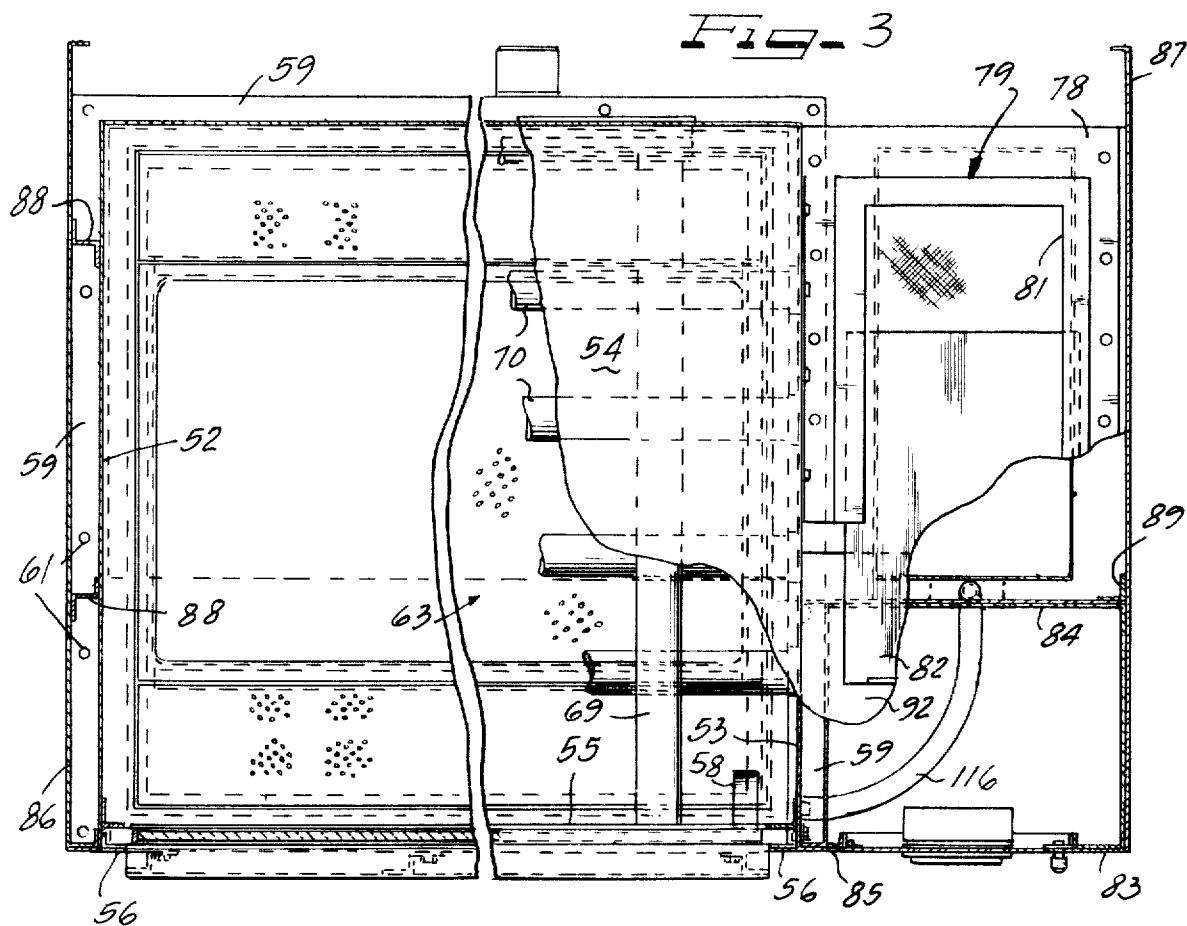


Fig. 8

Fig. 4

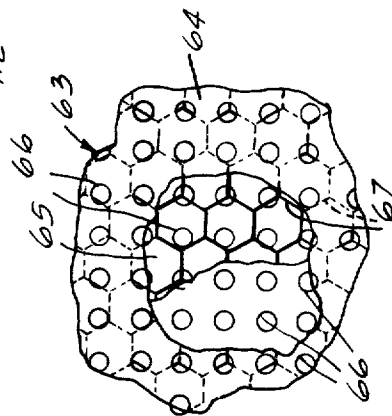
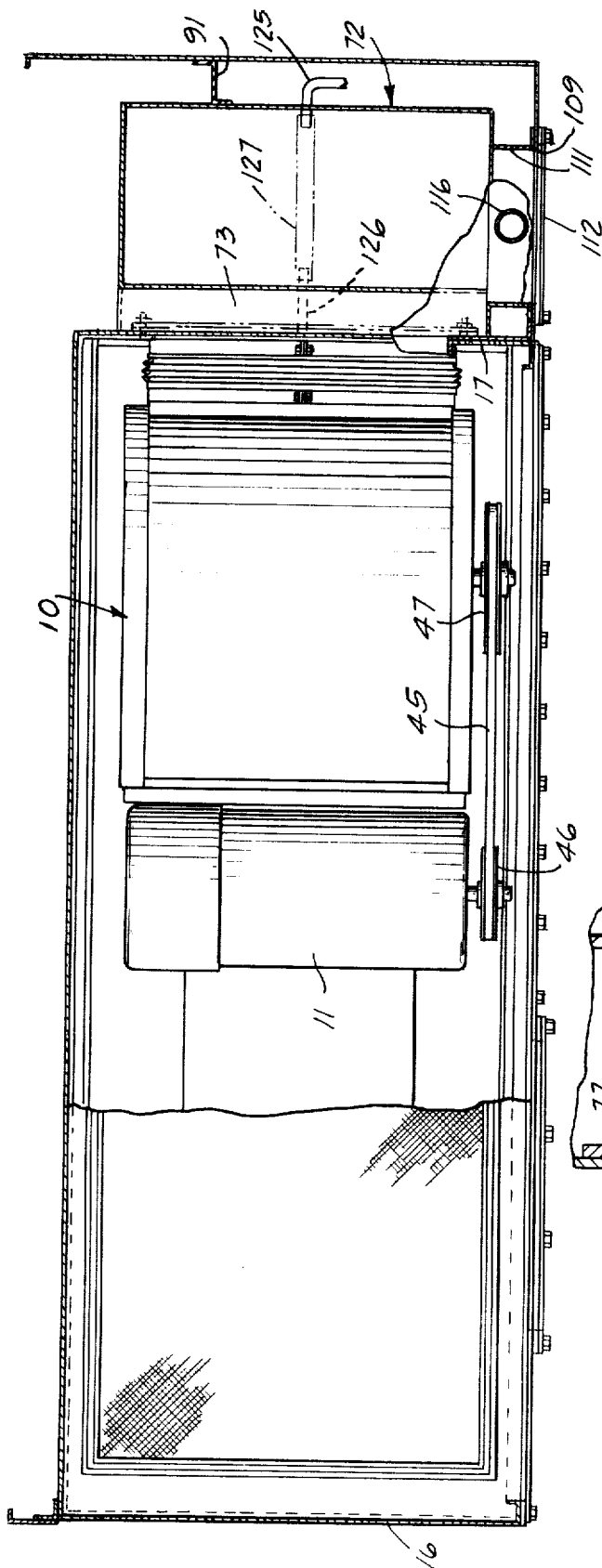


Fig. 5

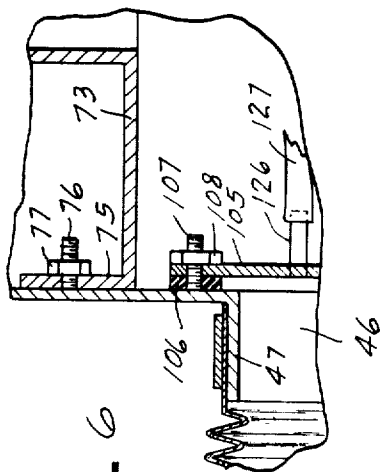


Fig. 6

BIOHAZARD SAFETY CABINET**BACKGROUND OF THE INVENTION**

With increased research activity in biotics, a need has arisen for so-called "biohazard" safety cabinets which are intended to provide a sterile work environment and simultaneously protect the surroundings from any air-borne contaminants.

In general, devices of this type employ a cabinet structure, adapted to be floor supported, and have provided with a horizontal work surface intermediate the top and bottom of the cabinet structure. The portion above such work surface in effect forms a protective hood operatively enclosing the space above the work surface, which includes a rear wall, side wall and a top wall structures, with the front wall thereof being provided with a laterally extending opening, usually co-extensive with the work surface and having a height sufficient to provide reasonable access to the work surface by utilizing personnel. To enable such personnel to conveniently review the operations being performed within the cabinet, the front wall thereof directly above the access opening is provided with a suitable transparent panel of glass or other suitable material.

In the operation of cabinets of this general type, a flow of air is circulated through the work chamber, such air being discharged into the chamber from the top thereof and withdrawn therefrom at the bottom of such chamber i.e., through suitable openings adjacent the actual work surface. Such air movement is effected by means of a suitable blower with the air, following passage through a decontaminating filter, being recirculated into the work chamber. As such air movement will also aspirate air at exterior of the cabinet, through the access opening, a volume of air is constantly being added to the recirculated air with substantially a like amount of circulating air being exhausted from the cabinet to the exterior.

It is common practice in cabinets of this type to dispose the air-moving blower in the portion of the cabinet below the work surface, which may be termed the "base portion" of the cabinet. Such cabinet is normally provided with a duct structure, at the rear of the work chamber, for the passage of air discharged by the blower to a space above the work chamber and a decontaminating filter is disposed adjacent the top of the work chamber whereby all air returned to the work chamber is decontaminated by passage through such filter. To insure decontamination of the excess air to be exhausted from the cabinet, usually from the top of the cabinet, the latter is provided with a second filter, disposed within the top portion of the cabinet at such exhaust outlet to decontaminate all air discharged exteriorly of the cabinet.

Cabinets of this general type of construction present numerous disadvantages, one of the most serious being that as the decontamination filter for the circulating air flow is disposed directly above the work chamber and thus substantially at the air inlet thereto for such air all other portions of the structure disposed in the recirculating air path, subsequent to the flow of such air from the work chamber at the bottom thereof carries or conducts air which is or may be contaminated, termed herein "contaminated air." Thus, in such constructions the entire cabinet volume with the exception of the actual work chamber must be efficiently sealed during operation with respect to the exterior to prevent possi-

ble escape of contaminated air from the cabinet. A relatively heavy type of construction is therefore employed.

Likewise, as the duct for returning air from below the work surface to the top of the work chamber is disposed behind the work chamber the physical dimensions of the cabinet from front to rear is accordingly enlarged and as such the resulting cabinet is normally both bulky and heavy and of a "unitary" design, its breakdown into individual sections units, and thus its transport through relatively small doorways, etc. is prevented.

Likewise such type of design necessitates the utilization of two decontaminating filters, one for the recirculating flow and the other for the exhaust flow, resulting in additional cost as well as necessitating the decontamination of two filters and the possible replacement of two filters instead of one.

Cabinets of this design employ a viewing window of fixed construction, above the access opening, for example, a bolted and gasketed panel, which must be removed if equipment having dimensions to large to permit insertion through the access opening, are to be placed in the work chamber. In some cases access is provided by a similar removable panel in one end wall of the cabinet.

As decontamination of structures of this type usually involve the circulation of suitable vapors, for example, a suitable formaldehyde or ethylene oxide, decontamination must take place with the cabinet efficiently sealed in air-tight relation, thus requiring in addition to the effected sealing of the viewing panel, the sealing of the access opening by a suitable closure member.

The pressurizing of substantially the entire system of prior devices with contaminated air further necessitates the effective sealing of all supply fixtures, electrical, gas, etc. at their entrance to the cabinet to prevent possible leakage of contaminated air thereat, and requires extensive test procedures to determine adequate sealing of all components.

The present invention therefore has as its principle objective to eliminate the various disadvantages of prior cabinet design.

BRIEF SUMMARY OF THE INVENTION

A considerable number of the disadvantages referred to in connection with prior devices, are eliminated in the present invention by the employment of a cabinet design in which the cabinet space or volume, subjected to contaminated air, is reduced to substantially a bare minimum, in particular, a relatively small volume disposed directly below the work surface, with the decontaminating filter being disposed to directly receive contaminated air within said volume. The decontaminated air at the outlet side of such filter is then conducted to the air intake of the circulating blower and from the latter conducted by suitable duct means to the upper portion of the hood, from which it is discharged into the work chamber. Thus, with this construction, only the volume involving contaminated air and such additional space as may be required or desirable to effect efficient decontamination procedures need be fabricated as an air-tight structure. The remaining ducts, hood, etc., carrying only decontaminated air, in particular air under pressure, does not require absolutely air-tight construction as would otherwise be imperative if the structures were carrying contaminated air. As a result,

usual or standard commercial fabrication techniques may be employed and no special sealing techniques are required with respect to electrical and other supply lines to such other portions of the cabinet. It will be apparent that any minor leakage that may result in such portions of the system are immaterial and have no effect upon the operation of the structure, particularly in view of the fact that normally a percentage of the circulating air will be exhausted to the exterior.

The present invention also employs a modular construction in which the base structure, hood structure and duct structure connecting the same are built as individual or unitary sub-assemblies which may be individually handled and transported and subsequently assembled at the location of usage, with the respective sub-assemblies or units each being sufficiently small that they may be readily carried through a standard 30 inch doorway.

In a preferred embodiment of the invention, the cabinet is constructed in 3 sections, a base unit or section, a hood unit or section, and a duct unit or section by means of which the base and hood sections are operatively connected. In this construction the blower and driving means therefore is located in the base structure which is of air-tight construction so that by suitable sealing of the upper face i.e., the work surface, of the cabinet and by similar sealing of the air outlet opening in the base structure, the latter may be effectively sealed in air-tight relation and suitably decontaminated.

Provision is also made for the inclusion of a suitable heating element within the base structure, by means of which decontaminating materials may be vaporized, and to facilitate the use of such structure the base section may, in addition to a suitable access opening enabling removal and/or replacement of the filter element, include a sealable access opening through which decontaminating material may be disposed within the base structure, preferably sealed by a transparent closing member to enable viewing of the interior during its decontaminating operation.

It will be appreciated that as the hood structure is subjected only to decontaminated air, under pressure, or decontaminated air under negative pressure, air-tight sealing of the viewing window structure is not required and the latter thus may be designed as a movable sash structure capable of being raised and lowered. In view of this construction the entire front wall of the work chamber may be readily opened to permit insertion of large object and equipment into the work chamber, eliminating any need for removing the window structure from the cabinet. Further, such sash structure may be of a size and so supported that it may be lowered to effectively close the work chamber with respect to the exterior when the chamber is not being utilized preventing the entry of duct and dirt therein and tending to keep the chamber in a reasonably sterile condition.

Further, by the inclusion of suitable control means, for example switches, arranged to be actuated by predetermined positioning of the sash structure, the blower may be suitably controlled, for example, shut down when the sash, is in closed position, or the operation of the blower reduced when the access opening is reduced beyond a certain point or is closed entirely, to insure an air circulation in the chamber commensurate with the particular positioning of the sash. Obviously,

in the event the chamber contains materials which have a contaminating action, adequate air circulation with a completely or partially closed sash, may be considerably less than the circulation desired when the sash is in its normal operable position, more or less corresponding to the fixed opening of prior structures.

It will also be appreciated that with this arrangement only a single filter is required, as the air is filtered immediately following its passage into the base structure, and in view of the positioning of the filter the latter may be of substantially the same area as the cross-sectional area as the base structure and without any material restrictions on the depth of the filter enabling the use of high capacity filters. Means may also be provided adjacent the front edge of the work surface i.e., adjacent the sash, for directing an inflow of air at the bottom of the access opening to improve the flow pattern adjacent the access opening and thus effectively reduce undesirable air turbulence at the access opening, particularly when an operator's arms are extended therethrough into the work chamber. Novel means also may be provided for discharging air under pressure adjacent the front edge of the work surface to improve the flow conditions thereat.

The present invention also may employ a novel air distribution assembly in the upper portion of the hood structure to insure efficient air flow across the entire cross-sectional area of the hood structure.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings wherein like characters indicate like or corresponding parts:

FIG. 1 is a front elevational view of a cabinet embodying the present inventions;

FIG. 2 is a sectional view taken approximately on the line II—II of FIG. 1;

FIG. 3 is a fragmentary top plan view with portions broken away to illustrate details of construction;

FIG. 4 is a sectional view through the base unit, taken approximately on the line IV—IV of FIG. 1;

FIG. 5 is a top plan view, with portions broken away, of the pressure plate defining the hood inlet for air circulated through the cabinet;

FIG. 6 is a sectional view of a portion of the base and duct structures at the air outlet of the blower;

FIG. 7 is a sectional view through a portion of the top of the base structure, illustrating the mounting thereon of a sealing plate for use in decontaminating the filter structure of the unit; and

FIG. 8 is a sectional view of a portion of the duct structure adjacent the access opening therein, illustrating the mounting of sealing means at the inlet of the auxiliary air duct, utilized when decontaminating the filter.

DETAILED DISCLOSURE OF THE INVENTION

Referring to FIGS. 1 and 2, the cabinet illustrated comprises three unitary sub-assemblies, a base structure or unit indicated generally by the numeral 1, a hood unit or structure indicated generally by the numeral 2, disposed above and supported by the base structure 1, and what may be generally termed a duct unit or structure indicated generally by the reference numeral 3, disposed at the right end of the assembled base and hood structures, as viewed in FIG. 1, and which also may be provided with a control panel 4,

adapted to contain such control and indicating equipment as may be desired.

The upper portion of the base unit 1 is provided with a forwardly extending portion 5 of greater horizontal area than the lower portion of the base unit with the top of the unit being constructed to provide a work surface, indicated generally by the numeral 6, which is enclosed at the rear and ends by the corresponding walls of the hood structure 2. The front of the hood is provided with a sash member, indicated generally by the numeral 7, which may be disposed as illustrated in the drawings with the lower edge 8 of the sash member spaced upwardly from the top of the base unit to define an access opening 9. Preferably, the sash 7 is movably supported whereby it may be raised from the position illustrated in the drawings to enlarge the access opening whereby equipment of greater size than the illustrated access opening may be readily disposed within the work chamber defined by the hood structure and the work surface 6. Likewise, preferably the sash member is so proportioned and supported that it may be moved downwardly to substantially completely close the access opening when the structure is not in use or when otherwise desired.

Disposed in the base unit 1 is suitable air moving means, illustrated as comprising a blower, indicated generally by the numeral 10, and a drive motor 11 therefor, both of which may be of standard construction, with the blower being adapted to draw air through the base unit, discharging the same in a portion of the duct structure 3 operative to conduct the same to the top of the hood structure 2. Also disposed in the base unit 1 is a suitably constructed decontaminating filter, indicated generally by the numeral 12, adapted to decontaminate circulating air prior to its entry into the blower 10 as hereinafter described in detail.

THE BASE UNIT

As illustrated, particularly in FIGS. 1 and 2, the base unit 1 comprises a rear wall 13, a bottom wall 14, and a front wall 15 which are connected at opposite ends by respective end walls 16 and 17. Extending across the upper portion of the base unit is a partition wall 18 which extends outwardly from the front wall 15 and is connected by a diagonally extending wall 19 to the front wall 21 of the portion 5. The wall 18 is provided with an opening 22 therein operatively connecting the upper chamber, defined by said wall, with the lower portion of the base unit, which opening is defined by a peripheral upwardly extending flange 23. The wall 18 and flange 23 thus cooperate to form a drip pan in which liquid may accumulate and be drawn off through a suitable valve 24.

Access to the interior of the base unit 2 is provided by a plurality of access openings in the front wall 5, two of which, 25 and 26 are of relatively large area and closed in air-tight relation by respective closure members or panels 25' and 26'. A third relatively small access opening 27 being provided in the closure member 26' and likewise closed in air-tight relation by a closure member or panel 27'. All of such panels are detachably secured to their respective supporting members by respective studs 28 and cooperable cap nuts 29, or by other suitable means, each closure member having a peripheral gasket interposed between it and the cooperable supporting member to provide the desired air-tight conditions. Preferably the panel 27' is constructed

at least in part of a transparent material, forming a window section through which the interior of the base unit may be viewed in connection with decontamination operations, as hereinafter described in detail. Extending between the end walls 16 and 17 of the base unit at the top thereof are a pair of support members 31, which are cooperable with flanges 32 disposed adjacent the front and rear wall of the portion 5, for supporting respective grill members 33 and a tray member 34, which form the work surface of the cabinet structure.

The filter structure 12 is disposed below the partition wall 18 and for example, may comprise a frame member 35 extending completely around the sides and ends of the structure, encircling and supporting the filter element 36 thereof which may be of standard construction readily procurable on the open market, for example, the so-called HEPA filters. The filter 12 is supported from the peripheral frame 35 thereof by an annular frame member 37 having its adjacent edges secured to the corresponding walls of the base unit in air-tight relation, for example, by means of welding or the like, and is provided with a central opening therein defined by an upwardly extending peripheral flange 38 adapted to be disposed in a cooperable peripheral groove 39 in the lower edges of the frame 35. A highly efficient air-tight seal therebetween is effected by means of a suitable mastic 41 disposed in the groove 39 and effectively embedding the flange 38 therein, with the filter being firmly retained in operative relation by suitable means such as a plurality of clamp bolts 42 suitably threaded in supporting brackets 43 whereby downward pressure can be exerted upon the filter structure, a sufficient number of such hold down members being provided to insure firm efficient retention of the filter in operative position.

As illustrated in FIG. 2, one or more extensions 44 may be provided at the front of the base unit, for example, adjacent opposite ends of the latter to provide additional stability for the cabinet structure. The motor 11 may be suitably connected with the blower 10 by a drive belt 45 operatively connecting the drive pulley 11' of the motor with the drive pulley 10' of the blower. Access to the motor and blower maintenance and service thereof may be readily achieved through the access opening 26.

As illustrated in FIG. 1, the end wall 17 of the base unit is provided with an air discharge opening 46 therein which is defined by an inwardly directed flange which is adapted to receive a flexible tubular connecting bellows 47 operatively connecting the outlet of the blower 10 with the discharge opening 46.

As illustrated in FIG. 2, the upper front corner of the portion 5 may be provided with a deflector member 48 of generally inverted L-shaped configuration, in transverse cross-section, which is secured to the front wall 21 by a plurality of longitudinally spaced members 49, whereby an air passageway extends from the exterior to the interior of the cabinet adjacent the work surface with the member 48, in the embodiment of the invention illustrated also forming a sill for the sash member 7.

THE HOOD ASSEMBLY

As clearly illustrated in FIGS. 2 and 3, the hood unit 2 comprises a rear wall 51, a pair of end walls 52 and 53, a top wall 54 and a front wall 55 extending across the upper portion of the hood structure. Carried by the

hood structure at each side of the access opening 9 therein are respective channel members, indicated generally by the numeral 56, of a size to receive the vertically extending side member 57 of the sash 7, thus forming guides in which the latter is vertically slidable. Mounted adjacent the ends of the front wall 55, at the inner side thereof, are suitable respective sash balances 58, of the spring type, which counter balance the weight of the sash 7 and is cooperable with the channels 56 to retain the sash in any of its adjusted vertical positions. It will be noted that the proportions of the sash, particularly the height thereof is sufficient to enable the sash to be moved downwardly into engagement with fill formed by the member 48, thus completely closing the interior of the hood, or raised to a position such as illustrated in FIG. 2, which may be termed a normal operating position, providing access for an operator to the interior of the structure. Likewise as a guides are open at their upper ends, and the front wall 55 is disposed inwardly with respect to the sash 7, the latter may be raised upwardly to position the lower edge of the sash substantially adjacent the bottom edge of the front wall 55, thereby exposing the entire frontal area of the work chamber of the hood and readily permitting the disposition of relatively large equipment and the like into the hood, which otherwise could not be inserted through the normal access opening 9, illustrated in FIG. 2.

The walls 51, 52, and 53 are provided at their lower edges in outwardly extending flanges 59. To insure the air tight relation of the base section, all additional elements secured thereto at the exterior thereof preferably are mounted and secured in relation by respective studs, welded or otherwise secured to the base unit and extending outwardly or upwardly therefrom, as the case may be, and cooperable cap nuts or other means 61 threaded thereon.

As illustrated in FIG. 2, the side wall 53 of the hood assembly is provided with an air inlet opening 62 therein through which clean or decontaminated air may enter the upper portion of the hood.

Disposed below the opening 62 and cooperable with the rear wall 51, top wall 54, end walls 52 and 53, and front wall 55 is a horizontally extending structure, hereinafter termed the "pressure plate," generally indicated by the reference numeral 63, which form an air inlet and distribution chamber extending across the top of the hood structure, adapted to be supplied with air through the inlet opening 62.

FIG. 5 is a plan view of a portion of the pressure plate or assembly 63 with a part thereof broken away to show the details of construction. As illustrated, the assembly 63 comprises an upper plate 64 and a lower plate 65 which extends parallel to the plate 64, both of such plates being provided with a plurality of like apertures 66 therein, illustrated as being substantially vertically aligned with one another, for example as a result of identical construction and configuration. Disposed between the plates 64 and 65 is a honeycomb grid structure, indicated generally by the reference numeral 67 comprising a plurality of vertically extending wall sections united along their junctures to form a plurality of parallel air passages, each of which has walls in common with other air passages, and each such air passage being of hexagonal configuration in transverse cross section. The plates 64 and 65 and the honeycomb grid structure 67 may be secured in assembled relation by

any suitable means as for example welding or the like adjacent their peripheral edges.

Disposed in the air inlet chamber, and extending from front to rear, are a plurality of air deflection or turning vanes 69, illustrated as being of increasing transverse width with increasing distance from the air inlet opening 62, and are arranged to promote distribution of air flow over the top of the pressure plate 63. The latter functions to create a slight head of air pressure within the air inlet chamber and at the same time tending to promote air flow through the pressure plate at right angles to the plane thereof whereby the air will be discharged in a smooth uniform substantially vertical flow. The vanes 69 and plate 63 thus cooperate to insure substantially uniform distribution of air into the top of the work chamber.

Extending across the upper portion of the hood, directly below the pressure plate 63 are a plurality of elongated fluorescent tubes 70 which may be suitably supported at their respective ends, for example, by the side walls 52 and 53, utilizing suitable conventional sockets, not illustrated in detail. Disposed below the lamps 69 is a light diffusing grill 71 which may be of plastic and of known configuration, such as a so-called "egg crate design," operative to direct light from the bulbs 69 substantially directly downwardly toward the work surface and thereby adequately illuminate the work chamber defined by the work surface 6, diffusing grill 71, hood walls 51 to 53 and sash 7.

The cabinet illustrated is also provided with a U.V. lamp 70' which extends across the rear wall 51, adjacent the grill 71, and preferably may be inset into such rear wall whereby it does not materially extend into the work chamber.

THE CONNECTING DUCT STRUCTURE

Referring to FIGS. 2 and 3 the blower outlet opening 46 in the end wall 17 of the base unit and the air inlet opening 62 in the end wall 53 of the hood assembly are operatively connected by the duct unit or assembly 3, which includes a duct member 72, of generally rectangular transverse cross section. The member 2 is adjacent its bottom end provided with a laterally extending connecting portion 73 and adjacent the top end with a laterally extending connecting portion 74. Both connecting portions may be provided with outwardly directed peripheral flanges such as the flanges 75 of the section 73, a portion of which is illustrated in section in FIG. 6, with the flanges 75 of the lower section 73 being secured to the adjacent wall 17 of the base unit by studs 76 extending outwardly from the wall 17 and cooperable nuts 77. The flange of the upper section 74 may be similarly secured to the end wall 53 of the hood structure, using for example sheet metal screws or the like.

Secured to the top wall 78 of the duct 72 is a damper structure indicated generally by the numeral 79 which is secured to the top wall 78 by suitable means such as sheet metal screws, spot welding or the like. The damper structure 79, illustrated as being of the slide type, determines the size of the air by-pass outlet opening 81, which is adapted to be partially or completely closed by adjustment of a sliding damper member 82, whereby the effective size of the by-pass opening may be varied. Thus by suitable adjustment of the damper member 82 of the amount of by-pass air discharged exteriorly of the cabinet and thereby the pressure head of

air existing at the pressure plate 63 may be adjusted to desired values. The duct subassembly or unit 3, includes, in addition to the duct member 72, a sheet metal structure indicated generally by the numeral 83, which has a front and side wall configuration which matches the corresponding configuration of the hood structure and the projecting portion 5 of the base structure 2, so that the structure 83 visually appears to be a lateral extension of the hood structure. As will be apparent from a reference to FIG. 3, the rear wall 84 of the structure 83, is extended downwardly to the floor and thus forms the lower front wall 84' of the duct structure 3, the wall 84' thus being disposed in substantially the same plane as the front wall 15 of the base unit. As clearly illustrated in FIGS. 1 and 3, the structure 83 provides a convenient front wall 85 upon which the control panel 4 may be mounted, the structure 83 thus providing a suitable container for such equipment.

As illustrated in FIG. 3 the end wall of the cabinet structure may be finished off to form plane surfaces by respective panels 86 and 87, the panel 86 extending above the base unit in the plane of the side wall 16 and being secured to the side wall 52 of the hood structure by suitable Z bars 88 which may be, for example, spot welded to the side wall 52 and secured by means of sheet metal screws or the like to the panel 86. In like manner the panel 87 is adapted to extend to the bottom of the base unit and disposed in the plane of the side wall of the structure 83, and secured in operative position to the latter and to the duct 72 by angle and Z bars 89 and 91 respectively which, for example, may be secured by spot welding or the like to their associated structure 83 or duct 72, and sheet metal screws or the like extending through the panel 87 and threaded into the associated angle or Z bars. As illustrated, the upper end of the structure 83 may, if desired, be closed by a cover member 92 of sheet metal and provided with downwardly extending flanges disposed at the inner faces of the wall of the structure 83 and secured thereto by sheet metal screws or the like.

It will be appreciated that the duct member 72, structure 83 and panel 87 thus may form a unitary subassembly, heretofore termed the "duct unit or subassembly," which may be cooperably assembled with the base and hood subassembly.

To reduce turbulence in the duct 72, a plurality of turning vanes 93 may be disposed in the duct adjacent the connecting portion 74, thereby promoting smooth, quiet airflow through the duct.

DECONTAMINATION PROVISIONS

Referring to FIGS. 2, 3 and 7, it will be noted that the grills 33 and tray 34 are encircled by the horizontal annular top wall 94 of the base unit 2. The flanges 32 extend entirely around the work surface and are connected to the wall 94 by vertically extending connecting walls 95 each of which are provided with a series of elongated, horizontally extending slots 96 therein.

FIG. 6 illustrates details of the means for sealing the top of the base unit, i.e., the work surface 6 including the grills 33, tray 34, during decontamination operations. As illustrated, the slots 96 in the vertical offset wall 95 extending around the grill members 33 and work pan 34 are adapted to receive horizontally extending projections 97 carried by respective screws 98 threaded into a closure plate 99. The latter is illustrated as having an upwardly turned peripheral flange 101 to

provide peripheral rigidity whereby an annular gasket 102 may be compressed between the peripheral portions of the plate 99 and the adjacent surface of annular top wall 94 of the base unit, by the application of clamping forces produced by the screws 98 and cooperating nuts 103 threaded upon the screws 98, which nuts are of the sealing type, effectively sealing the respective openings through which the bolts extend. Engagement of the projections 97 in the slots 96 may be readily effected by means of a screw driver or other tool inserted in the end slot 104 of the respective screws.

In like manner, the opening 46 may be readily sealed, during decontamination by a suitable closure plate 105 and cooperable annular gasket member 106, as illustrated in FIG. 6, the plate 105 being clamped in sealing relation by a plurality of studs 107 secured to the end wall 17 of the base unit and cooperating cap nuts 108 threaded on the studs 107. The sealing plate 105 may be readily placed in operative position by the utilization of the access openings 109' in the wall 84' which opens on the duct member communicating with the interior of the duct 72. The closure plate 112 for the access opening 109 may be suitably secured in place by sheet metal screws or other suitable means.

The described construction of the top of the base unit also enables in a simple manner, a supply of clean air under pressure to the work chamber adjacent the front edge of the base unit, for cooperation with the deflector 48 thereat. Referring particularly to FIG. 2, the base unit 2 is provided at its upper front corner with a diagonally extending partition member 113 secured to the adjacent walls in air-tight relation to form a duct 114 along such front edge of the work surface. The slots 96 in the wall 95 at such front edge thus operatively connects the duct 95 with the work chamber directly adjacent the grill 33 and the inner edge of the deflector 48. The duct 114 is provided with an air inlet opening 115 in the end wall 17, operatively connected to the interior of the duct 72 by a conduit 116, the supply end of which, as illustrated in FIG. 8, is mounted on a cooperable fitting 117 on the top wall of the duct member 111. The duct 114 thus is operatively connected to a supply of clean air under sufficient pressure to promote a nonturbulent flow of air through the space between the deflector 48 and the adjacent wall of the base unit, and thereby tends to reduce undesired turbulence in air entering the work chamber through the access opening 9. The conduit 116 may be operatively sealed during decontamination procedures by suitable means, such as a threaded plug 118 and gasket 119.

OPERATION OF THE DEVICE

In operation, air is exhausted from the blower 10 through the outlet opening 46, conducted therefrom by duct 72 to the air inlet opening 62 in the upper portion of the hood assembly 2, operative with the aid of the vanes 69, to build up a slight head of pressure at the pressure plate 63, whereby the air entering the work chamber flows downwardly substantially uniformly completely over the cross-sectional area of the work chamber, from which it flows downwardly to the work surface and drawn through the respective grill 33, through the opening in the partition wall 18, and filter 36 into the lower portion of the base unit to the inlet of the blower 10.

It will be particularly noted that as the filter 12 is disposed below the work surface 6, and substantially directly adjacent thereto the only space or volume in the entire cabinet, which may be subjected to contaminated air, is that volume which is operatively interposed between the work surface 6 and the filter 12 i.e., contaminated air flowing through the grill plates 33 passing through the opening 22 in the partition wall 18 to the inlet side of the filter. All other air passages and spaces, including the lower portion of the base unit 10 below the outlet side of the filter 12, the duct 72, and the entire work chamber are subjected only to clean or decontaminated air. Consequently all duct structures, etc., at the outlet side of the blower 10 i.e., at the outlet 46 in the wall 17 are not required to be of air-tight construction (as they would be if carrying contaminating air under pressure). Conventional sheet metal fabrication thus may be employed for all such structures and no elaborate air-tight sealing arrangement need be considered. Any leakage at joints or cracks, would in such case be minimal and would have no effect upon the operation of the system as a portion of the circulating air will normally be discharge through the by-pass opening 81 and any leakage thus can be compensated by a corresponding slight additional closure of the damper structure 79.

At the same time, the work chamber is substantially at a negative pressure adjacent the work surface 6 and thus adjacent any contaminating material, as a result of which negative pressure air will flow inwardly through the access opening 9. Consequently, any danger of an outflow of contaminated air from the work chamber is completely prevented. At the same time, the deflector structure 48 and cooperable air flow from the duct 114 insures an inflow of air directly adjacent the work surface, thus tending to prevent a reverse flow of contaminated air through the access opening 9, as well as insure a substantially uniform pressure across the work or access opening tending to minimize entrance turbulence. Likewise, as the hood enclosure is either under pressure from clean air or a negative pressure with respect to contaminated air, sealing of the hood structure with respect to the base unit is not necessary and again standard sheet metal construction techniques can be employed. The hood structure will normally be secured to the base unit with a suitable gasket member interposed therebetween. Likewise, for the same reasons, conventional mounting techniques may be employed in connection with electrical wiring, fittings, etc., in all units other than the base unit instead of air-tight connections which would otherwise be required if the associated structure were under pressure of contaminated air. Consequently, all wiring within the hood and duct assemblies may be installed without special sealing precautions.

Where, for any reason, it is desired to exhaust the by-pass air to a remote point, the damper structure 79 may be replaced by a duct 79' communicating with the by-pass opening 81, with the volume of air being discharged through the duct being controlled by a suitable damper member 82' which, for example, may be a butterfly valve member of standard construction.

As the sash member 7 is vertically adjustable to vary the size of the access or work opening 9, the position of such sash member may be utilized as a determining factor in the control of the system.

For example, in some cases it may be desirable to reduce the output of the blower 11 when the size of the access opening is reduced to a predetermined minimum, or in the event the sash is moved to a fully closed position. Likewise, in some applications it may be desirable to shut off the blower when the sash is moved to a fully closed position or in some cases to a fully open position. This can be readily accomplished by suitable disposition of a control switch, for example a switch 121 (FIG. 1), which is therein illustrated as being so positioned that it will be actuated when the sash 7 has been moved downwardly to the position illustrated in FIG. 1, with the switch 121 being utilized to control the motor in a desired manner, for example, at a different operational level, when the switch 93 is actuated by the sash. Likewise, a switch 122 (FIG. 1) may be provided which is adapted to be actuated by the sash 7 when the latter reaches a fully closed position, and which, for example, may be employed to reduce the operation of the blower or to shut the blower off completely, as desired. If desired a combination of such types of operation may be obtained by utilizing a plurality of such switches suitably located.

DECONTAMINATION OF THE SYSTEM

Filters of the type referred to for effecting decontamination of biologically contaminated air in most instances are adapted to be decontaminated by the use of ethylene oxide. Where formaldehyde is employed as the decontaminating vehicle, it will normally be vaporized by the application of heat within the contaminated volume, operative upon passing through the filter structure to destroy any contamination accumulated therein.

Prior biohazard cabinets of the type previously described in which the filter for the circulating air is disposed above the work chamber, adjacent the air inlet to the latter, and which require a supplemental filter for the by-passed air, of necessity involve constructions in which substantially the entire cabinet structure, with the possible exception of the work chamber, is exposed to contaminated air under pressure. Consequently with such constructions extreme care must be taken to insure that all portions of the cabinet structure coming in contact with or carrying contaminated air are of air-tight construction i.e., the entire cabinet structure. Likewise, due to this construction decontamination procedures must, of necessity, involve the entire cabinet structure. It therefore becomes necessary that the transparent front wall, through which operations in the cabinet may be viewed, be mounted on the cabinet structure in air-tight relation and that provisions be made for correspondingly sealing the access or work opening during decontaminating procedures. consequently, in such construction the transparent window portion of the front wall is normally bolted to the remainder of the cabinet structure, utilizing suitable gasket means to insure an air-tight seal therebetween, and provisions must be made to effect an air-tight closure at the access opening during the decontamination operations.

In contrast with such type of decontaminating procedures, as the only contaminated volume in the present cabinet, is in the base unit, and while only portions of the base unit, coming in contact with contaminated air, theoretically need be decontaminated, to facilitate the decontaminating operation, the entire base unit em-

plays an air-tight construction with respect to all joints etc., as the only two openings in the base unit, one at the top of the unit and the air discharge outlet 46, following sealing of such openings by the sealing plate 98 and 105, the decontaminating material may be introduced into the base portion to decontaminate the entire interior of the base structure, although only the filter 12 and space thereabove in the base unit, requires such decontamination, from a practical standpoint.

To facilitate such decontamination procedures with formaldehyde the interior of the base unit at the lower left hand bottom thereof may be provided with a suitable heating vessel indicated generally by the reference numeral 123, (FIG. 1) which may be permanently installed in the base unit and operatively connected to a suitable source of electricity, utilizing of course, air-tight electrical connectors etc., where required, and controlled by a suitable switch on the control panel 4. Access to the vessel 123 may be readily achieved through the opening 27 by removal of the transparent panel 27', following which the latter may be replaced. The decontamination operation may be viewed through the panel 27'.

In the event ethylene oxide is employed as the decontaminating material, it may be readily introduced into the base unit, following sealing of the latter as previously described, through the valve member 24.

It is common, in connection with the the operation of filters such as hereininvolved, to measure the pressure drop across the filter as a indication of the condition of filter. However, as such measurement is not a true indication of such condition, there is provided in the present invention a velocity indicating device by means of which the air velocity at the blower outlet may be determined, which will provide a much more accurate indication of the filter pressure drop and relative efficiency. Such indicating device may, for example comprise an indicating manometer having an indicating meter 124 or the like, mounted on the control panel 4 and including velocity sensing means, for example an air velocity sensing tube 125 extending into the duct 72 opposite the air outlet 46.

The air indicating device may also be utilized to sense the static pressure in the base unit during decontamination thereof, by providing a connector tube or pipe 126 on the sealing plate 105, which tube may be connected with tube 125 by a suitable length of hose 127, when the sealing plate 112 is removed.

It will also be noted that by suitable proportioning and disposition of the blower 10 and motor 11 in the base unit, for example, disposed horizontally enough vertical space may be gained to permit the work surface of the cabinet to be lowered from the normal 35" or 36" to table height of 30".

Having thus described my invention it is obvious that although minor modifications might be suggested by those versed in the art, it should be understood that we wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of our contribution to the art.

We claim:

1. In a biological safety cabinet for preventing contamination externally of the cabinet from a contaminant disposed therein, the combination of a hollow base structure, the upper portion of which is constructed to form a work surface, a hood structure ex-

tending above said work surface and adapted, in normal operation, to form a chamber enclosing said work surface, with the exception of an access opening adjacent one edge of said work surface, through which air may enter from exteriorly of the cabinet, the wall of said hood structure above said access opening being provided with a transparent window through which the interior thereof may be viewed, said base structure having openings therein adjacent said work surface for the flow of air from the hood interior into the base structure, an air distribution structure extending over the work surface, operative to discharge air in a downward direction toward said work surface, a vertically extending duct structure disposed adjacent the base and hood structures and operatively connecting the air distribution structure and said base structure and therewith forming an air path for the circulatory flow of air from said air distribution structure downwardly through said hood, through said openings in said base structure and said duct structure back to said air distribution structure, a contaminate filter disposed in said air flow path and positioned in said base structure below the plane of said work surface, operative to intercept and filter the air flowing through said openings in the base structure, air moving means, having an air inlet and an air outlet, disposed in said air flow path intermediate the discharge side of said filter and said air distribution structure, with its air inlet disposed to receive air which has passed through the filter, and its air outlet disposed to effect movement of air through said air distribution structure, said air flow path having an air discharge vent therein, at the air discharge side of said air moving means, through which a portion of the air flow in said path may be discharged from the cabinet, said air moving means being operative to draw all air, entering said chamber from said air distribution structure and from exteriorly of the cabinet, through said openings and through said filter, with the contaminated volume of the cabinet thus being restricted to that portion of the base structure operatively disposed between the work surface and the filter, with the air moving means, the upper portion of the hood and the connecting duct structure all being subjected only to uncontaminated air, the exterior walls of said contaminate-subjected portion of the base structure being of air-tight construction with respect to the exterior thereof.

2. A cabinet according to claim 1 wherein said transparent wall comprises a vertically extending sash member slidably supported by the associated hood structure and movable to vary the size of said access opening, and means cooperable with said sash, responsive to predetermined positioning of the latter, to effect a change in the operation of said air moving means.

3. A cabinet according to claim 1, wherein said air distribution structure comprises a pair of perforated plates disposed on spaced relation, between which extends a member of honey-comb configuration dividing the space between said plates into a plurality of passageways extending transversely to the plane of said plates, operative to direct air passing through said plates in substantially a common direction, with such a structure adapted to produce a predetermined pressure head at the air inlet side thereof.

4. A cabinet according to claim 1 wherein said filter is disposed beneath the work surface and extends substantially parallel thereto approximately coextensive with the cross sectional area of the base structure to

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provide a maximum filter area, and said air moving means is disposed in the base structure beneath the filter.

5. A cabinet according to claim 1, comprising in further combination respective releasable means engagable with said base structure at the top thereof and at the outlet of said air moving means for selectively sealing the interior of the base structure during decontamination of said filter.

6. A cabinet according to claim 5, wherein the sealing means for said outlet comprises a plate member and peripheral gasket means adapted to be mounted in sealing relation on said base structure at the air outlet therein, said duct structure having an access opening therein adjacent said air outlet for facilitating the mounting of such sealing means, and means for operatively closing said access opening.

7. A biological safety cabinet according to claim 1, wherein said air moving means includes a blower disposed in said base unit at the outlet side of said filter, said base unit having an air outlet opening therein communicating with the air outlet of said blower and the lower portion of said duct structure, and means for sealing said base unit during decontaminating operations, comprising a plate member adapted to extend over said work surface and secured in air-tight relation with respect to the peripheral top portions of said base unit, and a second plate member adapted to cover said air outlet in said base unit and secured to the latter in air-tight relation.

8. In a biological safety cabinet for preventing contamination externally of the cabinet from a contaminant disposed therein, the combination of a base structure, the top of which is constructed to provide a work surface, a hood structure operatively enclosing said work surface, and having an access opening therein adjacent the front edge of said work surface, means for circulating a flow of air through said work chamber downwardly from top to bottom thereof, including a blower, disposed in said base structure, having an air inlet and an air outlet, and duct means extending from the blower outlet to the top of said hood structure, the blower inlet communicating with the hood interior at the bottom thereof and adapted to withdraw all air entering the hood, decontaminating filter means disposed in the circulating air path for decontaminating all air flowing from the hood interior to the blower inlet, and means disposed adjacent said front edge of said work surface for discharging uncontaminated air generally horizontally inwardly therealong to improve inward air flow adjacent said access opening.

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9. In a biological safety cabinet for preventing contamination externally of the cabinet from a contaminant disposed therein, the combination of a base structure, the top of which is constructed to provide a work surface, a hood structure operatively enclosing said work surface, means for circulating a flow of air through said work chamber downwardly from top to bottom thereof, including a blower, disposed in said base structure, having an air inlet and an air outlet, and duct means extending from the blower outlet to the top of said hood structure, the blower inlet communicating with the hood interior at the bottom thereof and adapted to withdraw all air entering the hood, decontaminating filter means disposed in said base unit for decontaminating all air flowing from the hood interior to the blower inlet, said base unit being adapted to be sealed during decontaminating operations, an air velocity indicator device having an input sensing tube operatively disposed in the decontaminated air flow path from said filter, and means for selectively connecting said input tube to the interior of said base unit when the latter is so sealed for decontaminating purposes, whereby said indicator device will indicate static fluid pressure therein.

10. In a biological safety cabinet for preventing contamination externally of the cabinet from a contaminant disposed therein, the combination of a base structure, the top of which is constructed to provide a work surface, a hood structure operatively enclosing said work surface and constructed to provide an access opening adjacent the front edges of said work surface, means for circulating a flow of air through said work chamber from top to bottom thereof, including a blower, having an air inlet and an air outlet, disposed in said base unit, the latter having an air outlet opening therein communicating with the air outlet of said blower, and an air inlet opening in the top portion thereof through which all air entering the hood is adapted to be withdrawn, decontaminating filter means disposed in said base unit, intermediate the air inlet opening thereof and the air inlet of said blower, for decontaminating all air flowing therethrough, and means for sealing said base unit during decontaminating operations comprising a plate member adapted to extend over said work surface and secured in air-tight relation with respect to the peripheral top portion of said base unit, and a second plate member adapted to cover said air outlet in said base unit and secured to the latter in air-tight relation.

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