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3,425,335

LABORATORY FUME HOOD

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FIG. 1.

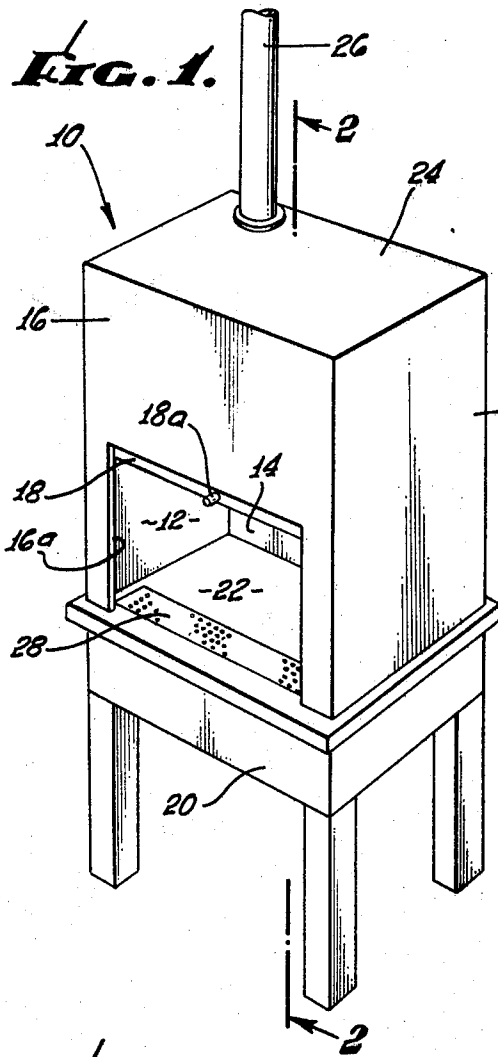


FIG. 3.

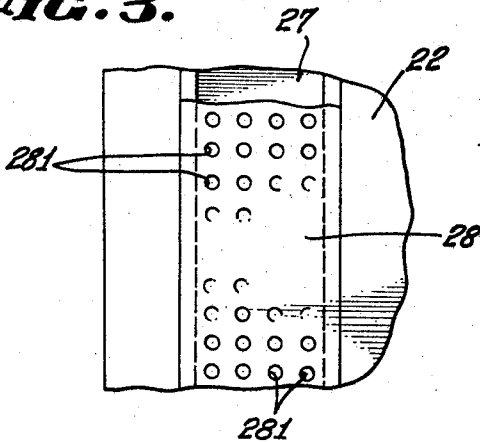
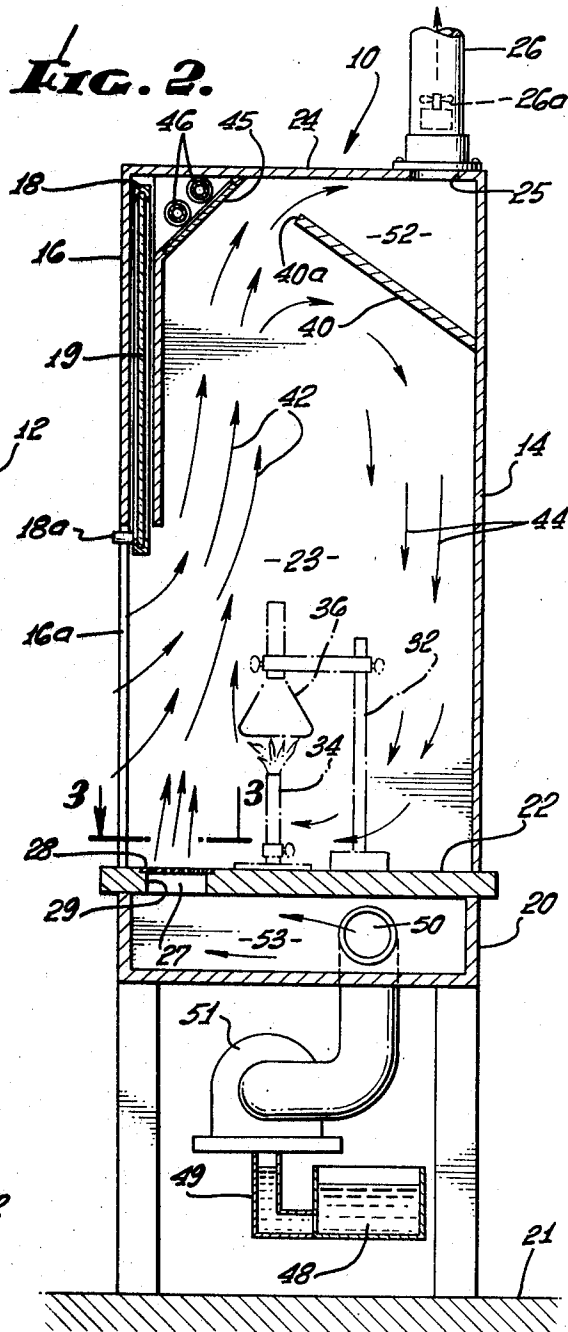


FIG. 2.



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1

3,425,335

LABORATORY FUME HOOD

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Continuation-in-part of application Ser. No. 549,260,

May 11, 1966. This application Jan. 24, 1968, Ser.

No. 700,167

U.S. Cl. 98—115

Int. Cl. F23j 11/00; F24f 9/00

6 Claims

ABSTRACT OF THE DISCLOSURE

Absence of working area turbulence and positive separation of outside air and fume hood air is achieved in a fume hood having an elongated air flow directing grill in the bottom wall, underlying the openable front wall, and communicating with a pressurized air supply to displace air in a vertical air curtain flow pattern across the hood front to positively separate inside and outside air volumes and to simultaneously induce a circular flow of air within the hood to define a central working zone free of turbulent air. Furthermore, the air constituting the curtain can incorporate biologically active materials.

REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of my co-pending application Ser. No. 549,260, filed May 11, 1966 and now abandoned.

BACKGROUND OF THE INVENTION

Field of the invention.—Fume hoods are cabinet-like structures utilized to contain noisome, odoriferous, toxic or otherwise undesirable or dangerous materials used in or formed from reactions, experiments and tests carried out in laboratories. By their nature many of these activities require the attention and manipulation of an operator. Accordingly ready accessibility is important for maximum convenience.

Prior art.—Some fume hoods are designed to stay completely closed during use. Glove boxes are of this type, where interior manipulation is achieved with glove-clad hands extending through a wall of the box.

Most fume hoods, however, are commonly used open to the room in which they are located. A vent to outside air carries away contaminated air.

Two air sources are generally used in air fume hoods. The first is a pressurized air supply such as is produced by a fan or blower. A second air supply is the general environment of the hood which is enlisted by the entrainment of air at the open front of the hood. Such hoods are "auxiliary air" fume hoods.

In fume hoods previously known, the positioning of the positive auxiliary air supply has caused a turbulent or cyclonic condition within the hood and undue velocity in the environmental air indraft in these hoods. Turbulence is the result of forcing air to abruptly collide within the hood. For example, in U.S. Patent 3,000,292 to Wojan, the source of positive pressure air is a fan or blower mounted in the roof forwardly of the exhaust opening. As there described, air is forced downwardly toward the bottom rear corner of the hood, but is simultaneously drawn upwardly toward the top rear corner of the hood with the result that a turbulent condition is produced in the working area of the hood. While a slight degree of turbulence can be tolerated, an undue amount can disturb reaction vessels, extinguish burners, and, in the worst case overcome the provided level of pressurized air and result in the spilling of fumes out through the front of the hood, endangering personnel and defeating the purpose of the hood.

2

In U.S. Patent 2,649,727 to Snow et al. at least two cross-current air streams, one downward and one inward and slightly upward are utilized, increasing the likelihood of excessive turbulence in the hood working zone.

SUMMARY OF THE INVENTION

Accordingly, it is the object of the present invention to provide a fume hood obviating the disadvantage of prior known fume hoods. It is another object to provide a fume hood wherein turbulence within the working zone in the fume hood is avoided. It is a further object to provide a fume hood wherein a spilling out of fumes is positively prevented. It is a still further object of the invention to provide a fume hood enabling relatively great volumes of air to be swept through the fume hood and with quite small components of conditioned environmental air.

These and other objects of the invention are achieved with the fume hood of the present invention by the provision of an air curtain moving upwardly, generally in the plane of the hood front wall as the sole air supply. This curtain induces a rolling of air along the back and bottom of the hood toward the air curtain providing a sweeping of all hood surfaces by an air stream which leaves the central or working portion of the hood free of cross or counter currents and therefore turbulence.

Specifically there is provided in the present invention a method of operating a fume hood to control outflow of unwanted material from the hood interior toward the operator, which includes confining all input air to the hood in a single, generally vertical curtain of air rising from the bottom front of the hood toward the top thereof and inducing generally circular flow within the hood around the working zone therein by the curtain flow to sweep the hood interior without turbulence in the working zone. The circular air movement is about the elongated central portion of the hood interior, the working zone, specifically downwardly along the back of the hood interior and forwardly along the bottom of the hood interior. At the top of the hood air may be exhausted all across the hood width to maintain the curtain of air extending fully across the hood front.

In a specific case, e.g., where live bacteria or other microorganisms are used within the hood, safe operation of the hood even with the hood front wall not in place may be realized by biologically conditioning the air to control organism species entrained therein as by adding a biologically active material, e.g., bacteriostat to be airborne in the air curtain stream.

Apparatus useful for carrying out the method is provided in the form of a fume hood structure comprising a chamber including an openable front wall, a top wall, a bottom wall providing a working surface, side walls and a rear wall, an elongated air flow-directing grill mounted in the bottom wall to underlie the front wall, means forming a reduced pressure zone along the top wall and having an elongated inlet spaced from the rear wall, a pressurized supply of auxiliary air communicating with the grill and operating to displace air through the grill when the front wall is open in a vertical air curtain flow pattern across the open front of the chamber and toward the reduced pressure zone inlet, said air curtain flow acting to positively separate auxiliary chamber air from outside air and to induce a circular flow of air in a rolling pattern within the chamber downwardly along the rear wall and forwardly along the working surface, to join the air curtain flow, the circular pattern air defining a central zone free of turbulent air within the chamber.

The air flow directing grill may comprise a perforate plate or other means having an arrangement of openings which are preferably aligned to provide multilaminar flow vertically upward from the working surface.

The reduced pressure zone is typically formed by a generally horizontal baffle extending across the hood width and in spaced relation with the top wall to form therewith the zone inlet. Suitably the baffle slopes downwardly to the rear of the chamber to join the rear wall.

With the aforescribed arrangement of grill, air supply and baffle "chimney effect" baffles parallel to and closely spaced from the rear wall are not required and indeed are detrimental to maintenance of the desired flow pattern.

In specific application, control of the biological properties of the air curtain may be desirable. Hence in certain embodiments provision is made for adding a biologically active material to the air supply in advance of issuance from the grill from a supply of suitable material.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be further described as to details of illustrative embodiments thereof in conjunction with the attached drawings wherein:

FIG. 1, is an isometric view of the fume hood of the present invention;

FIG. 2, is a side elevation in section of the fume hood shown in FIG. 1 taken along line 2—2 in FIG. 1;

FIG. 3, is an enlarged fragmentary plan view of the air inlet grill taken along line 3—3 in FIG. 2.

Referring now to the drawings in detail, there is shown in FIGS. 1 and 2 a generally rectangular fume hood structure indicated at 10 comprising a chamber generally having side walls 12, rear wall 14, front wall 16 provided with a sliding sash 18 containing pane 19 and movable in opening 16a by sash lifting knob 18a. Chamber 10 is supported on a table or platform 20, representative of a counter or other structure of convenient height resting on the flooring 21. Within the chamber 10 there is a generally horizontal floor providing a working surface 22. Overlying the working surface 22, there is provided a top wall 24. Leading from the interior of the fume hood through eduction outlet or orifice 25 in top wall 24 is exhaust pipe 26 having a suction means or an exhaust device such as a fan 26a. Between the top wall 24 and working surface 22 is the working zone specifically indicated at 23. Within zone 23 in phantom outline there is shown a typical reaction set-up including stand 32, Bunsen burner 34 and flask 36. Exhaust orifice 25 is above and behind horizontal baffle 40, so that as air is exhausted from chamber 62 by fan 26a, a reduced pressure zone is created by a partial vacuum being generated in chamber 52 defined by baffle 40, top wall 24 and rear wall 14.

Air inlet means in the form of grill 28 are provided adjacent the working surface 22 along the openable side of the chamber cut the chamber floor as shown in FIG. 2 or at the front peripheral edge of the floor. As shown in FIG. 2, grill 28 overlies a channel 27 having walls 29 formed just forward of the working surface 22 and within the plane of the sash 18 of wall 16. An air supply port 50 leading from a pressurized air supply means such as a fan or blower 51, provides air along duct 53 to grill 28 extending across channel 27. Grill 28 is shown as a perforated barrier plate having a plurality of holes 281 therein placed in the path of the air flow as shown in FIG. 2. Air from port 50 passes through grill holes 281 and is sent substantially vertically upwardly to the interior of fume hood 10 as a multilaminar wide, thin column herein termed an air curtain (see arrows) and generally indicated at 42. Simultaneously, air is entrained from the open front face of the hood through opening 16a by a venturi effect caused by air directed upward and drawn by the force of the fan 26a at orifice 25. In general, the extent of entrainment of environmental air will be determined by the ratio of the volume of air forced through pressurized air inlet grill 28 and the volume of air being exhausted through orifice 25. In a typical embodiment, per lineal foot of face opening, 125 cubic feet per minute (c.f.m.) of air are provided through grill 28, 150 c.f.m. are exhausted through orifice 25 and correspondingly 25 c.f.m.

are entrained through the open front face of the hood. Air through the face opening at a linear velocity as low as 10 feet per minutes can be drawn through the front opening under these conditions. The pressurized air volume should be less than the exhaust air volume to ensure air intake from the front of the hood. Front intake of as low as 1% of the exhaust volume may be adequate to turn the air curtain inward for partially open hood fronts, for fully open fronts, however, at least 35% of the exhaust air volume should be drawn through the front opening 16a for efficient fume removal.

All air to exhaust orifice 25 as described is drawn either through the space between baffle upper edge 40a and top wall 24. The result is an entraining of fume laden air into the air curtain 42 rising between working zone 23 and front opening 16a, indicated by the substantially vertical arrows in FIG. 2, and the conveying of this fume laden air to the eduction orifice 25 without its being commingled with the environment-derived air also being entrained in the air curtain. A second result is the entrainment of relatively heavy particles, vapors and gases by an air sweep forwardly across the working surface into the air curtain 42. It will thus be seen that an inflow of environmental air is not required to be utilized to sweep the fume hood working surface in the present invention and, therefore, this quantity of air can be substantially reduced; in fact reduced to only enough volume to turn the air curtain inward under sash 18. Additionally, the lowermost portion of the fume hood, particularly the areas immediately adjacent the working surface 22 where heavy vapors collect are traversed by a partial vacuum induced flow of air along working surface 22.

Air curtain 42 entrains air from the working zone 23. This results in creation of a partial vacuum in this zone. Accordingly at points generally lying on a line just below the baffle edge 40a a portion of the air curtain 42 air is induced to move inwardly under the baffle 40. This air indicated at 44 moves to the rear of the chamber interior to the rear wall 14 whence it proceeds downwardly to the greater partial vacuum created inwardly adjacent the grill 28. The result is a rolling clockwise circular or cylindrical air flow from the air curtain 42 at the baffle 40 and to the air curtain at the working surface 22. This cylinder of air revolves about and thus defines the working zone 23. The zone 23 is thereby substantially free of turbulence since all air flows around it are concurrent and no air is forced directly through the zone.

Means such as grill 28 direct air essentially vertically upwardly uniformly across the face of the hood. The normal effect of the air entrained from without the hood is to cause the air curtain to incline inwardly to thereby create a natural fluid barrier between the worker at the hood and the fumes to be withdrawn. It has been found that this air curtain can be temporarily disturbed without loss of effectiveness. For example, arms extended through the air curtain to adjust reaction equipment or whatever and withdrawn do not deleteriously affect the air curtain performance; the upward draft being sufficient to rebuild the curtain rapidly and overcome the temporary interruption caused by movement of solid objects therethrough. This performance is to be contrasted with the effect realized when a downward draft fume hood air flow pattern is disturbed. In such devices the result is a spill-out of fumes and hood failures which can only be overcome by drawing extraordinary amounts of air through the front of the hood.

Various configurations can be used to provide desired air direction through grill 28. It is only required that a substantially uniform, substantial vertically upward flow of air across the entire hood front be provided. Uniformity of flow is obtained by providing a barrier means having a uniform opening or array of openings which offer a pressure equalizing restriction of the air flow path in duct 53 to the air flow from air supply 50. Perforations, reticulations and packed fibers in patterns, shapes and/or

5

sizes, affording substantially equal air flow open areas across the hood front as well as slotted arrangements can be used. To ensure uniformity of air flow across the air outlet, a slight back pressure should be maintained in duct 53. In general, backpressures measuring as little as 0.01 inch of water is adequate with 0.02 inch and up to 0.15 inch being preferred with up to 1-inch offering advantage.

For illumination within the hood behind lens 45 fluorescent bulbs 46 are provided in the upper inner forward corner of the apparatus 10.

As mentioned above, biologic conditioning of the air curtain 42 may be desired to control movement of active organisms from the working zone 23. For this purpose, a supply of bacteriostat is provided in the form of container 48 in open communication with the inlet side of blower 51 whereby contents of the container are educted through delivery tube 49 at a predetermined rate into the air stream emanating from the blower 51 for delivery through grill 28. Suitable bacteriostats include quaternary ammonium compounds, phenolic compounds, metal salts, halogens, alcohols and aldehydes in appropriate form e.g. solution, for dispersion or aspiration into an air stream.

I claim:

1. A fume hood structure comprising
 - (A) a chamber including an openable front wall, a top wall, a bottom wall providing a working surface, side walls and a rear wall;
 - (B) an elongated air flow directing grill mounted in the bottom wall to underlie the front wall;
 - (C) means forming a reduced pressure zone along the top wall and having an elongated inlet spaced from said rear wall;
 - (D) pressurized air supply communicating with the grill and operating to displace air through the grill when the front wall is open in a vertical air curtain flow pattern across the open front of the chamber and toward said reduced pressure zone inlet, said air curtain flow acting to positively separate chamber

6

air from outside air and to induce a circular flow of air within the chamber downwardly along the rear wall and forwardly along the working surface to join the air curtain flow, said circular air flow defining a central zone free of turbulent air within said chamber.

2. Fume hood structure according to claim 1 in which said grill includes an arrangement of openings providing multilaminar flow vertically upward from the working surface.

3. Fume hood structure according to claim 2 in which said grill comprises a perforate plate.

4. Fume hood structure according to claim 1 in which the means (C) includes a baffle extending across the width of the hood in spaced relation to the top wall to define said reduced pressure zone.

5. Fume hood structure according to claim 4 in which said baffle slopes rearwardly and downwardly within the chamber to join the rear wall.

6. Fume hood structure according to claim 1 including also means to biologically isolate the chamber comprising a supply of biologically active material arranged for addition to said air supply for delivery through said grill.

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U.S. Cl. X.R.

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