Feb. 3, 1953 H. S. MORROW 2,627,220

FUME HOOD

Filed Nov. 4, 1950 3 Sheets-Sheet 1

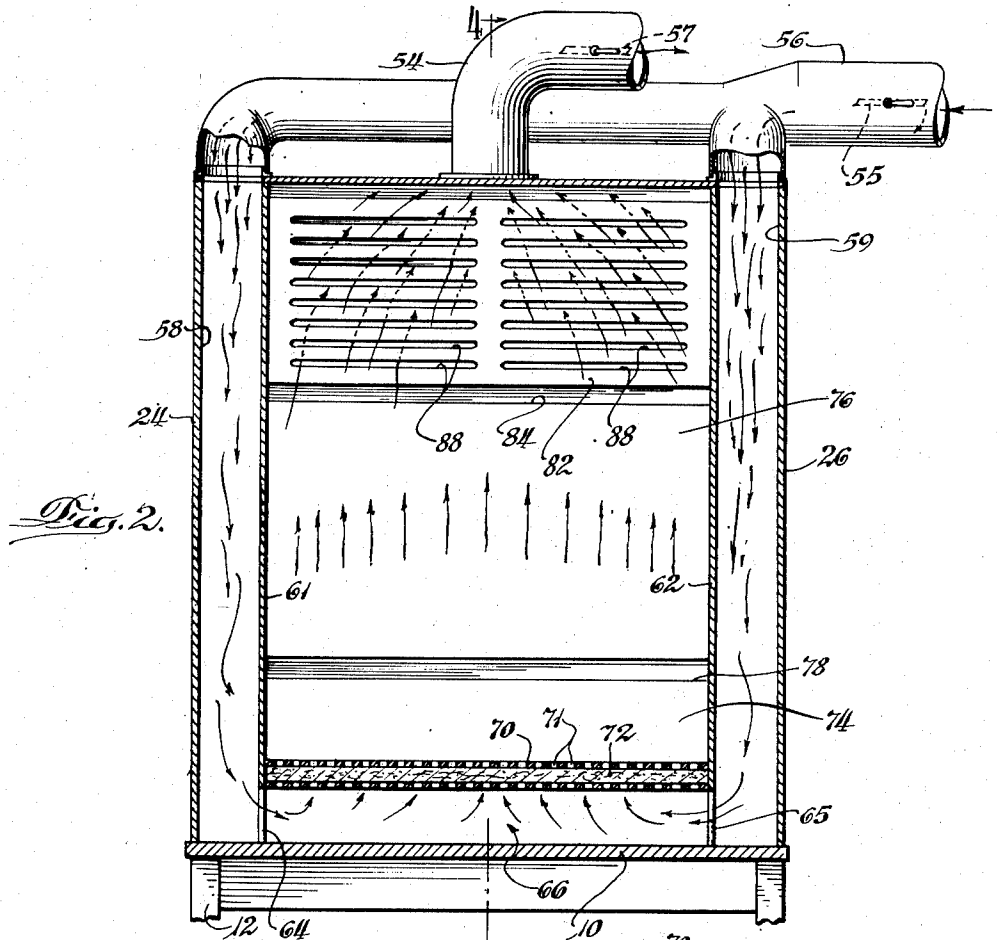


Fig. 2.

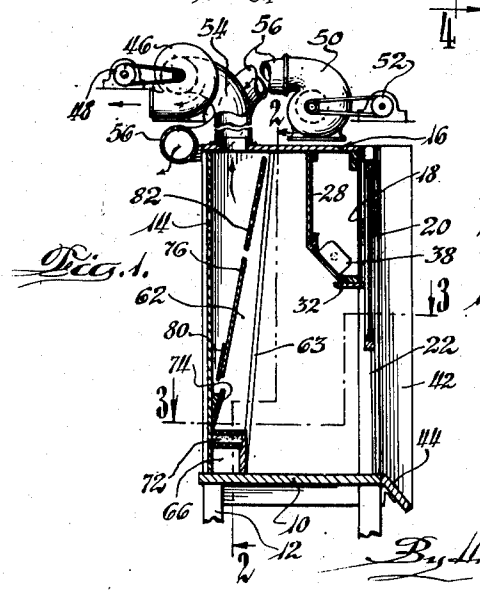


Fig. 1.

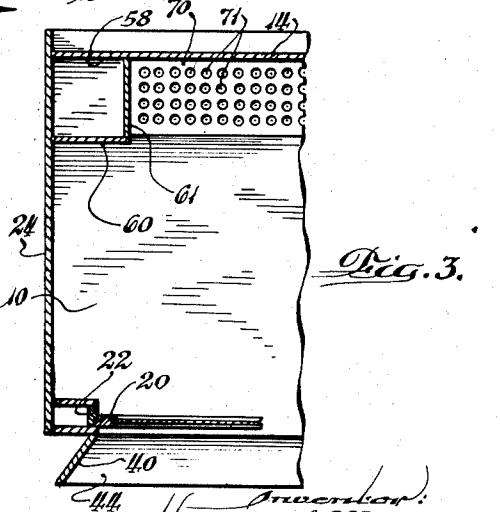


Fig. 3.

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FUME HOOD

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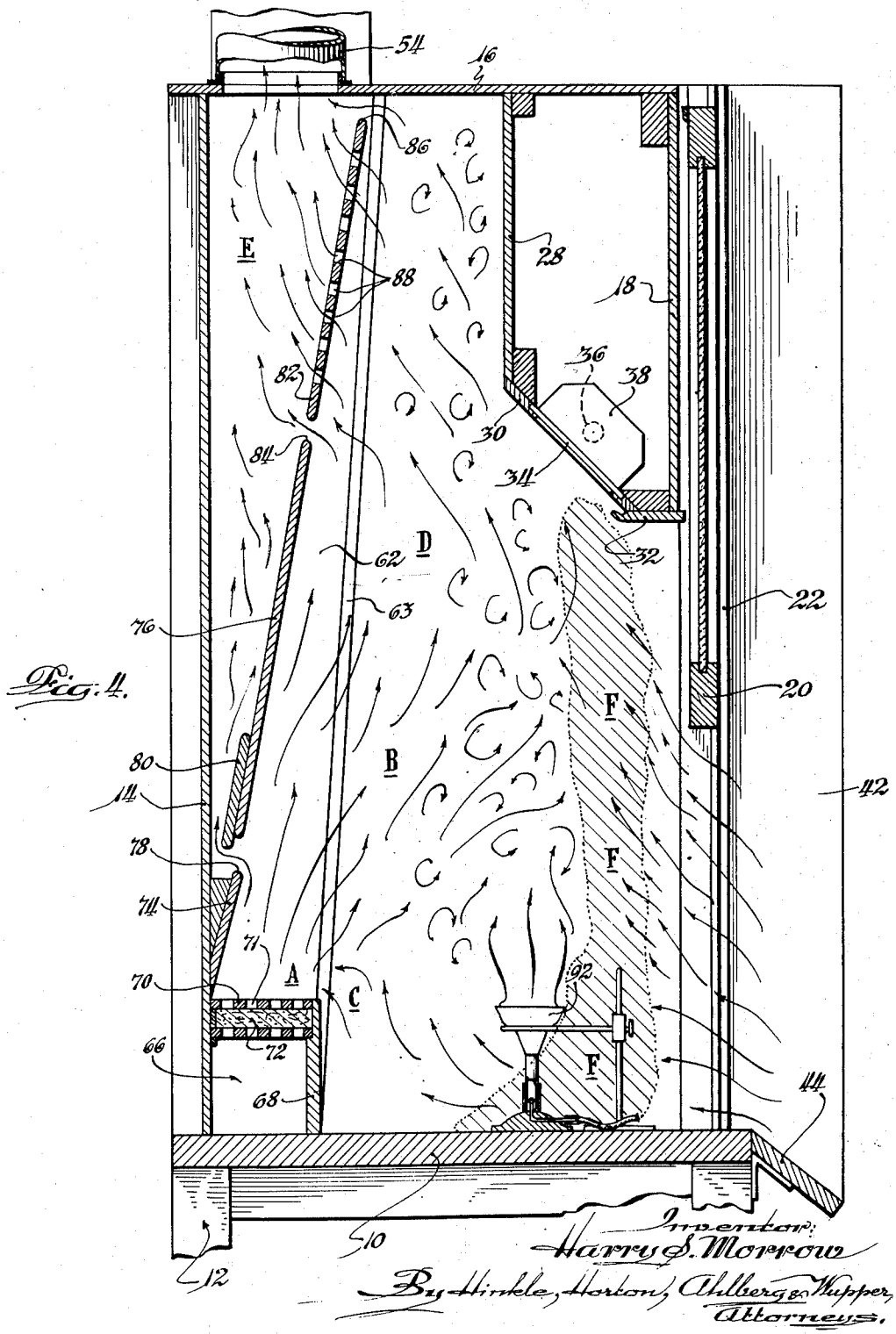


Fig. 4.

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FUME HOOD

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Fig. 7.

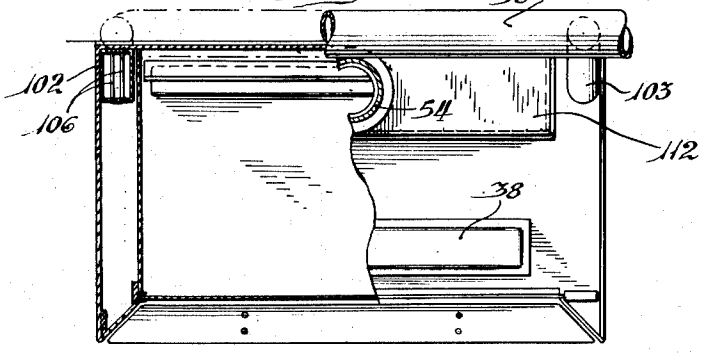


Fig. 5.

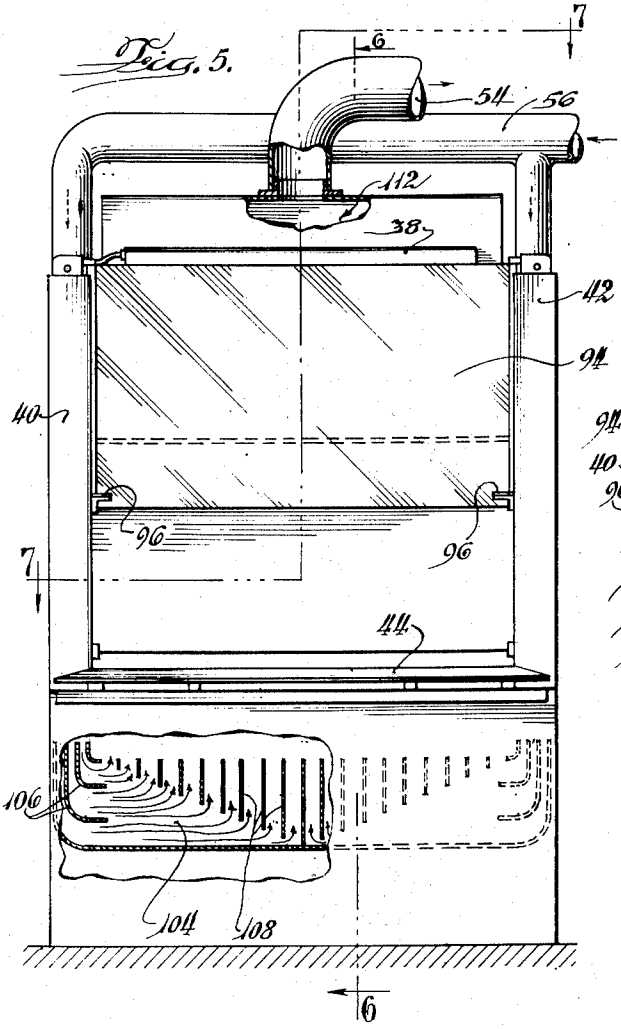
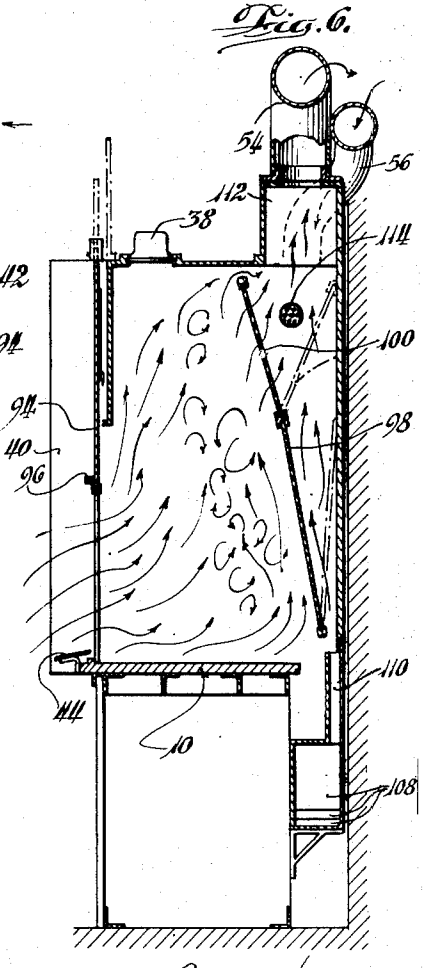


Fig. 6.



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UNITED STATES PATENT OFFICE

2,627,220

FUME HOOD

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Application November 4, 1950, Serial No. 194,176

8 Claims. (Cl. 98—115)

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My invention relates generally to fume hoods forming parts of laboratory equipment for exhausting to the atmosphere toxic and noxious fumes which may be formed as a result of various chemical reactions which take place within the hood. More particularly, my invention relates to pressurized hoods for air conditioned laboratories, in which the amount of air drawn into the hood from the laboratory room is greatly reduced as compared with conventional fume exhausting hoods used in chemical and other laboratories.

In conventional fume hoods, the gaseous fumes resulting from chemical reactions are drawn by a suction fan through the opening in the hood and exhausted to the atmosphere. In order that all of the fumes be drawn into the suction conduit and none escape to the room through the working opening in the hood, a relatively large capacity suction fan must be employed, and this results in the withdrawal of a large amount of air from the room in which the hood is located. In most laboratories the air in the room must be heated or cooled during at least portions of the year, and may have to have its humidity reduced by suitable air conditioning apparatus. The withdrawal of the large quantity of air from the room to prevent escape of the fumes into the room, and to provide adequate dilution of the fumes in such prior systems, makes it necessary that the capacity of the heating or air conditioning equipment, or both, be very large and correspondingly costly. This is because a large working opening in the hood is required, this opening being usually in the order of two to three feet in height, and four to five feet in width, and because a lineal air speed of 70 feet per minute is desirable to provide adequate dilution of the fumes and to prevent escape of the fumes into the room.

Assuming, for example, that the hood has an opening of ten square feet, 700 cubic feet of air per minute would be drawn from the laboratory through a single fume hood. The laboratory may have a number of such hoods, and the volume of conditioned air removed from the laboratory room would be correspondingly multiplied. Such loss of conditioned air from the laboratory room is greatly reduced by the use of the fume hood of my invention, and is accomplished in part by supplying atmospheric air under positive pressure to the fume hood, as well as by creating a negative pressure area for the exhaust of the polluted air to the atmosphere. Further, the fume hood is so constructed that the atmospheric air under positive pressure forced into the hood, due to a Venturi-like effect, causes a slight negative pressure

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zone within the hood, to which air may flow at a relatively slow linear speed through the working opening in the fume hood and thus be admixed with the fresh air and fumes and exhausted from the hood through a plenum chamber connected to an exhaust conduit in which the negative pressure is maintained.

For most installations I have discovered that of the total air removed from the hood it is practical to exhaust as little as twenty per cent through the working opening of the hood, the remaining eighty per cent being atmospheric air forced into the hood by a blower drawing air directly from the atmosphere. As a result, the load on the heating or air conditioning equipment, due to the use of the fume hood, or hoods, is reduced to approximately one-fifth of that which it would be if all of the air used for withdrawing and diluting the fumes generated within the hood were taken from the laboratory room.

Furthermore, since the lineal speed of the air passing through the hood opening is greatly reduced, there is less turbulence which would interfere with the gas flames of Busen burners, or the like, and there is consequently less cooling of heating apparatus and accessories which are used within the hood. In addition, because the lineal speed of the air flowing through the working opening of the fume hood is greatly reduced, the formerly objectionable draft upon the person working at the fume hood opening is substantially eliminated.

All of these factors added together, render the fume hood of my invention much more efficient than those af the prior art, with respect both to the total amount of equipment necessary for the heating or air conditioning apparatus, or both, and for the exhaust of the fumes from the hood, as well as reducing the amount of power required for the operation of such equipment.

It is therefore the primary object of my invention to provide an improved fume exhaust hood in which only a portion of the air used to carry away fumes from the hood is supplied from the room in which the hood is located.

A further object is to provide an improved fume hood in which is included improved baffling means for controlling the flow of air into and through the fume hood.

Other objects and advantages will be apparent from the following description, reference being had to the accompanying drawings, in which:

Fig. 1 is a central vertical sectional view of the improved fume hood, with the pressure and suction blowers shown conventionally;

Fig. 2 is a vertical sectional view taken on the line 2—2 of Fig. 1, and to an enlarged scale;

Fig. 3 is an enlarged scale fragmentary horizontal sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is a vertical sectional view taken on the line 4—4 of Fig. 2;

Fig. 5 is a front elevational view of a modified form of hood, portions thereof being shown in section;

Fig. 6 is a vertical sectional view taken on the line 6—6 of Fig. 5; and

Fig. 7 is a plan view, partly in section, taken on the line 7—7 of Fig. 5.

This application is a continuation-in-part of my copending applications Serial No. 639,475, filed January 5, 1946, and Serial No. 98,528, filed June 11, 1949, both now abandoned.

Referring to Fig. 1, the fume hood comprises a slab 10 forming the working surface upon which the chemical apparatus producing toxic or noxious fumes is placed. The slab 10 is supported at a convenient height from the floor by any suitable structure 12, which is usually in the form of a cabinet or a chest of drawers, for instruments and apparatus. The fume hood proper consists of a rear wall 14, a top 16, a front wall 18 extending across the top portion only of the hood, and a glazed sash 20 which is slidable in a suitable frame 22 and provided with counterbalance weights in the usual manner of a window sash. The hood includes a left side wall 24 and a right side wall 26. The slab, walls, top, and window frame are secured together in the customary manner of cabinet construction.

The depth of the hood near its upper end is reduced by a vertical wall 28 joined to a diagonal frame 30 secured to the lower edge of the front wall 18 by a horizontal board 32. The frame 30 holds an elongated sheet of glass 34 providing a window for a fluorescent lamp 36 enclosed in a suitable housing 38.

Exterior baffles 40 and 42 extend outwardly at an angle of approximately 45 degrees with respect to the plane of the sash frame, and are suitably secured to the vertical edges of the latter. A similar baffle 44 is similarly secured at the front edge of the slab 10. These baffles form a funnel-like structure for the working opening beneath the sash 20.

Referring to Fig. 1, air and fumes are exhausted from the fume hood by a suction fan 46 driven by an electric motor 48, while atmospheric air is supplied to the fume hood by means of a fan or blower 50 driven by a motor 52, the suction fan being connected to the fume hood by a suitable pipe or conduit 54 which is provided with means, shown as a damper 57 (Fig. 2), to regulate the flow. The fan or blower 50 is connected to the fume hood by a suitable duct or conduit 56 having a similar flow regulating damper 55.

The fans or blowers 46 and 50 are preferably mounted upon the roof of the laboratory, or at least have their respective exhaust and inlet connected directly to the outside atmosphere. The duct 56 is suitably connected to a pair of vertical ducts 58 and 59 built into the rear corners of the interior of the hood by means of boards 60, 61, 62, and 63, it being noted that the boards 61 and 62 are of greater width at the top and taper in width toward the bottom, as is apparent from the shape of the board 62 shown in Fig. 4. The ducts 58 and 59 are thus of progressively decreasing cross sectional area. The lower

ends of the board 62 are cut away to form ports 64 and 65 (Fig. 2) leading to a manifold or plenum chamber 66 formed between the slab 10, the lower end of the back wall 14, and a vertical board 63. The top of the plenum chamber is formed by a pair of similarly perforated boards 70 which are supported in spaced relation by the board 63 and the rear wall 14, and which encloses a suitable air filtering material 72, such as spun glass.

Directly above, and extending the full length of the perforated boards 70, is a diagonal lower baffle 74 suitably secured to the rear wall 14. An inclined intermediate baffle 76 is suitably secured to the boards 61 and 62 approximately in alignment with the lower baffle 74, being spaced from the latter to provide an elongated horizontal secondary exhaust port 78. If desired, the effective width of the port 78 may be changed by an adjusting baffle 80.

An exhaust baffle 82 is in substantial alignment with the baffle 76 and spaced therefrom to provide a horizontal elongated exhaust port 84, and is spaced from the top 16 to provide a primary horizontal elongated exhaust port 86. The baffle 82 is provided with a plurality of slots 88 which may be arranged as best shown in Fig. 2.

In using the fume hood, the motors 48 and 52 are energized to drive the fans 46 and 50, the controls for these motors preferably being so arranged that the suction blower or fan must be in operation before the pressure fan or blower is started. The capacities of these fans are such, and the dampers 55 and 57 are so adjusted, that the blower fan forces into the hood approximately eighty per cent of the air which is withdrawn from the hood by the exhaust or suction fan during a given period. The air flowing through the conduit 56 is divided between the two ducts 58 and 59, and flows downwardly through these ducts at increasing velocity into the plenum chamber 66 due to the tapering cross sectional area of the ducts 58 and 59. In the plenum chamber 66, the velocity pressure of the air is partially converted into static pressure, and this air flows through the perforations 71 formed in the filter board 70 in jets (at A) so that the static pressure is again converted into velocity pressure, the jets expanding gradually in cross sectional area and flowing forwardly and upwardly into the fume hood as indicated by the arrows in the vicinity of B in Fig. 4. Due to the high velocity of the jets emerging from the perforations 71, a negative pressure is produced, as indicated by the arrows in the vicinity of C, the negative pressure at this place causing continuous flow of air along the top surface of the slab 10 to sweep this surface of any fumes which may be given off by chemicals placed in containers on the surface, or which may have been spilled on this surface. The smooth regular flow of this stream of air over the top surface of the slab 10 is improved by the provision of the exterior baffle 44 which has a funneling effect and reduces, or substantially eliminates, turbulence along the front edge of the slab 10.

As the jets of air increase in cross sectional area, and consequently lose some velocity, they are drawn upwardly as indicated by the arrows in the vicinity of D, due to the negative pressure present in the space E behind the baffle 82. Air flowing through the working opening beneath the sash 20 meets the air supplied through the perforations in board 70 to produce a buffer zone F, indicated by the light cross hatched lines, in

which the pressure is but slightly negative with respect to the pressure in the room, so that the flow of air from the room through the opening beneath sash 20 is of such low velocity that only approximately twenty per cent of the air and fumes exhausted through the conduit 54 is taken from the room in which the hood is located. In the region to the left (Fig. 4) of the zone F, there is substantial turbulence, as indicated by the semi-circular arrows, so that the air forced into the fume hood, as well as the air drawn through the working opening, intermix thoroughly with the fumes, with resultant adequate dilution of the fumes, the fumes being indicated by the heavy arrows emanating from the crucible 92.

The baffle 82, although having openings of substantial aggregate cross sectional area, nevertheless affords a sufficient restriction to free flow of air, that the flow of air is substantially uniform throughout the width of the hood even though the exhaust conduit 54 is connected to the exhaust plenum chamber E at the center thereof.

The Venturi effect of the high velocity air jets from the openings 74 is of substantial advantage in that it assures continuous uniform flow of air along the surface of slab 10.

The velocity of flow of air and fumes within and from the hood is sufficiently great that the fumes, even though heavier than air, will be swept upwardly within the hood and exhausted from the exhaust chamber E through the exhaust conduit 54. This is true despite the fact that the velocity of flow of air through the access opening is relatively low. Escape of fumes from the hood is precluded by virtue of the presence of the buffer or barrier zone indicated by the cross hatching and the letters F, and by virtue of the provision of the exterior baffles 42, 43, and 44, which, through a funnel-like action, direct air toward the access opening and prevent turbulence immediately adjacent the access opening.

The invention may be embodied in variant forms, one such modification being shown in Figs. 5, 6, and 7, wherein parts corresponding to those previously described have had corresponding reference characters applied thereto so that a repetition of the description of them will be unnecessary.

In the construction shown in these figures, the sash is provided by a single sheet 94 of plate glass provided with handles 96 and is suitably counterbalanced. The interior of the hood is rectangular in vertical as well as horizontal cross section, and is provided with a solid baffle 98 and an apertured baffle 100. These baffles are preferably mounted for pivotal movement between the positions in which they are shown in full lines and the positions in which they are shown in dotted lines.

In this embodiment, the air under pressure is supplied through two vertical ducts 102 and 103, which at their lower ends communicate with a plenum chamber 104. Suitable elbow baffles 105 (Fig. 5) are preferably provided to induce laminar flow of the air and to cause it to flow at substantially uniform velocity as it enters the plenum chamber 104.

Depending vertical baffles 108 of progressively increasing length from the sides toward the center are provided to induce substantially uniform distribution of the air flow lengthwise of the plenum chamber 104. Air is discharged from the plenum chamber 104 through a nozzle 110 which extends substantially the full width of the fume hood between the ducts 102 and 103. Air emerging from the nozzle 110 impinges in part against the lower edge of the baffle 98 so that at least some of the air flows upwardly along the front surface of the baffles 98 to provide some turbulence, indicated by the semi-circular shaped arrows. The major portion of the jet from the nozzle 110 flows in the space between the rear wall of the housing and the baffles 98 and 100 into an enlarged exhaust plenum chamber 112, and from thence to the exhaust conduit 54. The baffles 98 and 100 are pivotally mounted so that both sides thereof may be washed by a water spray discharged from a nozzle 114.

The modified form of the invention shown in Figs. 5, 6, and 7, may be used where the gases are exhausted from the hood in part by convection so that the capacity of the exhaust fan may be reduced, and in such cases where the noise resultant from the discharge of air through the large number of jet orifices 71 of the first described embodiment would be undesirable. Thus the fume hood shown in Figs. 5, 6, and 7, has advantages in particular installations, even though it will withdraw substantially more than twenty per cent (even as much as fifty per cent) of the exhausted air from the laboratory room. In such installations, where work at the table is intermittent so that the access opening may be closed or substantially closed a large portion of the time, the form of the invention shown in Figs. 5, 6, and 7, is very practical and efficient. However, the form of the invention shown in Figs. 1 to 4 will be preferred whenever all, or most, of the energy for exhausting the hood must be supplied mechanically, and especially in such installations in which the sash is in its upper position most of the time, or in which the hood is not equipped with a sash to close the access opening.

In both embodiments of the invention, the amount of conditioned air removed from the laboratory room is greatly reduced as compared with fume hoods of the prior art, the fumes generated in the hood are well diluted, the air flows over the working surface of the table at relatively low velocity so as not to interfere with burner flames or unduly to cool heated apparatus placed on the work table, and escape of fumes from the hood to the laboratory room is precluded.

While I have shown and described preferred embodiments of my invention, it will be apparent that numerous variations and modifications thereof may be made without departing from the underlying principles of the invention. I therefore desire, by the following claims, to include within the scope of the invention all such variations and modifications by which substantially the results of my invention may be obtained through the use of substantially the same or equivalent means.

I claim:

1. A fume exhaust hood comprising means forming a work surface, a housing over said means having means to provide a front access opening to the work surface, blower means forcing air taken from the outside atmosphere into said housing along the lower portion of the rear wall thereof, means along the lower rear wall of the housing to cause the atmospheric air entering the housing to form high velocity upwardly directed jets, inclined baffle means extending along the rear of the housing positioned to deflect the jets forwardly, the space between the rear wall and said baffle means form-

ing an exhaust plenum chamber, said baffle means having a large number of exhaust openings of relatively large aggregate cross sectional area in the upper portion thereof to permit flow of air and fumes from the main portion of the housing to the plenum chamber, and suction means to create a negative pressure in the plenum chamber and connected to exhaust air and fumes therefrom to the outside atmosphere, the capacity of said suction producing means being substantially greater than that of the blower means so as to cause air to flow from the room in which the fume hood is located through the access opening into the housing at a relatively low velocity.

2. A fume exhaust hood comprising means forming a work surface, a housing over said means having means to provide a front access opening to the work surface, blower means for forcing air taken from the outside atmosphere into said housing along the lower rear wall thereof, means along the lower rear wall of the housing to cause the atmospheric air entering the housing to form high velocity upwardly directed jets, inclined baffle means extending along the rear of the housing positioned to deflect the jets forwardly, the space between the rear wall and said baffle means forming a plenum chamber, said baffle means having a large number of exhaust openings of relatively large aggregate cross sectional area in the upper portion thereof and a horizontal slot of smaller cross sectional area near the bottom thereof to permit flow of air and fumes from the main portion of the housing to the plenum chamber, and suction means to create a negative pressure in the plenum chamber and to exhaust air and fumes therein to the outside atmosphere, the capacity of said suction producing means being approximately twenty-five per cent greater than that of the blower means so as to cause approximately twenty per cent of the gases exhausted to flow from the room in which the fume hood is located through the access opening into the housing.

3. In a fume hood for use in a laboratory, the combination of means forming a working surface for the reception of apparatus and chemicals which may produce toxic or noxious fumes, means forming a housing over said surface and including a sash movable to position to provide a relatively large opening at the front through which the laboratory technician may have access to apparatus placed on the working surface, means forming a plurality of apertures spaced along the rear wall near the lower edge thereof to produce upwardly directed jets of air, forwardly inclined baffle means extending across the housing in a position to direct the air jets upwardly and forwardly, said baffle means having a plurality of discharge openings in the upper portion thereof and together with the rear wall of the housing forming an exhaust plenum chamber, blower means for forcing air under pressure to the jet aperture forming means, and suction producing means connected to said plenum chamber and to the outside atmosphere to exhaust air and fumes from the plenum chamber, the blower means and the suction producing means being of such relative capacities that a negative pressure with respect to that of the laboratory in which the hood is located is produced within the front portion of the hood and such that approximately eighty per cent of the gases which are exhausted from the hood by the suction producing means will be atmospheric air supplied by the blower means, the remaining exhausted gases including air withdrawn from the laboratory through the access opening and the fumes generated within the housing.

4. In a pressurized fume hood for a slab forming a work surface, the combination of a housing having an opening for access to apparatus placed on the work surface, means for supplying air under pressure in an upwardly directed stream near the rear edge of the slab, baffle means to deflect a portion of said stream of air forwardly, said baffle means being apertured and forming with the housing an exhaust chamber, and means connected to the exhaust chamber to create a negative pressure therein, the capacity of the last named means being slightly greater than that of the means for supplying air under pressure whereby a minor portion of the gases withdrawn from the exhaust chamber will be air drawn through the access opening.

5. In a pressurized fume hood for a slab forming a work surface, the combination of a housing having an opening for access to apparatus placed on the work surface, means for supplying air under pressure in an upwardly directed stream near the rear edge of the slab, baffle means to deflect a portion of said stream of air forwardly, said baffle means being apertured and forming with the housing an exhaust chamber, means connected to the exhaust chamber to create a negative pressure therein, the capacity of the last named means being slightly greater than that of the means for supplying air under pressure whereby a minor portion of the gases withdrawn from the exhaust chamber will be air drawn through the access opening, and external baffles secured to the housing along the sides and bottom of the access opening shaped to funnel air into the access opening and to prevent excessive turbulence at the bottom and sides of the access opening.

6. A fume hood for a generally rectangular laboratory table comprising, a housing secured to the table and providing at its front an access opening for manipulation of apparatus on the table, means for supplying air under pressure to the housing in an upwardly directed stream along the lower rear edge of the table, baffle means to deflect a portion of said air stream forwardly toward the central portion of the space within the housing, the upper portion of the baffle means having discharge openings therein and being spaced from the upper portion of the rear wall of the housing to provide an exhaust chamber, and means to withdraw gases from the exhaust chamber, the capacity of the last named means being greater than that of the means for supplying air under pressure, whereby air will flow into the hood through the access opening.

7. In a fume hood for a laboratory work table, the combination of means forming a rear wall, two side walls, a top, and an adjustable front wall capable of being moved to a position to provide an access opening to the space above the work table, suction producing means, means forming an exhaust opening at the top and rear of the hood, means connecting the exhaust opening to the suction producing means to exhaust gases from the hood to the atmosphere, means forming air inlet openings near the rear of the work table to direct air upwardly, air pressure producing means connected to the inlet openings for causing flow of atmospheric air thereto, and apertured baffle means extending from near the

lower end of the rear wall and inclined forwardly into close proximity to the top.

8. In a fume hood structure for laboratory work table slabs, the combination of means forming a housing over the work surface of the table, means forming a top, side walls, a rear wall, and an adjustable opening front wall in which the opening is directly above the work slab for access to apparatus placed thereon, means communicating with the outside atmosphere for producing positive and negative pressures, conduit means connecting the negative pressure producing means to the fume hood housing near the top and at the rear of the housing, conduit means connecting the positive pressure producing means to inlet openings at the rear and at the bottom of the housing, an apertured inclined baffle means extending across the housing from the lower end of the rear wall substantially to the top of the housing in spaced relation to the rear wall to provide a negative pressure plenum chamber in communication with the first conduit means, the apertures in the baffle means being located mainly in the upper portion thereof and the lower edge of the baffle means being located above the inlet openings to cause some of the air discharged therefrom to pass upwardly behind the baffle means and to cause the remaining air discharged from the inlet openings to be deflected forwardly to commingle with fumes which may be produced by apparatus placed on the work table, and means for adjusting the rate of flow of atmospheric air to the hood and the rate of exhaust of air from the hood to the atmosphere such that for a given period of time the volume of gases exhausted from the hood will be twenty-five to one hundred per cent greater than the volume of air supplied by the positive pressure producing means, whereby some air will be drawn into the hood through the access opening at the front thereof whenever the front wall is adjusted to provide such access opening.

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