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GAS-LIQUID CONTACT METHOD

Original Filed March 22, 1956

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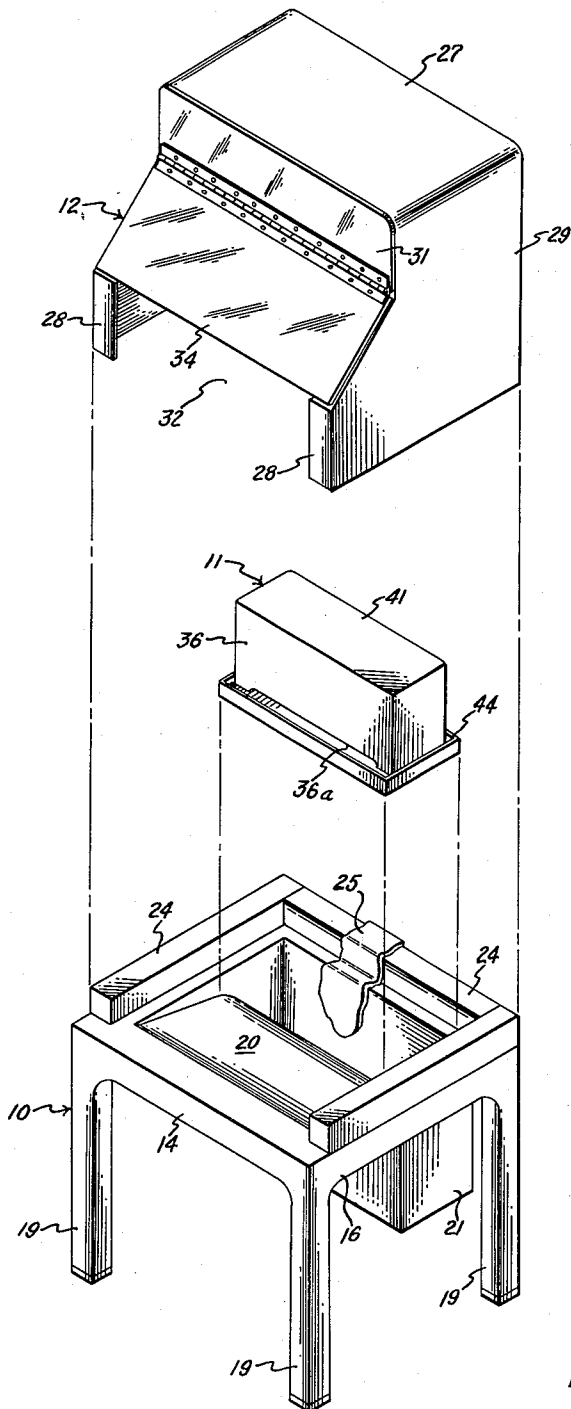


Fig. 1

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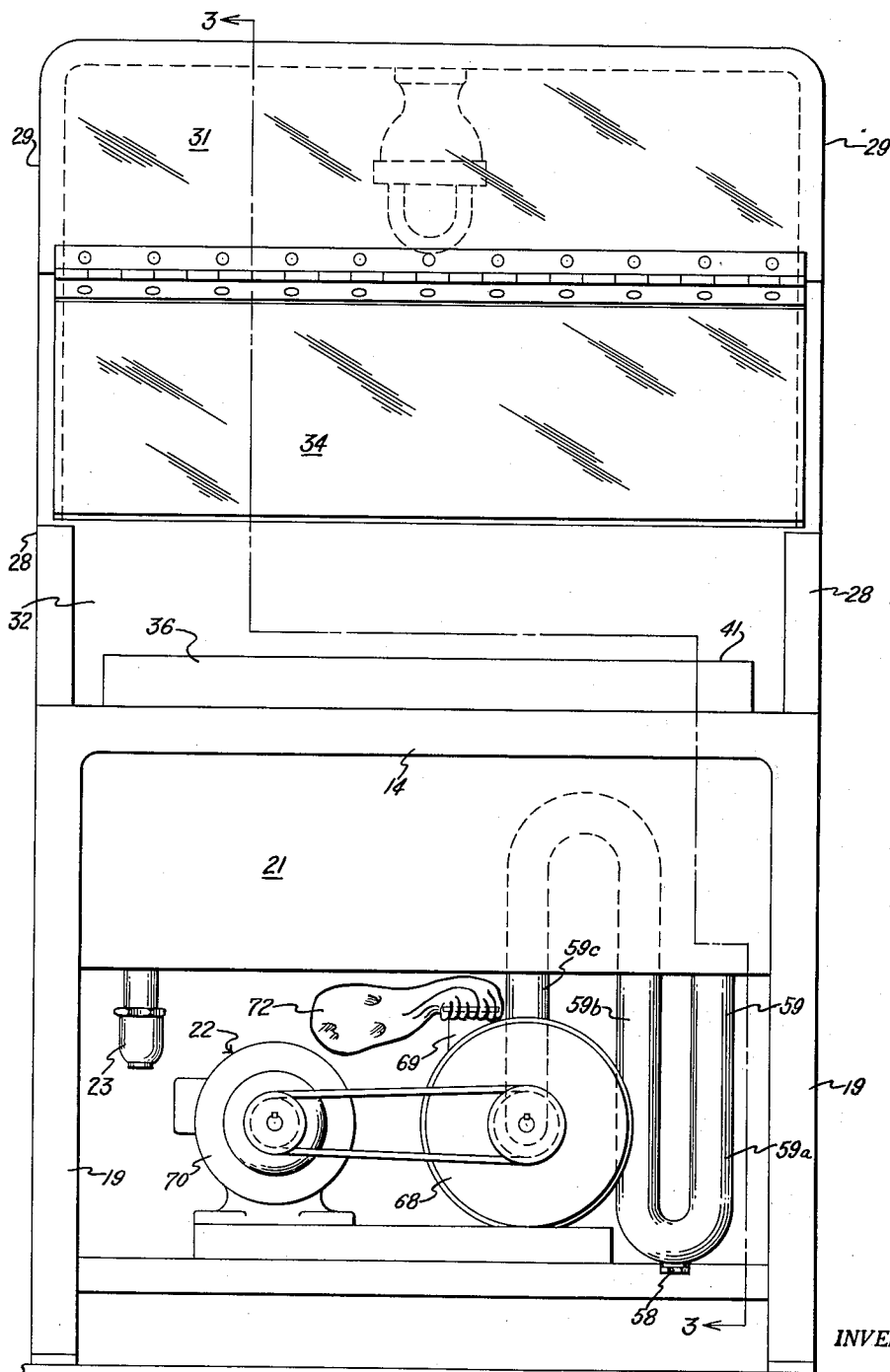
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Fig. 2

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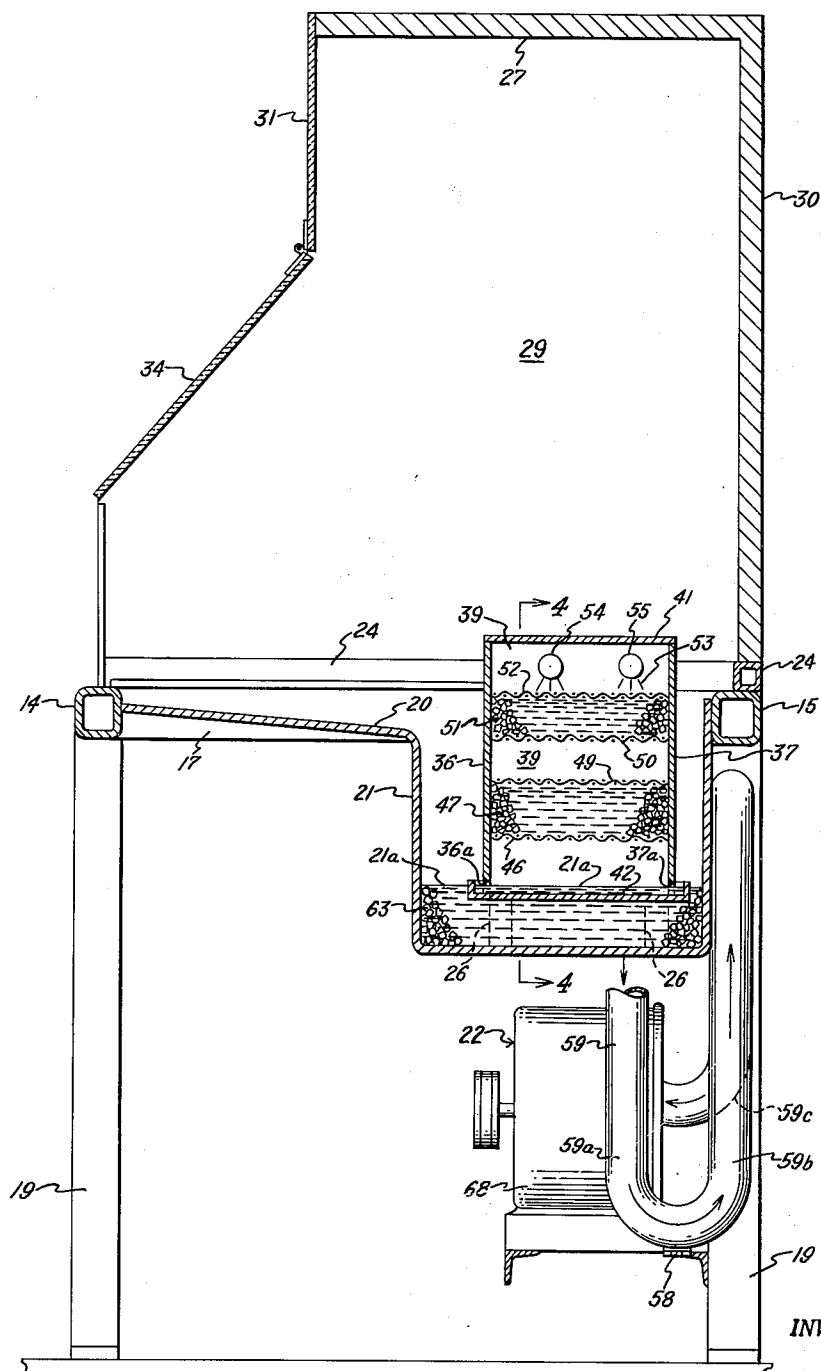


Fig. 3

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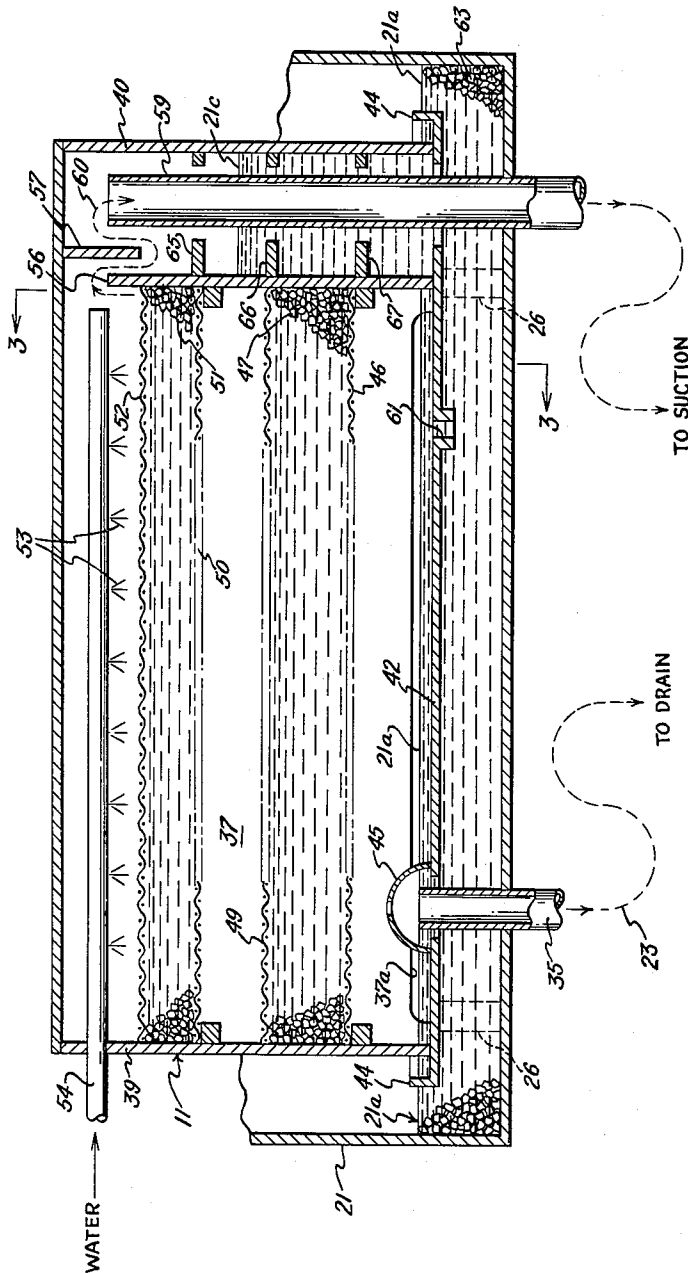


Fig. 4

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GAS-LIQUID CONTACT METHOD

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Continuation of application Ser. No. 573,166, Mar. 22,
1956. This application Oct. 24, 1960, Ser. No. 64,553
7 Claims. (Cl. 23-2)

This invention relates to a gas-liquid contact method and apparatus, shown as a chemical hood or the like, i.e., apparatus which provides a work space for operations which may result in dust or dangerous fumes and which provides for disposal of such by-products.

Among the objects of the present invention are to provide a self-contained, unitary hood unit which purges the air from the hood of fumes and dust before exhausting the air; to provide a hood unit which may be used with no exhaust from the room other than the regular air-conditioning exhaust from the room; to provide a unitary hood unit which may be prebuilt in complete form and which requires only electrical, water supply and drain connections thereto upon being installed; to provide a hood unit which is portable in the sense that it can be readily moved into the work-room and put into use and then be readily transferred from location to location as occasion may require; to provide a small, compact hood unit having the foregoing features and advantages; and generally to improve the effectiveness, efficiency and simplicity of chemical-hood units.

Further objects, and objects relating to details and economies of construction, operation and use, will more definitely appear from the detailed description to follow.

My invention is clearly defined in the claims. In the claims, as well as in the description, parts of the construction and parts of the operating system may at times be identified by specific names for clarity and convenience, but such nomenclature is to be understood as having the broadest meaning consistent with the context and with the concept of my invention as distinguished from the pertinent prior art. The best form in which I have contemplated applying my invention is illustrated in the accompanying drawings forming part of this specification, in which:

FIG. 1 is a somewhat diagrammatic exploded view of a chemical-hood unit embodying the invention, the view being simplified and certain parts being omitted.

FIG. 2 is a partly diagrammatic front elevation of the chemical-hood unit.

FIG. 3 is a transverse, vertical section of the chemical-hood unit taken in general on the line 3-3 of FIG. 2.

FIG. 4 is a longitudinal, vertical sectional view illustrating the scrubbing unit shown in FIGS. 1, 2 and 3, the plane of the section being generally on the line 4-4 of FIG. 3.

Referring to FIG. 1, the complete chemical-hood unit includes three subunits, viz., a base unit 10, a scrubbing unit 11 and an enclosure unit 12. When assembled as shown in FIGS. 2 and 3, the scrubbing unit 11 nests within a sink in the base unit 10 and the enclosure unit 12 overlies the two.

The construction of the base unit 10 will be understood from FIGS. 1, 2 and 3. This unit comprises a horizontal, rectangular frame preferably made of rectangular, seamless tubing, the frame having front and back portions 14 and 15 and side portions 16 and 17. This frame is supported by four legs 19. Attached to and supported by the horizontal frame is a sink unit comprising a work surface or drainboard 20 which slopes toward and merges with a sink proper 21. The horizontal frame, the supporting legs, the work surface and the sink may be of welded-steel construction. Supported from the rear legs 19, is a motor and blower unit designated as a whole by

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22 (FIGS. 2 and 3) which will be referred to later. Resting upon the horizontal frame composed of portions 14, 15, 16 and 17 is a member 24 made of rectangular, seamless tubing and which is U-shaped in a horizontal plane so that it registers with frame members 15, 16 and 17. The member 24 is also of welded-steel construction.

The interior of the sink proper 21, the work surface 20, the top and front of frame member 14 and the inwardly-facing portions of frame members 14, 15, 16 and 17 which lie above the sink unit are covered with a $\frac{3}{32}$ -inch-thick sheet of acid-resisting plastic, with sealed joints. This may be the polyvinyl chloride sold by B. F. Goodrich under the name of "Koroseal." A fragment of this covering is shown at 25 in FIG. 1. This covering is continued upwardly over the tops of the three branches of member 24 and, when the enclosure member 12 is put in place, acts as a gasket between the member 24 and the enclosure unit 12. Once the three subunits 10, 11 and 12 of the hood unit have been placed in assembled relation, this relationship may be retained in any suitable manner, as by suitably located bolts or clamps (not shown).

The scrubbing unit 11 which, as shown in FIG. 1, is generally boxlike as regards its exterior shape, rests in the sink 21 and is supported from the bottom of the sink by blocks or other suitable means which are spaced from one another, and may be perforated in addition, to permit liquid to flow freely in all directions beneath the scrubbing unit. One of these blocks is shown at 26 in FIG. 3. The interior construction of the scrubbing unit will be described later.

The enclosure unit 12 has top 27, sides 29, 29, back 30 and a transparent front panel 31. The front edges of sides 29, 29 may be provided with trim pieces 28, 28 which extend toward each other and overlie the free ends of U-shaped member 24. Access to the work space 20 is obtained through the rectangular space at 32 which extends across the front of the enclosure unit 12 and upwardly from the top of frame member 14 to the bottom edge of transparent panel 34 which lies in an inclined position and has its upper edge hinged to panel 31. A greater degree of access to the work space 20, and to the interior of the enclosure unit 12, may be obtained by swinging upwardly the hinged panel 34. Fixed panel 31 and hinged panel 34 may each be made of thick, rigid sheets of suitable transparent plastic.

Reference will now be had to the showing in FIG. 4 of the scrubbing unit 11 located in the sink 21. As will presently appear, the air and fumes within the enclosure unit 12 laden with fumes or dust generated in the vicinity of the work surface 20, are drawn downwardly around the outside of the scrubbing unit 11, in at the bottom of the scrubbing unit, and upwardly through the scrubbing unit to remove the fumes and dust, after which the cleansed air is drawn downwardly through a conduit and returned to the room at a point below the level of the sink.

There is provided a water-discharge pipe 35 which leads through a trap 23 to a drain. The top or inlet of discharge pipe 35 may be positioned above the bottom of the sink, as shown. Thus, when the apparatus is in operation a depth of water will be maintained in the sink equal to the height of discharge pipe 35 above the bottom of the sink. This water level is indicated at 21a. The gas enters the scrubbing unit at or slightly below this water level.

The scrubbing unit 11 is supported in the sink in the position shown in FIG. 4, resting on spaced blocks such as block 26 in FIG. 3 as previously referred to. The casing of the scrubbing unit 11 includes a front wall 36, a back wall 37, a left-end wall 39, a right-end wall 40, a top 41

and a bottom 42. The bottom 42 projects horizontally a short distance beyond the vertical walls 36, 37, 39 and 40 and is provided, as shown in FIG. 4, with a short, upwardly extending lip 44 which extends entirely around the perimeter of the bottom. Above discharge pipe 35 the bottom 42 is provided with a domelike member 45 which overlies the discharge pipe 35 and provides a vent in conjunction with space for water to flow from the sink into the top of pipe 35.

Referring to FIGS. 1 and 3, it will be seen that the bottom edge of front wall 36 is recessed upwardly for a considerable portion of its length, providing an elongated slitlike port 36a. A similar elongated slitlike port 37a is provided at the bottom of back wall 37 as shown in FIG. 4. Air and fumes are drawn from the interior of enclosure unit 12 through these two ports to the interior of the scrubbing unit 11. After entering the scrubbing unit 11, the air passes upwardly through a horizontal wire screen 46, a layer of aggregate 47, another horizontal wire screen 49, the space between screen 49 and a third horizontal screen 50, through a layer of aggregate 51 and thence through a fourth horizontal wire screen 52. The layers of aggregate 47 and 51 are kept substantially flooded with water issuing in finely divided form through a number of spray nozzles at 53 fed by pipes 54 and 55 (see also FIG. 3). Screen 46 supports the aggregate 47, screen 49 serving to retain the aggregate in fixed or unyielding position. Likewise screen 50 serves to support the aggregate layer 51, screen 52 overlying the aggregate layer to assure that the aggregate remains in a fixed position.

During its passage upwardly through the scrubbing chamber, the air is scrubbed and the dust and fumes removed therefrom. Upon reaching the space above screen 52, the air is drawn over the top of vertical partition 56, beneath the bottom of baffle 57 and into downwardly extending exhaust conduit 59, in the path indicated by the serpentine arrow 60. This serpentine path involves abrupt changes in direction at high velocity, thereby throwing out droplets of water that may be entrained, and with the result that the cleansed air is relatively free of entrained water when it enters the air-discharge conduit 59 that is under suction.

The aggregate in layers 47 and 51 is composed of relatively small particles, that are packed or shaken together sufficiently to prevent the individual particles from shifting under the action of air currents as the air is drawn upwardly through the layers of aggregate. Thus, the air being scrubbed cannot channel its way through the aggregate, but instead is forced to widely disperse and, in finely divided form, come into contact with a very large area of water that is on the surface of the pieces of the aggregate and which also substantially fills the space between the pieces of the aggregate since the supply of water is sufficient to maintain the beds of aggregate at 47 and 51 in substantially flooded condition.

For the absorption of acid fumes, of nitric, hydrofluoric, hydrochloric and others, I have employed an aggregate composed of marble (calcium carbonate) very successfully. In particular I have used the commercial product Carrara Italian marble, No. 2 chips. The smaller No. 1 chips and the larger No. 3 chips are also useful under some conditions. I have used a scrubbing-chamber area, in horizontal cross section of from one to four square feet per 100 cubic feet of air per minute with depths of the aggregate (in both beds taken together) up to eight inches, and with water fed by the sprays of from one-half to two gallons per minute.

After descending through the beds of aggregate 51 and 47, the water passes through an outlet opening 61 in the bottom 42 of the scrubbing unit. As shown in FIG. 4, this opening is remote from the water-discharge pipe 35 and hence the water must make its way quite a distance before entering the discharge pipe. The space in the sink beneath the bottom 42 of the scrubbing unit may be

filled with marble chips as shown at 63 so that the water has to work its way slowly through the interstices between the chips before it reaches the discharge pipe 35. These chips may be the same as in beds 47 and 51. By the time the water reaches the discharge pipe 35, it has been largely neutralized by the action of the marble chips at 63.

Due to the negative pressure in exhaust conduit 59, water will rise from the sink into the vertical chamber between partition 56 and end wall 40 to the level indicated at 21c since this chamber or conduit communicates with the space above aggregate bed 51 and conduit 59. Horizontal baffles 65, 66 and 67 separate the water in this chamber into more or less stratified layers.

Referring to FIGS. 2 and 3, the air-exhaust conduit 59 extends downwardly at 59a to a point a little above the floor level, thence upwardly at 59b to a point a little below the level of the frame member 15 and thence downwardly at 59c and into the inlet of blower 68 which is driven through any suitable mechanical connection as by means of an electric motor 70, as shown. After passing through the blower, the cleansed air is returned to the room through blower outlet 69 on which may be fastened a muslin bag 72. The purpose of the muslin bag is to help diffuse the air, prevent drafts, and minimize blasts when the blower is started. The lower curved bend between conduit sections 59a and 59b is sufficiently below the upper recurved bend between conduit sections 59b and 59c to prevent water from accidentally entering the blower. Ordinarily there will be no water in this air conduit, but should water be drawn over into it for any reason the head of water between the two recurved bends in the conduit is sufficient, because of the limited suction of the blower, to prevent water from being drawn into the blower. Any water accidentally collecting in the duct 59 can be removed through the drain plug 58, as shown.

The chemical-hood unit is provided with an electrical system, a water system and a drain connection which, upon installation of the unit, are simply connected to points in the supply and drainage systems of the building. Trap 23 (FIGS. 2 and 4) is shown as connected to the building drain.

This application is a continuation of my prior application, Serial No. 573,166, filed March 22, 1956, now abandoned.

I claim:

1. The method of contacting liquid and gas, comprising maintaining a bed of particles of aggregate in a fixed position with the spaces between said particles constituting passages for liquids and gas therethrough, introducing gas beneath said aggregate bed and inducing a steady flow thereof upwardly through said bed, introducing liquid onto the upper surface of said bed of aggregate for down-flow by gravity through the passages therein, counter-current to the induced up-flow of said gas through said passages, and maintaining the flow of said gas and of said liquid at a rate sufficient to flood said bed to maintain the spaces between the particles substantially filled with liquid during normal operation.

2. The method recited in claim 1, the passages through said aggregate bed being irregular, tortuous and interconnected throughout the bed.

3. The method recited in claim 1, the upward gas flow through the passages in said bed being induced by suction from above said bed.

4. The method of contacting liquid and gas in counter-current flow, comprising downwardly flowing a liquid through the passages between the particles in a fixed bed of particles of aggregate, forcibly passing gas widely dispersed and in finely divided form through said passages upwardly through the liquid in said passages, and maintaining the flow of said gas and said liquid at a rate sufficient to flood said bed to maintain said passages substantially filled with liquid during normal operation.

5. The method of contacting liquid and gas, comprising maintaining vertically spaced beds of particles of ag-

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gregate with the particles in fixed positions in said beds and with the spaces between said particles constituting tortuous and interconnected passages for said liquid and gas, introducing gas into a space beneath the lower of said beds and inducing a flow thereof upwardly through said beds and through the space between said beds, introducing liquid onto the upper surface of the upper bed for down-flow by gravity progressively through said beds and the space between them, counter-current to the induced up-flow of gas through said beds, and maintaining the flow of said gas and of said liquid at a rate sufficient to flood said beds to maintain the spaces between the particles substantially filled with liquid during normal operation.

6. The method recited in claim 5, said beds being positioned one directly above the other and of substantially the same horizontal dimensions.

7. The method of removing a constituent from a gas, comprising inducing a flow of said gas upwardly through a plurality of spaced, aligned, fixed beds of aggregate particles introducing a liquid onto the upper portion of an overlying aggregate bed for down flow by gravity through said overlying bed, then through the space between said beds, then through an underlying bed in continuous flow, inducing a flow of gas, containing substances to be removed, upwardly through an underlying bed of

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said aggregate particles, with the gas in widely dispersed, finely divided form, while contacting said particles and the downflowing liquid flooding said bed, intermingling the particles of gas in the space between said beds and continuing the induced flow thereof upwardly through an upper said bed of aggregate particles in the same widely dispersed, finely divided form, the flow of said gas and said liquid being maintained at a rate sufficient to flood said beds and maintaining said passages substantially filled with liquid during normal operation, removing the cleaned gas from above said upper bed and discharging the liquid with its removed substances from beneath said underlying bed.

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