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E. J. BECKER

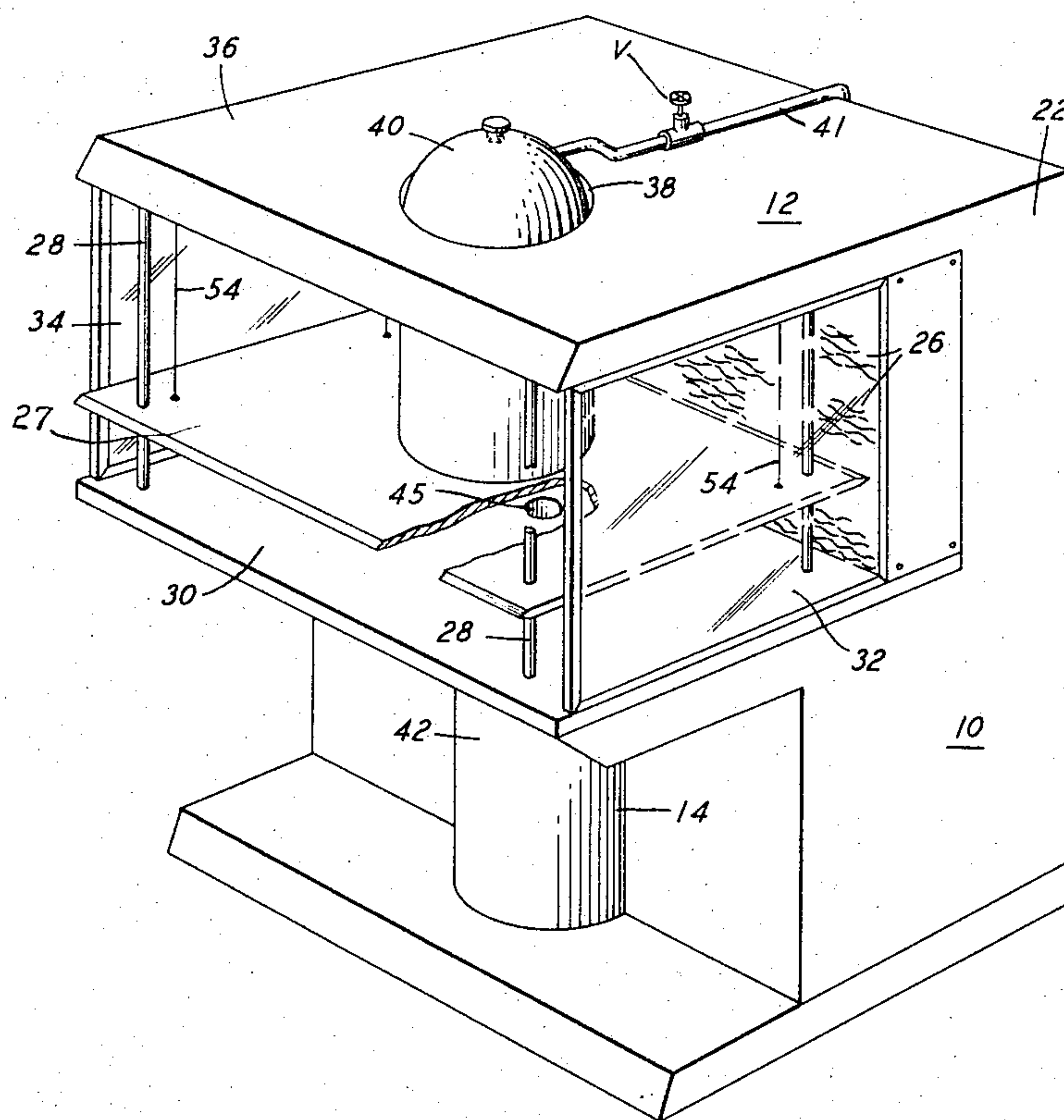
3,368,523

LAMINAR FLOW WORK STATION

Filed May 13, 1965

2 Sheets-Sheet 1

FIG. 1



INVENTOR
E. J. BECKER
BY *Leo Stanger*
ATTORNEY

Feb. 13, 1968

E. J. BECKER

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FIG. 2

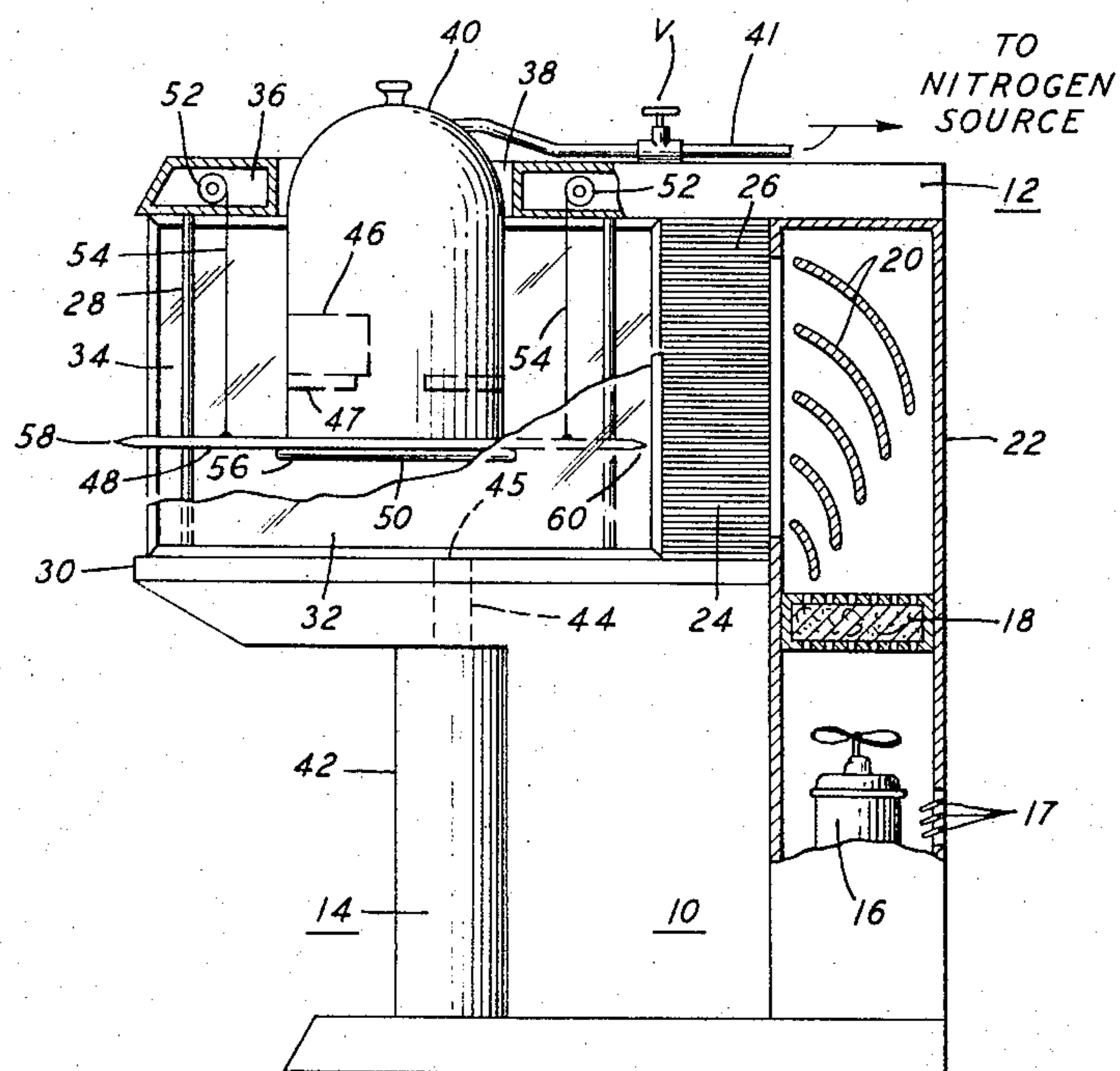
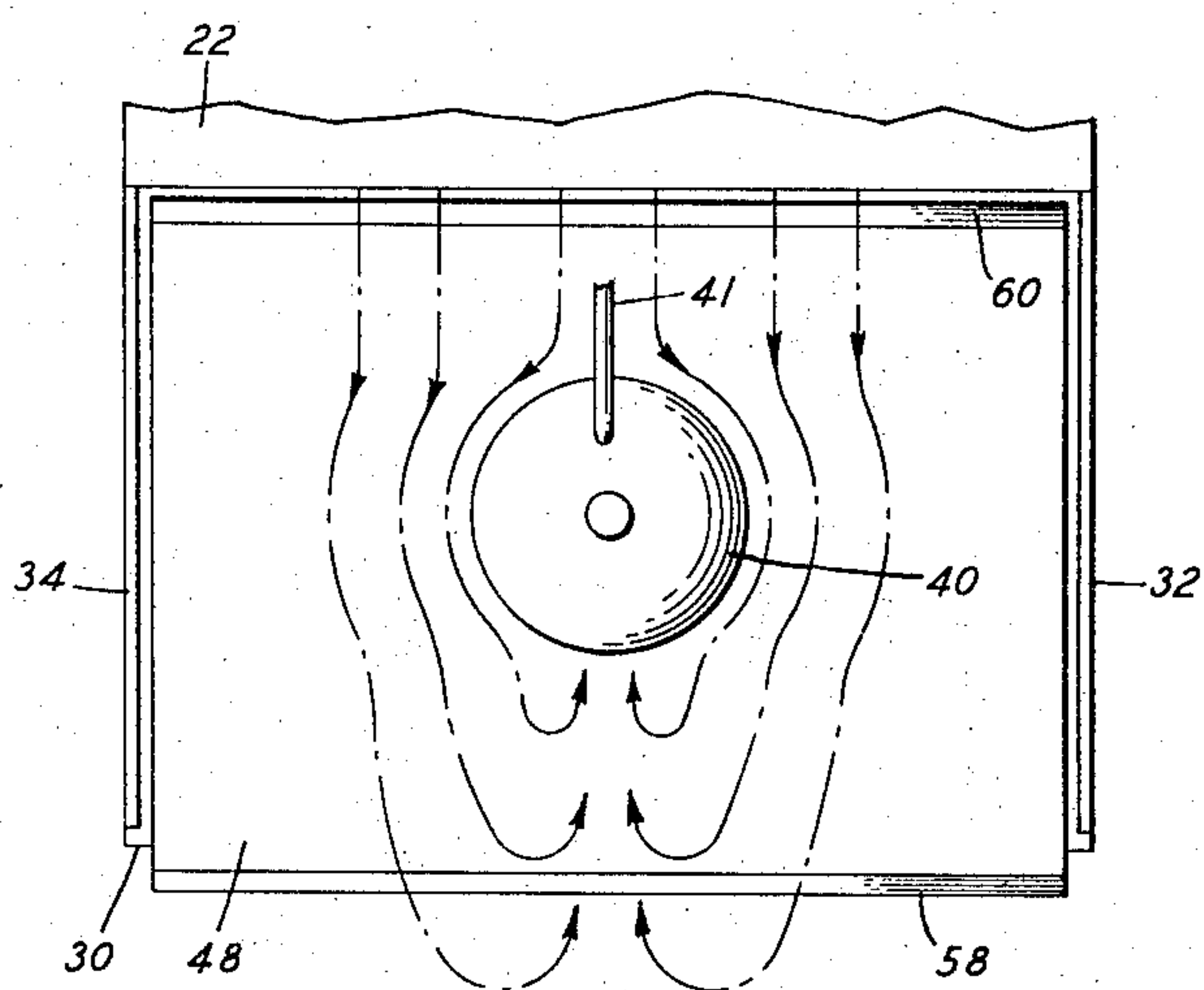


FIG. 3



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LAMINAR FLOW WORK STATION

Edward J. Becker, Millington, N.J., assignor to Bell Telephone Laboratories, Incorporated, New York, N.Y., a corporation of New York

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11 Claims. (Cl. 118-49)

ABSTRACT OF THE DISCLOSURE

In a hooded work station a horizontal laminar flow of filtered air clears a horizontal workface and a bell jar moves down until its lower lip rests on the workface. In that position the jar interior can be evacuated. A horizontal plate extends outwardly from the lip across the work station. This prevents eddy currents that are imparted to the laminar flow above the lip by the bell jar surface from disturbing any workpiece below the bell jar.

This invention relates to work stations, particularly for providing a controlled ultraclean atmosphere which permits handling of sensitive elements such as those involved in the production of thin-film circuits.

Thin-film circuits are formed by subjecting a partially masked insulating substrate to a vaporized conductive material so that the vapor condenses and solidifies on the unmasked portion. This is done within the vacuum chamber of a vacuum evaporator. The vacuum chamber generally comprises a vertically movable bell-shaped jar resting on a work face and is large enough to hold or cover the vaporizing equipment. To prevent foreign particles from interfering with vapor deposition, the atmosphere within the chamber is kept uncontaminated by charging it with ultraclean nitrogen. To prevent contaminating particles from entering the chamber while it is being loaded, the atmosphere surrounding the chamber must also be contamination free. Such an ultraclean atmosphere is available either in a very expensive "clean room" or in a less complex laminar flow work station.

Such work stations comprise a hood or booth open at one vertical face to permit interior access by an operator wherein the opposite vertical face forces a horizontal laminar air flow across a horizontal work face and toward the open face, but only after filtering the air with a high-efficiency particulate filter. The filter furnishes only ultraclean air to the work face. Contamination from back currents of air drawn into the box through the open face due to random flow and air from the filter is prevented by the laminar flow of ultraclean air.

Unfortunately, when a vacuum evaporator is located in such a work station to permit loading in an ultraclean atmosphere, the bell-shaped vacuum housing containing the deposition equipment disturbs the laminar flow to such an extent that the resulting eddy currents frequently draw unfiltered air into the chamber through the open access face. This unfiltered air may deposit contaminants on the thin-film materials while the vacuum chamber is raised or otherwise opened for a loading or unloading operation.

An object of the invention is to improve work stations, and particularly to avoid this type of contamination.

Another object of the invention is to clean the area of a work station without the danger of drawing contaminated air therein despite the presence of vacuum chambers within the work station booth.

The objects are achieved in whole or in part in a laminar flow work station wherein a vacuum chamber is lifted for loading of a vacuum pump by mounting around the mouth of the inverted jar a horizontal plate extending outwardly from the opening under the jar

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parallel to the laminar work flow. Means are provided to maintain this parallel relation between the plate and the flow during lifting of the chamber so that in any position the plate separates the flow above and below the chamber opening. This restricts the eddy currents imparted to the laminar flow by the chamber to the space above the plate, and permits the area below the plate to be "scoured" by the undisturbed laminar flow of ultraclean air.

These and other features of the invention are pointed out in the claims. Other objects and advantages of the invention will become obvious from the following detailed description of a device embodying features of the invention when read in light of the accompanying drawing wherein:

FIG. 1 is a perspective view of a work station embodying features of the invention;

FIG. 2 is a vertical cross section of FIG. 1; and

FIG. 3 is a horizontal cross section of FIG. 1 showing air flow patterns formed by the vacuum chamber.

In FIGS. 1, 2, and 3 the work station generally comprises a booth-supporting pedestal 10, a work-containing hood or booth 12 above the pedestal 10, and a vacuum system 14 for operation within the booth. A pump 16 in the pedestal 10 drawing air from suitable louvers 17 forces the air upwardly through a prefilter 18 behind the hood 12. A number of curved blades 20 shaped like Venetian blinds and extending horizontally along the back section 22 of the work station direct the upcoming prefiltered air flow horizontally and distribute it into parallel paths. These air paths now pass through a high-efficiency particulate filter 24. The filter 24 purifies the air forced therethrough by retaining all particles greater than 0.3 micron in diameter. Corrugated members 26 (see FIG. 1) in the filter 24 possess corrugations extending horizontally fore-and-aft in the work station, and separate the moving ultraclean air into laminar flows that pass horizontally through the booth 12 and exhaust through an open front face 27. The booth 12 comprises a lower horizontal work face 30 bounded at the back by the filter 24 and on the sides by two glass air confining plates 32 and 34. Closing the top of the chamber is a roof 36. A circular opening 38 in the roof receives a vertically movable bell-shaped vacuum chamber 40 whose open underside provides access to its interior. A flexible hose 41 having a selectively operable valve V connects to a source of ultraclean nitrogen for charging the chamber and cleaning it of contaminated air. A vacuum pump 42 of conventional type beneath the hood 12 communicates with the interior of the hood by way of a passage 44 going through the work face 30 and terminating at an opening 45. The chamber 40 is furnished with suitable heating, sputtering, or other evaporating equipment 46, together with interior mounts 47 for holding the insulating substrates that form the workpieces.

Mounted at the lower periphery of the mouth of the chamber 40 is a plate 48 having a central hole 50 whose periphery is sealed with the lower periphery of the mouth on the chamber 40. The chamber 40 and the plate 48 form an assembly which is movable along two pairs of vertical guide rods 28 extending from the work face 30 to the roof 36. Above each rod 28 in the roof 36 spring-loaded winches 52 serving as counterweights draw up on depending wires 54 for holding the plate 48 and the chamber 40 in predetermined positions set by an operator. A sealing ring 56 at the periphery of the hole 50 seals the chamber 40 when the plate 48 is lowered against the face 30. The resistance of the plate 48 to oncoming air flow is decreased by feathering the front and rear edges 58 and 60.

In operation the valve V is off. A switch (not shown) starts the pump 16. The latter forces air through the

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prefilter 18 into the high-efficiency particulate filter 24 through the corrugated members 26, through the booth 12, across the face 30, and out of the open face 27. An operator grasps the front edge 58 of the plate 48 and lifts the chamber 40, aided by the spring-loaded winches 52 to permit loading of the workpiece and other material into the chamber 40. He then opens the valve V long enough to charge the chamber 40 with ultraclean nitrogen. Laminar flow of ultraclean air passes through the hood both above and below the horizontal plate 48. It assures an uncontaminated atmosphere during loading of workpieces in the chamber. The operator lowers the plate 48 and the loaded chamber 40 over the workpiece until the ring 56 sits on the work face 30. Laminar flow may now be stopped by turning off motor 16. Suitable means then start operation of the vacuum pump 42, which draws out air from the chamber 40 through the passage 44. Electrical connections (not shown) to the chamber 40 enable the equipment 46 to heat the material to be vaporized and deposited, and otherwise perform the deposition operation. Upon completion of the operation under vacuum, the pump 16 is turned on to resume laminar flow. The chamber 40 and the plate 48 are raised and the completed or partially completed thin-film circuit removed. Laminar air flow continues during the removal.

The large chamber 40 disturbs laminar air flow above the plate 48. It produces erratic air patterns above the plate 48 such as those shown in FIG. 3. Here at least some of the air flow forms eddy currents beyond the end of chamber 40 that draw unfiltered air from the open face 27 of the booth 12. However, the plate 48 separates the laminar flow above and below it. No large impedance to flow of laminar air exists below the plate, and the undisturbed laminar air flow is exhausted at the opening 28 without returning. Thus the materials being loaded and unloaded into chamber 40 experience only an ultraclean atmosphere. The plate 48 protects them from the contaminated effect of the eddy currents formed by the chamber 40. The invention also contemplates evacuating the chamber 40 from above by means of a duct rather than through the passage 44.

While an embodiment of the invention has been described in detail, it will be obvious to those skilled in the art that the invention may be embodied otherwise without departing from its spirit and scope.

What is claimed is:

1. A work station comprising an evacuable chamber having an access opening, means for closing said opening, said chamber defining a periphery about said opening, flow guiding means for guiding an air flow, laminar flow converting means for rendering the flow laminar and for directing the laminar flow across the opening and a sheet extending outwardly from said periphery parallel to said laminar flow, whereby the flow across said chamber and across said opening are separated.

2. A thin-film-producing assembly comprising high-temperature means for vaporizing a conductive material, mounting means for holding a substrate so as to expose it to the vaporized material, a chamber for surrounding said high-temperature means and said mounting means, pump means for evacuating said chamber, an access opening in said chamber and defining a periphery, means for closing said opening, flow producing means for generating an air flow, laminar flow converting means for rendering the flow laminar and for directing the laminar flow across the said opening, and a sheet extending outwardly from the periphery parallel to the laminar flow.

3. A work station comprising an evacuable chamber having an access opening, means for closing said opening, said chamber defining a periphery about said opening, flow guiding means for guiding an air flow, conditioning means in the path of the flow for effecting a substantial contamination-free conditioning of air passed therethrough, laminar flow converting means for rendering the flow emerging from said conditioning means lam-

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inar and for directing the laminar flow across the opening, and a sheet extending outwardly from said periphery parallel to said laminar flow, whereby the flow across said chamber and across said opening are separated, said sheet having a leading and a trailing edge relative to the flow, said leading edge and said trailing edge being feathered.

4. A work station comprising an evacuable chamber having an opening, means for closing said evacuable chamber, said chamber defining a periphery about said opening, pump means for evacuating said chamber, flow producing means for generating an air flow, said periphery defining a plane, conditioning means in the path of the flow for effecting a substantially contamination-free conditioning of air passed therethrough, laminar flow converting means for rendering the flow emerging from said conditioning means laminar and for directing the laminar flow parallel to the plane including the opening, and a plate extending outwardly from said periphery parallel to said laminar flow for separating the laminar flow.

5. A work station comprising a workface, an evacuable chamber having an opening facing said workface, means for moving said evacuable chamber from and toward said workface until said workface covers said opening, said chamber defining a periphery about said opening, pump means behind said workface and terminating in an opening in said workface for evacuating said chamber when said chamber rests against said workface, flow producing means for generating an air flow, said periphery defining a plane, conditioning means in the path of the flow for effecting a substantially contamination-free conditioning of air passed therethrough, laminar flow converting means for rendering the flow emerging from said conditioning means laminar and for directing the laminar flow parallel to the plane including and externally of the opening, and a plate extending outwardly from said periphery parallel to said laminar flow.

6. A work station comprising a workface, a bell jar having an opening, means for moving said bell jar toward said workface so said workface covers said opening, said jar having a lip about said opening, flow producing means for generating an air flow, a plate extending outwardly from said lip and parallel to said workface, and laminar flow converting means for rendering the flow laminar and for directing the laminar flow parallel to said plate.

7. A work station comprising a horizontal workface, an evacuable chamber above said workface and having a lower opening, means for moving said evacuable chamber vertically until the workface covers the opening, said chamber defining a horizontal periphery about said opening, flow producing means for generating an air flow, conditioning means in the path of the flow for effecting a substantially contamination-free conditioning of air passed therethrough, laminar flow converting means for rendering the flow passed through said conditioning means laminar and for directing the laminar flow horizontally across said workface and across the plane including and externally of the opening, and a horizontal plate extending outwardly from said periphery parallel to said laminar flow.

8. A work station comprising a horizontal workface, a bell jar having a lower opening, means for moving said bell jar vertically until said workface covers the opening, said jar having a horizontal peripheral lip about said opening, flow guiding means for guiding an air flow, laminar flow converting means for rendering the flow laminar and for directing the laminar air flow horizontally across said workface both above and below the horizontal peripheral lip of the opening at all positions of the jar, and a horizontal sheet extending outwardly from said lip and parallel to said flow.

9. A work station comprising a horizontal workface, a bell jar having a lower opening, means for moving said bell jar vertically until said workface covers the open-

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ing, pump means for evacuating said bell jar, said jar having a lip about said opening, flow producing means for generating an air flow, a horizontal sheet extending outwardly from said lip, and laminar flow converting means for rendering the flow laminar and for directing the laminar flow horizontally across the workface and above and below said sheet.

10. A work station comprising a horizontal workface, a bell jar having a lower opening, means for moving said bell jar vertically until said workface covers the opening, pump means behind said workface and terminating in an opening in said workface for evacuating said bell jar when it rests on said workface, said jar having a lip about said opening, flow producing means for generating an air flow, said opening defining by its lip a horizontal plane, conditioning means in the path of the flow for effecting a substantially contamination-free conditioning of air passed therethrough, laminar flow converting means for rendering the flow through said conditioning means laminar and for directing the laminar flow horizontally across the workface and both above and below said lip, and a horizontal plate extending outwardly from said lip and parallel to said flow.

11. A work station comprising a horizontal workface, a bell jar having a lower opening, means for moving said bell jar vertically until said workface covers the opening, pump means behind said workface and terminating in an

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opening in said workface for evacuating said bell jar when it rests on said workface, said jar having a horizontal peripheral lip about said opening, flow producing means for generating an air flow, a particulate filter in the path of the flow for removing particles from the flow, corrugated means passing through the filter for rendering the filtered air laminar and directing the laminar flow horizontally across said workface and above and below said lip in a plurality of positions of said jar, a horizontal plate extending outwardly from said lip and parallel to said flow, said plate having a leading edge and a trailing edge relative to the flow, said trailing and said leading edges being feathered, and means for charging said chamber with a gas.

References Cited

UNITED STATES PATENTS

2,558,997	7/1951	Voelker	62—265
2,724,663	11/1955	Bond	118—49 X
2,862,369	12/1958	Simons	62—89
2,999,448	9/1961	Abler et al.	98—115
3,038,400	6/1962	Ruff	62—265 X
3,143,952	8/1964	Simons	98—36
3,148,956	9/1964	Hetherwick et al.	34—88 X

MORRIS KAPLAN, *Primary Examiner.*