United States Patent

Rabilloud et al.

[15] **3,686,836**

[45] **Aug. 29, 1972**

[54] **DUST-FREE WORK STATION WITH TWO CROSSED LAMINAR FLOWS**

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[22] Filed: **June 22, 1970**

[21] Appl. No.: **48,172**

[30] **Foreign Application Priority Data**

June 23, 1969 France.....6921026

[52] **U.S. Cl.**.....**55/467,** 55/473, 55/DIG. 29, 98/115 LH

[51] **Int. Cl.**.....**B01d 19/00**

[58] **Field of Search**.....55/473, 461, DIG. 29; 98/115 LH

[56] **References Cited**

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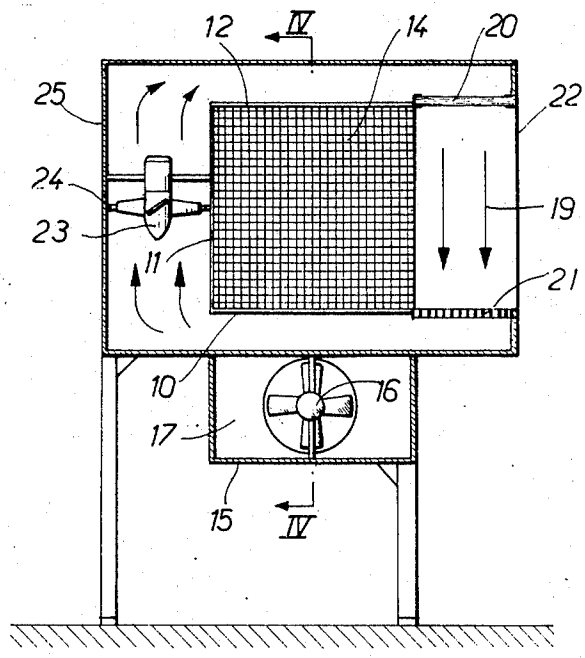
[57] **ABSTRACT**

A dust-free work station according to the invention comprises a working space limited inter alia by a substantially horizontal lower surface and apertured side walls, and provided with a passage in front. Means are provided for establishing two laminar flows of air, i.e., horizontally between side walls and vertically through said passage.

8 Claims, 4 Drawing Figures



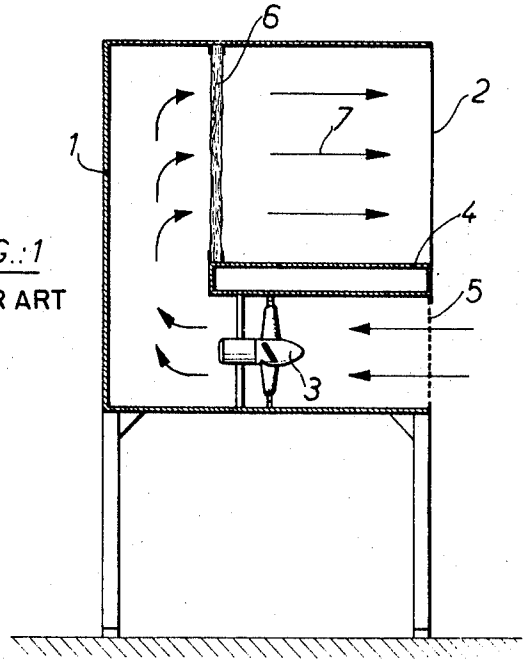


FIG.:1
PRIOR ART

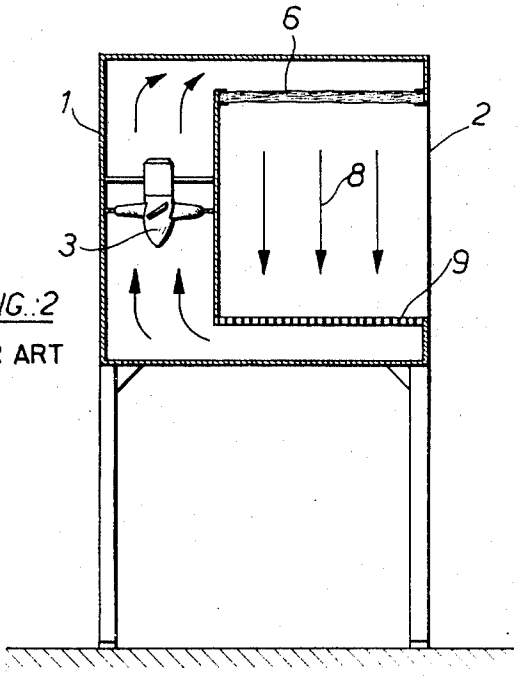


FIG.:2
PRIOR ART

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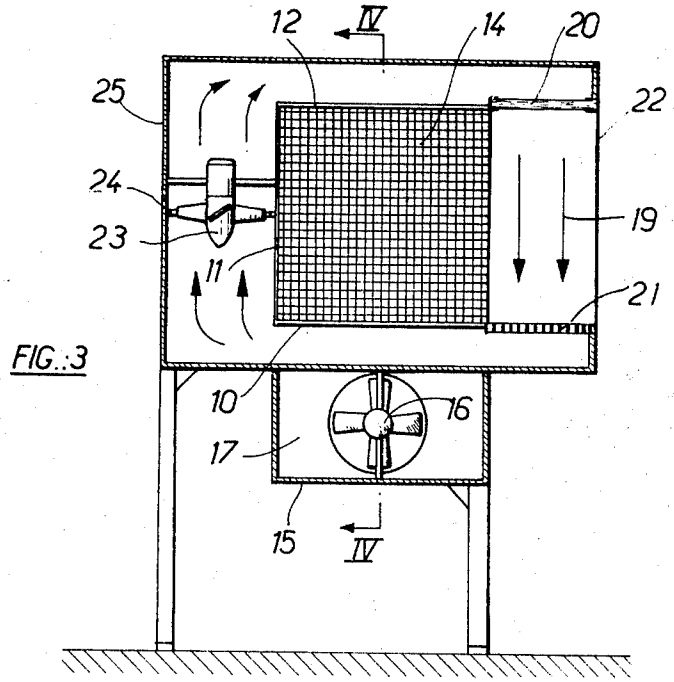
12
IV
14
20
25
22
24
19
23
11
21
10
16
17
15
IV

FIG.:3

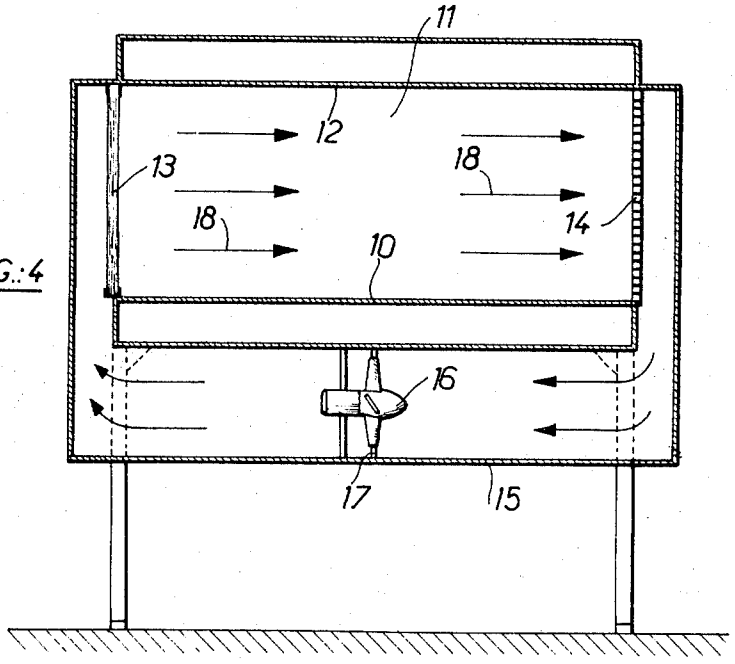
11
12
13
18
18
14
10
16
17
15

FIG.:4

DUST-FREE WORK STATION WITH TWO CROSSED LAMINAR FLOWS

This invention relates to work environments free from any form of pollution, which "spearhead" and conventional techniques alike are coming to require increasingly.

In the case of large facilities, such as are used for manufacturing electronic equipment or building spacecraft, it is possible to use so-called "clean" rooms with wall-to-wall or ceiling-to-floor laminar flows, and the personnel who work in such rooms are suitably clothed in order not to pollute them. However, the work involved in numerous production processes can be broken down into individual operations each of which requires its own small clean space. Altough such a space can be provided in the form of a glove-box, the latter is not a very practical solution and is tending wherever possible to be abandoned in favor of dust-free work stations that are usually located in a room which is air-conditioned and dust-freed by conventional methods and in which the personnel works.

Work stations of this kind are invariably of the laminar flow type. It must be pointed out that, in the technique in question, the term "laminar flow" should not be taken to mean a flow defined by a Reynolds number of under 2,000 but a flow characterized by the fact that a thin stream of smoke injected into its midst will be discharged in the general direction of the flow in the form of a plume which, though it broadens out slightly, maintains an axis which is straight and parallel to that direction.

A result of this basic property is that stations of this type not only provide a dust-free work surface but that pollution at any point is discharged along a constrained path and all the dangerous zones are known. In particular, any continuous or accidental polluting with dust remains under control.

There are at present two known kinds of work station of this type which, in this respect, have different characteristics depending on whether they employ horizontal or vertical flows, as will be explained hereinafter.

It should also be recalled that in addition to the problem of ensuring non-pollution of the work environment by the operator or by the atmosphere in the room in which he works, which is the problem to which most attention is usually paid, there is a further problem, to wit that of avoiding pollution of the operator himself by the dust, emanations or gases released by the work process itself. It has been found that in this latter respect horizontal flow type dust-free stations satisfactorily resolve the first problem but not the second, whereas vertical flow type dust-free stations, depending on whether the suction flow rate is slightly less or slightly greater than the blown flow rate, are capable of resolving either the first or the second problem but never both simultaneously. Consequently, one or the other has to be ignored, as the case may be.

It is the object of the present invention to provide a laminar flow type work station of the kind referred to but in which the two problems set forth precedingly can be resolved simultaneously, to wit non-pollution of the work environment by the operator and non-pollution of the operator by the work.

A dust-free work station according to this invention comprises two sections, to wit a rear section which surmounts the work surface proper and which is crossed by a horizontal transverse laminar flow and another narrower section located between the first section and the operator and crossed by a vertical laminar flow.

The comparative description which follows of the two conventional types of dust-free rooms and of an exemplary non-limitative embodiment of a dust-free room according to this invention, given with reference to the accompanying drawing, will give a clearer understanding of how the invention can be carried into practice.

In the drawing:

FIG. 1 shows in vertical section a conventional horizontal flow type dust-free station;

FIG. 2 shows in vertical section a conventional flow type dust-free station;

FIG. 3 shows in vertical section a dust-free station according to this invention; and

FIG. 4 is a vertical section taken through the line IV—IV of FIG. 3.

FIG. 1 shows a horizontal laminar flow type station formed by a chest 1 open at the front at 2 and comprising a blower 3 which is located beneath work surface 4 and which sucks in air from the room at 5 and impels it toward the rear end of the chest, whence it flows through a filter 6 as a laminar flow 7 directed toward the operator. The air which is continuously drawn in form and expelled into the work premises sweeps the work surface 4 horizontally. All polluting agents are discharged in a direction parallel to the work surface and, along this parallel, everything lying past the source of dust is polluted. However, there is total independence of sources of pollution located in the same vertical plane perpendicular to the flow. A vertical plane of this kind is polluted locally only by those sources of pollution which lie upstream of the flow.

FIG. 2 shows that, in the case of a vertical flow, the arrangement is similar to that in FIG. 1 but that in this case the air flows in a vertical laminar flow 8 and issues through the work surface 9 which is compulsorily formed by a perforated grid-like surface. The flow is taken up by a blower 3 as in the case of FIG. 1 and is impelled toward a filter 6 located above the work station. Assuming a perfect flow, the same mass of air would be ceaselessly recycled. All polluting agents are discharged in a vertical direction and, along this perpendicular at right angles to the work surface, everything lying downwardly of the source of pollution is polluted. In this case there is total independence of the sources of pollution lying in the same horizontal plane. A given vertical plane will be polluted along perpendiculars to the work surface only by such sources as lie thereon.

In order to be able to choose the type of work station best suited in each particular instance, a closer examination will now be made of what happens to the polluting agents released on the work surface. In the case of a horizontal flow, such agents are discharged into the work premises, as already explained. In the case of a vertical flow type station, the need for an access opening 2 means that exchanges necessarily occur between the flow 8 and the environment, so that it is usually necessary to opt for either of two opposite forms of adjustment:

either it is necessary to draw through work surface **9** a mass flow greater than that impelled through ceiling filter **6**. This prevents emergence to the exterior of part of the flow and of the polluting agents it contains, but on the otherhand the inflow from the environment pollutes the work surface more or less, in addition to which the laminar nature of the flow is very adversely affected at this level;

or it is necessary to draw through work surface **9** a mass flow less than that impelled through ceiling filter **6**. In this case the flow remains laminar and the work surface is not contaminated by the environment, but on the otherhand possible polluting agents from the flow are discharged in part into the work premises. And if the surplus air is sucked into the premises themselves, and if the polluting agent is of the gaseous variety, the premises will obviously be completely invaded ultimately.

Consequently neither the horizontal nor the vertical flow type systems will assure segregation of the atmosphere in which the operator works, with respect to gaseous or other polluting agents released into the work premises, or else such segregation can be achieved only to the detriment of the cleaness of the working environment in cases where a vertical flow is used. Numerous cases are therefore encountered in practice in which neither of these systems is suitable.

A first case in point concerns bacteriology, in which the preparation must be isolated from the operator and often also, for safety reasons, the operator must likewise be isolated from the preparation in order to avoid inhaling dangerous germs. While a hood with a laminar flow provides the first type of segregation it cannot offer the second type as well, as already explained. In such cases, therefore, operators continue to use a glove-box in spite of its inconvenience.

In "clean chemistry" likewise it is often necessary to attack solid substances with concentrated acids in vessels with a capacity of 500 cubic centimeters or more, in atmospheres that are as dust-free as possible. The vertical flow which it is then mandatory to use undergoes heavy gaseous contamination which, in the present state of the art, is eliminated by being partially discharged to the exterior, the make-up flow being drawn from the environment and partly contaminating the work surface.

A final example involves the manufacture of certain types of microelectronic circuitry, which must be carried out in a dust-free atmosphere with a relative humidity of under 10 percent. Such small objects cannot be placed on perforated grids, thereby excluding a vertical flow. Moreover, to use a horizontal flow would be to discharge very dry air at a high rate into the premises, which would soon cause acute discomfort to the operators.

The above-mentioned drawbacks can be overcome with advantage by recourse to a dust-free work station according to this invention. As shown in FIGS. **3** and **4**, such a station comprises a work surface **10** surmounted by a chest formed by an end-wall **11** and a ceiling wall **12**, the side walls of the chest being replaced by an air filter **13** on one side and by an offtake grid **14** on the other. A suitable duct **15** containing a blower **16** mounted in an opening in a transverse wall **17** draws off air at **14** and delivers it through **13**. There is thus obtained, inside said chest, a horizontal laminar flow **18** moving from left to right above work surface **10**, instead of from front to rear with respect to the operator, as in the case of FIG. **1**.

Between this horizontal laminar flow and the operator is further provided, in accordance with this invention, a vertical laminar flow **19** generated between a horizontal filter **20** forming an extension of ceiling **12** and a horizontal offtake grid **21** forming an extension of work surface **10**. This flow moves parallel to lateral surfaces **22** located on the extensions of portions **13** and **14** and is preferably engendered by a further blower **23** mounted in a transverse partition wall **24** located across a suitable duct **25** enabling air to be sucked through **21** and blown through **20**. Obviously, the same blower could be used to engender both flows, but a two-blower arrangement permits greater independence of adjustment. Similarly, the directions of flows **18** and **19** could easily be reversed by interchanging the positions of the filters and the offtake grids without in any way affecting the properties of the system.

The laterally circulating horizontal laminar flow **18** is the one which keeps the work surface **10** clean. The work station can be so adjusted as to maintain laminarity over the entire work surface. The principal properties of this flow are the independence of polluting sources lying in a vertical plane perpendicular to the direction of the flow, and also the fact that any horizontal plane can be polluted along horizontal paths perpendicular to filter **13** only by such sources of pollution as lie in that plane. There is thus obtained a type of flow akin to the conventional horizontal flow depicted in FIG. **1** except that in this case, when the work surface is being used, cleanness decays from left to right, in keeping with the chosen direction, whereas in conventional work stations the decay in performance takes place from front to rear with respect to the operator. There is total accessibility to the clean zone.

The vertical flow serves a dual purpose :

From the aerodynamic point of view, it provides a movable wall which must be adjusted so as to allow the horizontal flow **18** to establish and maintain itself all the way to offtake grid **21**, there being at the most a narrow eddy zone in which adjacent layers of the two flows mingle over a small depth close to grid **21**.

From the contamination point of view, it provides mutual segregation between the horizontal flow and the exterior by virtue of its properties referred to precedingly.

A non-limitative embodiment will now be considered by way of example, in which the lateral flow **18** is blown through a filter cell **13** with a section measuring 610 millimeters by 610 millimeters and is drawn through an identical cross-sectional area. Work surface **10**, which is 610 millimeters deep, is 1,500 millimeters wide. The mean velocity of the flow **18**, as measured by a hot-wire anemometer, is 0.5 meter per second. The vertical flow **19** is blown through an area measuring 30 millimeters by 1,250 millimeters and is drawn out through an identical cross-section. Good adjustment is obtained when the offtake flow rate through **21** is slightly greater than the blowing rate through **20**, the surplus air being discharged through a leak orifice downstream of blower **23**. This form of adjustment is selected when the aim is to get rid of a specific type of pollution.

When gaseous pollution is involved, it is possible to operate with a blowing rate through **20** slightly greater than the rate of offtake through **21**, the difference being made up by an air intake provided upstream of blower **23**. The mean velocity of flow **19** is in the region of 0.6 meter per second for a total height of 610 millimeters.

In this particular embodiment the air flow rates are 670 m^3/hr and 1,072 m^3/hr respectively. As already indicated, they are preferably generated by two blowers supplying two separate circuits, thereby permitting readier adjustment by virtue of this segregation. Each circuit operates with a continuous recycling process, with or without an input of fresh air (usually drawn from the surrounding air), the tainted air being possibly discharged outside the premises. Both flows may be flows of air or any other gas, either alone or in a mixture. Each circuit may have inserted thereinto absolute filters and layers of activated carbon in order to absorb dangerous vapors. It is likewise possible, and is of especial advantage in the case of the horizontal flow **18**, for the circuits to comprise complete or partial air-conditioning. Lastly, for certain embodiments, the flows can be led out from a central airconditioning unit.

A dust-free work station according to this invention is usable for most current applications of hoods utilizing horizontal or vertical flows. It provides a solution to problems which could hitherto be resolved only by the use of glove-boxes, particularly when it is necessary to operate in a clean atmosphere on jobs which generate gaseous or other polluting agents that must not be allowed to escape to the exterior, or when the working atmosphere must exhibit special properties such as a low relative humidity or a low or high temperature, or must contain a special gas that precludes any form of mingling with the environment in the work premises.

It goes without saying that many changes may be made to the exemplary embodiment and its possible variants without departing from the scope of the invention. For instance, the height or length of the vertical and horizontal flows could be made different by interposing screens between the two flows and between the vertical flow and the exterior.

We claim:

1. A dust-free work station comprising, for the purpose of bounding a working space, a set of walls including a generally horizontal work surface having an access opening to said surface in a non-horizontal side of said walls, means for producing a first laminar air current within said space above said work surface moving generally horizontally from one wall side to an opposite wall side, and means for producing a second curtain-like laminar current of air, distinct from said first current, passing in a generally vertical direction over said access opening outside said work space.

2. A work station as claimed in claim **1** wherein said set of walls includes an end-wall opposite said opening, a ceiling wall, and two side walls formed by a diffusion grid and by an offtake grip respectively.

3. A work station as claimed in claim **2** including a second set of walls generally surrounding said first set and providing a second opening arranged in forwardly spaced communicating relation to said first opening, said second current moving vertically in the space between said first and second openings.

4. A work station as claimed in claim **2** wherein said diffusion grid is formed by a dust filter.

5. A work station as claimed in claim **1** wherein separate means are provided for impelling said horizontal flow and said vertical flow.

6. A work station as claimed in claim **1** wherein separate means are provided for impelling said horizontal and vertical flows at different rates.

7. A work station as claimed in claim **1** including an enclosed conduit extending outside said space with its opposite ends in communication with said grids to provide a circulatory path for said first air current, and air impelling means in said conduit.

8. A work station as claimed in claim **1** including an enclosed conduit extending outside said space and terminating at its opposite ends in mutually facing openings disposed adjacent the upper and lower edges of said access opening, the planes of said mutually facing openings projecting forwardly and generally perpendicularly of the plane of said access opening, to provide a circulatory path for said second air current, and air impelling means in said conduit.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,686,836 Dated August 29, 1972

Inventor(s) Pierre RABILLOUD et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In The Heading of The Patent, insert --

Assignee: Societe d'Aerodynamique et de Thermodynamique Francaise en abrege "S.O.F.R.A.I.R." , Boulogne, France, and Institut National de Recherche Chimique Appliquee I.R.C.H.A., Paris, France --.

Signed and sealed this 23rd day of January 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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