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Kelso et al.

[11] **3,715,972**

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[54] CLEAN WORK STATION

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[21] Appl. No.: **147,774**

[52] **U.S. Cl.** .....**98/115 LH,** 55/467, 55/DIG. 29, 23/259, 312/239

[51] **Int. Cl.** **F23j 11/00**

[58] **Field of Search**.98/42, 115 LH, 115 R; 312/239; 55/467, DIG. 29, DIG. 18; 23/259

[56] **References Cited**

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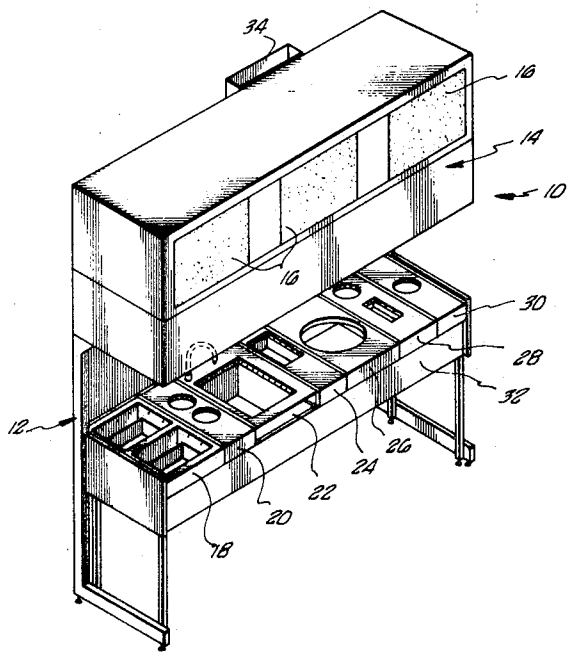
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Primary Examiner—William E. Warner
Assistant Examiner—William E. Tapolcai, Jr.
Attorney—Robert R. Thornton

[57] **ABSTRACT**

A laminar flow clean work station adapted for rapid change in work setup by utilizing a common exhaust plenum and drain and interchangeable work modules. Each module empties separately into the common exhaust plenum and drain. Each module has a separate exhaust damper which is adjustable to suit the particular exhaust requirement of the work to be undertaken at the module. Air is exhausted through the series of apertures formed in each module below a work receiving opening the station work surface. The opening forms a lip overhanging the module work receiving space and has a depending flange to further baffle the apertures from the station work surface.

9 Claims, 9 Drawing Figures



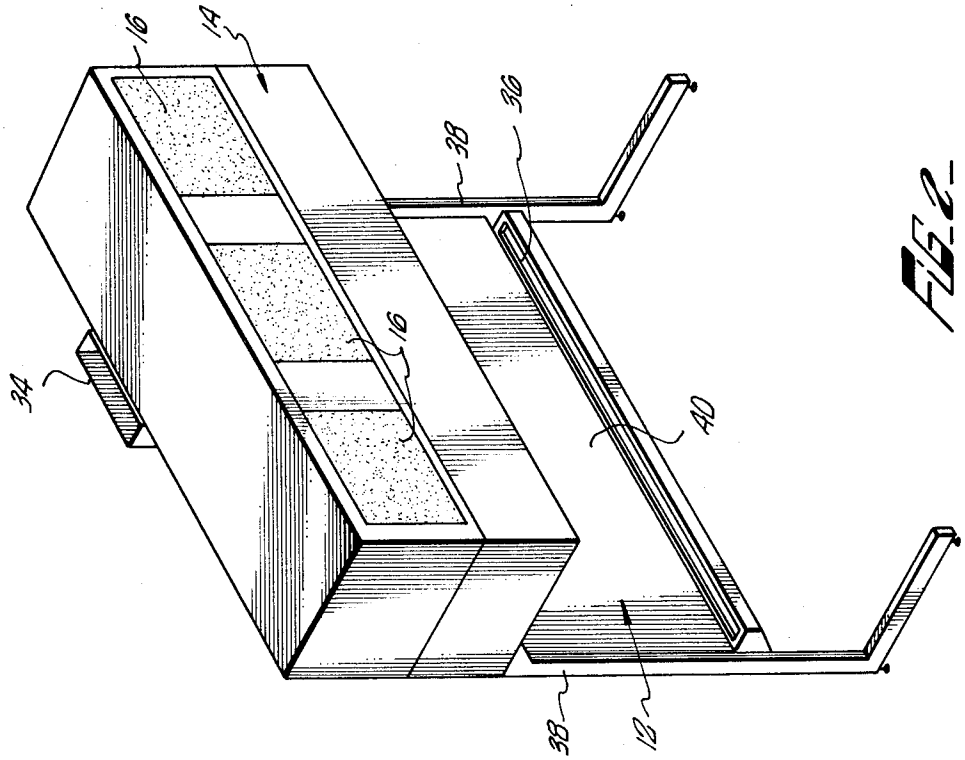


FIG 2

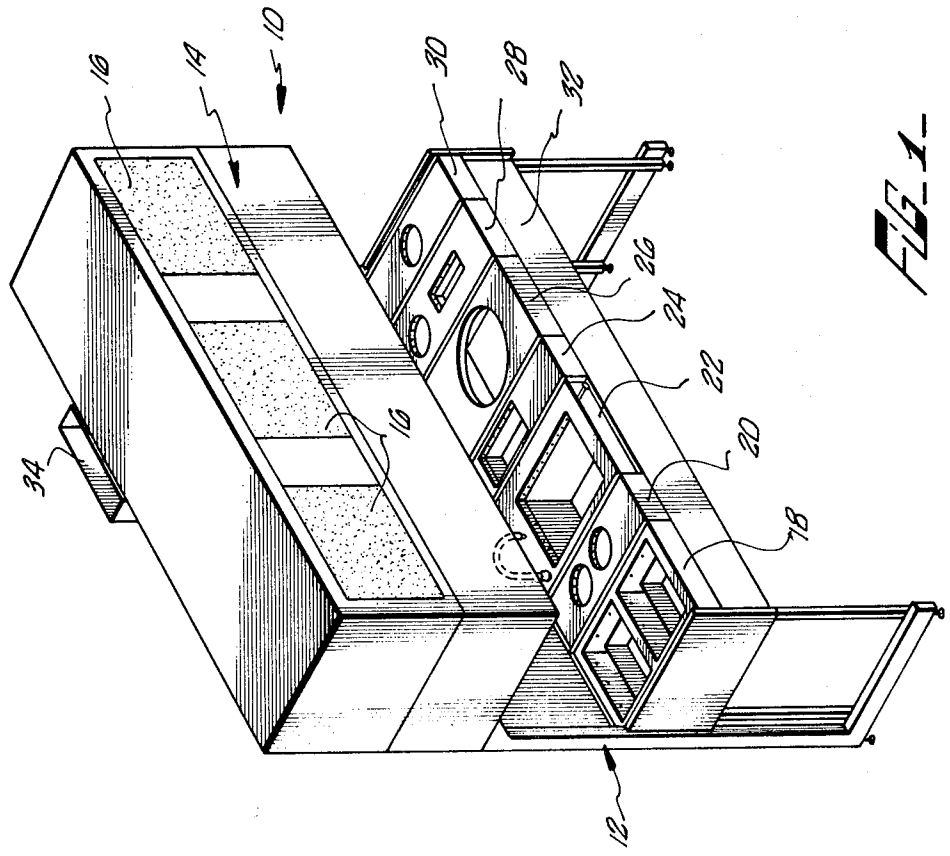


FIG 1

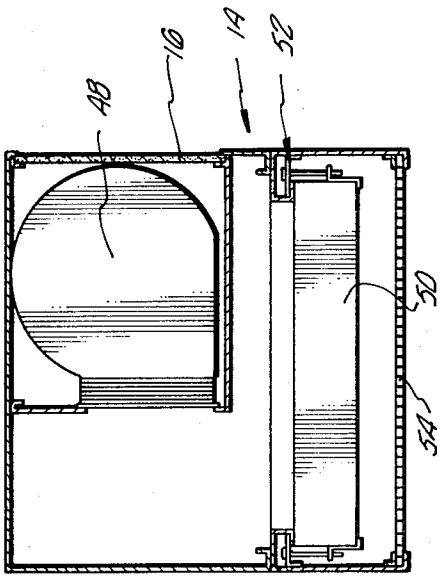


FIG. 5

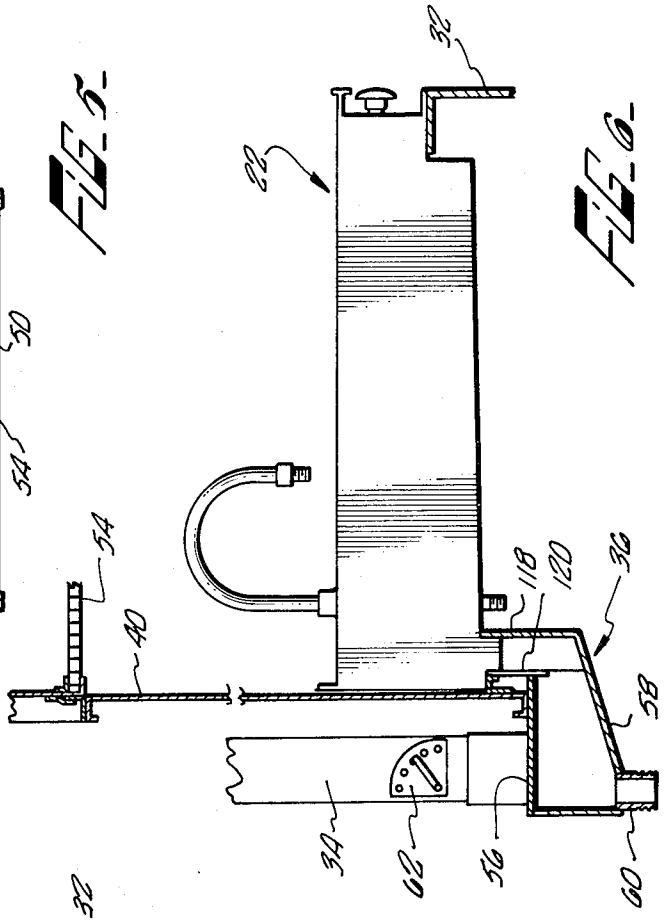


FIG. 6

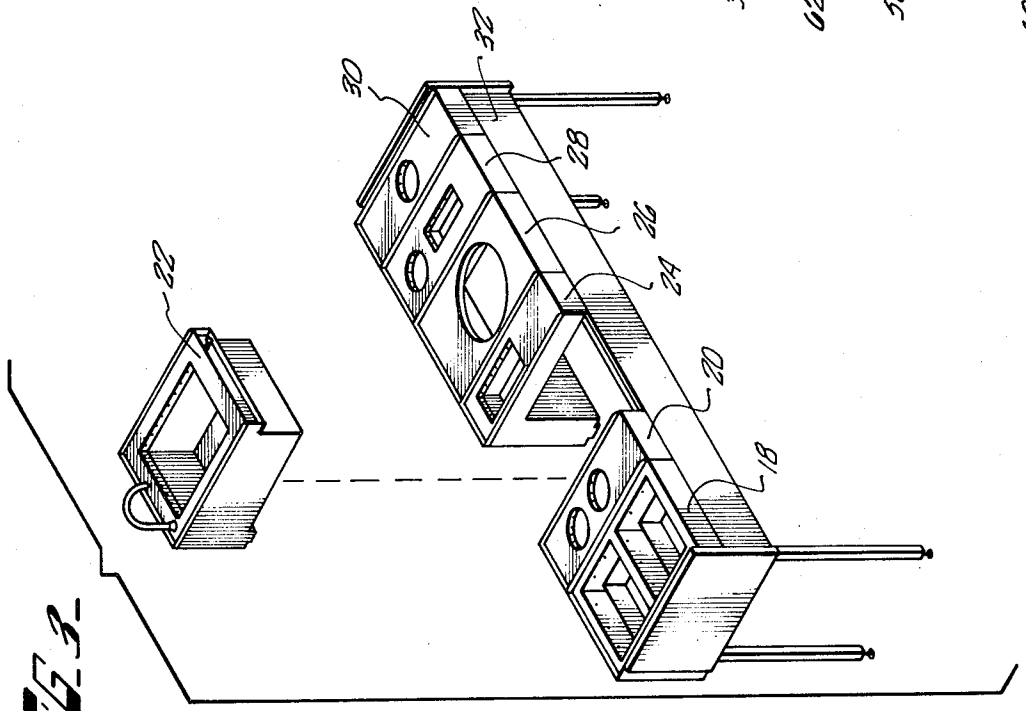


FIG. 3

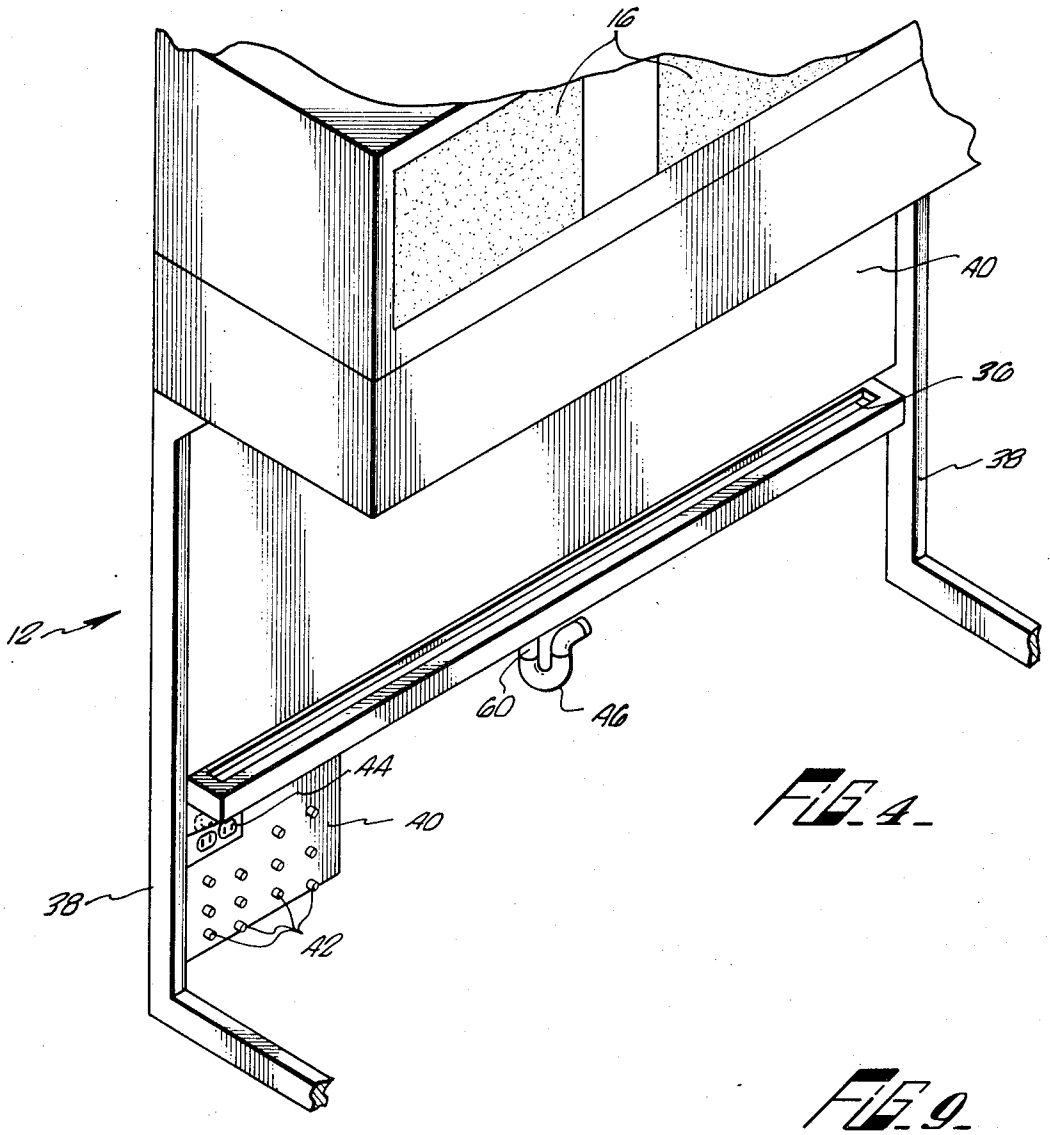

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FIG. 4

FIG. 9

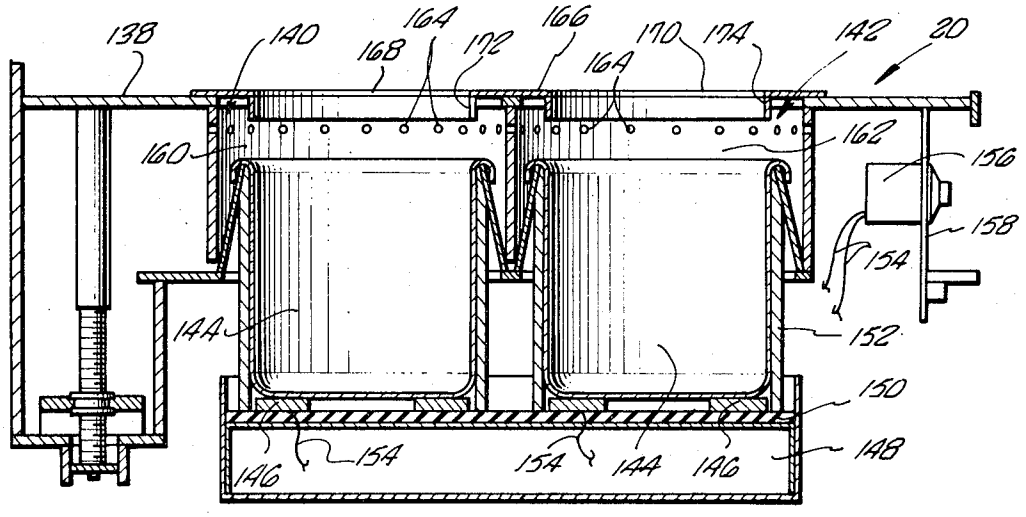

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FIG. 7

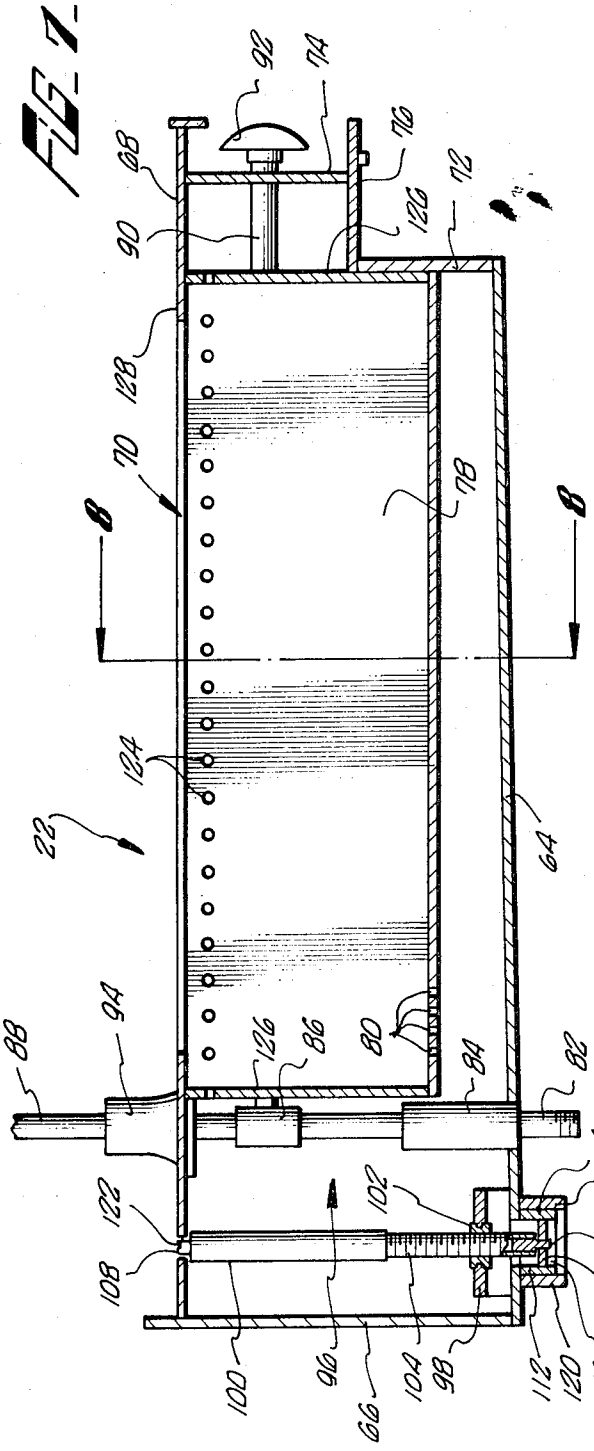
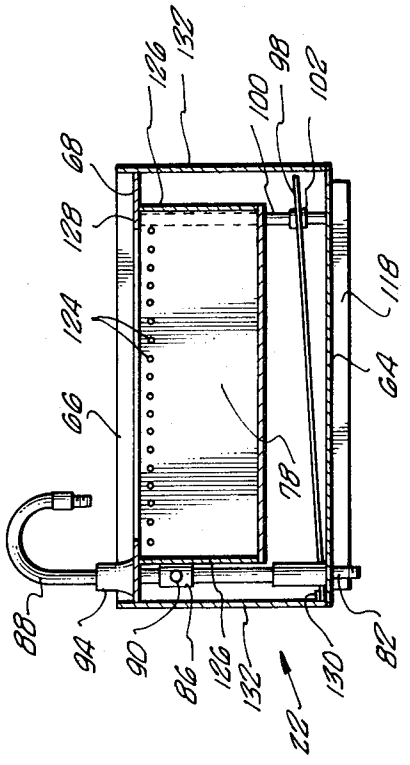

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FIG. 8


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CLEAN WORK STATION

FIELD OF THE INVENTION

This invention pertains to a clean work station, i.e., a work bench or similar working enclosure characterized by having its own filtered air or gas supply.

DESCRIPTION OF THE PRIOR ART

Clean work stations are well known in the prior art, and are the subject of Federal Standard Number 209*a* dated Aug. 10, 1966. Clean work stations may be divided generally into nonlaminar flow types and laminar flow types. Laminar flow refers to an air flow in which the entire body of air within the contained area moves with uniform velocity along parallel flow lines. Thus, a laminar air flow clean work station is a work station in which the laminar air flow characteristics predominate throughout the air space, with a minimum of eddies. Laminar flow clean work stations may fall into one of two general classifications, that in which air flow is horizontal and exhaust is directly out of the work station into the surrounding atmosphere, such as is shown in FIG. 7 of Federal Standard Number 209*a* and that in which the air flow is vertical and is exhausted through the work surface by means of the application of a vacuum, such as is shown in FIG. 8 of the aforesaid Federal Standard.

For certain applications, such as the boiling of concentrated acids, processes using noxious gasses, and the like, neither of the general layouts for clean work stations shown in FIG. 7 or FIG. 8 of the aforesaid Federal Standard are practical, since in both instances at least part of the clean air exhausts directly into the surrounding atmosphere. In such an embodiment, the objectionable gas would be carried into the surrounding atmosphere, causing discomfort, if not injury, to workers in the area. Therefore, it has become the practice when dealing with such substances, to utilize vertical laminar flow clean work stations with increased exhaust capacity, so that air is drawn from the surrounding atmosphere through the work area into the exhaust system of the work station. Thus, the passage of the objectionable gasses into the surrounding atmosphere is avoided. However, the exhaust capacity of the work station must be increased in order to insure an excess of exhaust capacity over clean air input.

In an effort to reduce the exhaust capacity required in such embodiments, the total surface area to be exhausted has been reduced by various methods. For example, rather than exhausting across the entire surface, a solid work area may be used with a perimetrical exhaust inlet. This inlet may completely surround the work area in some embodiments, and in other embodiments, the exhaust may be taken at the front and back of the work area, with the intermediate portion being a solid surface upon which the work is accomplished. In either of these prior art embodiments, the exhaust vacuum is applied equally about the entire work area, without regard to the particular type of work being carried on at any one location and the actual quantity of air required to be exhausted in order to avoid atmospheric contamination by material in that location.

A further disadvantage of prior art laminar flow clean work stations has been their lack of flexibility. It has been the practice in the prior art to design and construct such a work station for a given work capability or operation. If the work capability or operation of the station is to be changed by reason of a change in manufacturing process or the like, it has been necessary to remove the work station and install a different work station specifically constructed for the new process or operation. This has been the case even as to work stations available as component part subassemblies. In such devices, the work area itself has not been capable of being rapidly changed in configuration to adapt to different process requirements. Rather, an entirely new work surface has been required which would contain the necessary utilities and facilities to carry out the particular work desired.

SUMMARY

According to the present invention, the work area of a laminar flow clean work station is divided into separate subcomponents or modules which are detachably mounted to a work station frame. The work modules have a generally flat upper surface with a work receiving opening formed therein, a hollow interior, a module exhaust plenum connected to the hollow interior, and an adjustable damper control for the module exhaust plenum. The work station frame has a common exhaust plenum into which the module exhaust plenums empty, so that the module damper control controls the flow of air from the hollow interior of each work module to the common exhaust plenum. Each work module has a wall formed within the module below and recessed from the periphery of the work receiving opening, so that the opening forms an overhanging lip about the wall. A plurality of apertures are formed within the wall and disposed in horizontal alignment immediately below the overhanging lip. In the preferred embodiment, the overhanging lip has a depending flange which functions to further baffle the apertures from the work surface. By such a structure, the individual requirements, as to exhaust, for each of the various modules and the work operations being conducted thereon, are individually adjusted and controlled. By utilizing a modular structure in which the modules are readily detachable and interchangeable, so that a given work station frame may be utilized for a variety of work operations by the simple interchange of appropriate modules and corresponding adjustment of the module damper controls.

BRIEF DESCRIPTION OF THE DRAWING

Referring now to the drawing,

FIG. 1 shows a clean work bench or work station according to the present invention;

FIG. 2 shows the work frame of the work station of FIG. 1, together with the clean air supply;

FIG. 3 shows the work module support frame, upon which the work modules are mounted, with one work module illustrated as removed from the frame;

FIG. 4 is a detailed view of a portion of the work frame of FIG. 2, illustrating the utility supply and exhaust system;

FIG. 5 is a view of the clean air supply system for the work station.

FIG. 6 is a view of a work module as installed in the work frame;

FIG. 7 is a view, in section, of the work module of FIG. 6;

FIG. 8 is a view of the work module of FIG. 7 taken along lines 8—8 thereof; and

FIG. 9 is a view, in section, of another embodiment of a work module, designed for a different operation or process.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is shown a clean work station or bench 10 of the laminar flow type. The work station or bench 10 has a frame 12 which carries an air supply unit 14. The air supply unit includes one or more blowers (not shown, see FIG. 5) which draw air from the atmosphere surrounding the work station 10 through prefilters 16. The prefilters 16 may be, for example, one-half inch thick polyurethane foam which is 63.8 percent or more effective on atmospheric dust by the standard Filter Institute test. Disposed below the air supply unit 14 is a work area which contains a series of work modules 18, 20, 22, 24, 26, 28, 30 supported from a module stand 32 and from the station frame 12, as will be explained hereinafter with respect to FIGS. 6, 7, 8 and 9. As will be apparent from FIG. 1, each of the work modules 18, 20, 22, 24, 26, 28, 30 is designed for utilization in a different process or to accomplish a different type of work. Where appropriate, an actual work module may have substituted for it a blank work module. At the rear of the work station 10 an exhaust outlet 34 is adapted for connection to the exhaust system in the plant or building in which the work station is located, so as to provide a vacuum exhaust which will be applied to the work modules 18, 20, 22, 24, 26, 28, 30, as will be explained hereinafter.

Referring now to FIG. 2, the work station frame and air supply unit are shown. Extending transversely across the lower portion of the work station frame 12 is a common exhaust plenum 36, which empties into the exhaust outlet 34. As is seen in FIG. 2, the work station frame 12 consists of a pair of L-shaped legs 38 which support the air supply unit 14. A rear wall 40 is attached between the legs 38 above the common exhaust plenum 36.

In FIG. 3, the module stand 32 and the work modules are shown as removed from the work station frame 12. Also, the work module 22 has been removed from the module stand 32 to better illustrate the disposition of the work modules on the stand.

FIG. 4 illustrates, in greater detail, the structure of the work station frame 12. In FIG. 4, a utilities panel 40 is supported from one of the legs 38. The panel 40 contains an array of couplings 42 which extend through the panel 40 to control valves (not shown). The control valves are, in turn, connected to the utility supply lines in the plant where the work station is located. For example, in addition to an electrical outlet 44, the utilities panel 40 may supply nitrogen, a source of vacuum, city water, and distilled water at the couplings 42. Also seen in FIG. 4 is a drain outlet 46 which is connected to the common exhaust plenum 36.

FIG. 5 is a sectional view of the air supply unit 14. An exhaust blower 48 functions to draw air through the prefilter 16 into the interior of the air supply unit 14. The air then passes through a high efficiency particulate air filter unit (HEPA filter) 50. The HEPA filter 50 is supported within the air supply unit 14 by a bracket assembly 52 so as to be readily removable for changing or replacement. HEPA filters are described in TID7023, a publication of the U. S. Atomic Energy Commission. The air, after passing through the HEPA filter, passes out the lower portion of the air supply unit through a grating 54. Air supply units, such as that shown in FIG. 5, are well known in the art.

In FIG. 6, there is shown one of the work modules in place in the work station. The particular work module 22 shown in FIG. 6 is a wash basin. As will be seen, the wash basin work module 22 is supported, at its front, by the module stand 32 and, at its rear, by the common exhaust plenum 36. The common exhaust plenum 36 may be made of any appropriate material, such as polypropylene, and includes a flat upper surface 56, to which the exhaust outlet 34 is attached so as to open into the common exhaust plenum 36. The common exhaust plenum 36 also has a sloping bottom surface 58 and a drain fitting 60 at the lower most portion thereof. The drain fittings 60 has the drain outlet 46 attached thereto (see FIG. 4). In the exhaust outlet 34, a master damper control 62 provides overall control of the amount of vacuum which is applied to the common exhaust plenum 36. This master damper control permits the vacuum applied to the work station from the vacuum supply available in the plant to be reduced to about one inch of water, which is sufficient vacuum for the operation of the work bench of the present invention.

FIG. 7 is a view in section of the wash basin module 22 shown in FIG. 6. As will be seen in FIG. 7, the module 22 is constructed in the shape of a generally rectangular box by means of a bottom 64, a back side 66, and a flat upper surface 68. The flat upper surface 68 has a work receiving opening 70 formed therein. At the front of the work module 22, a lower front plate 72 is connected to the bottom 64 and a control panel 74 is connected to the flat upper surface 68. The enclosure is completed by the support plate 76 which rests upon the module stand 32 (see FIG. 6). Disposed in the generally hollow interior of the work module 22 is a sink 78 having drain holes 80 toward the rear thereof. A water inlet pipe 82 extends through the bottom 64 and is fixed in place by a support sleeve 84. A ball valve 86 is disposed between the water inlet pipe 82 and a goose neck 88 so as to control the flow of water from the water inlet pipe through the goose neck into the sink. A valve actuator stem 90 extends between the ball valve 86 and a valve actuator knob 92. The knob is turned to open or close the ball valve as appropriate. The goose neck 88 is mounted by means of a boss 94 to the flat upper surface 68.

A module exhaust plenum 96 is formed within the module 22 between the sink 78 and the back side 66. The module exhaust plenum 96 has a module damper 98 mounted on a module damper control 100 by means of a mounting sleeve 102, to which the module damper 98 is attached, and which threadably engages a threaded portion 104 of the module damper control. The module damper control 100 terminates, at each end, in pins 106 and 108, respectively. The pin 106 extends through an aperture in a mounting plate 110 which is fastened between a pair of rectangular plates 112, 114 attached to the bottom 64 of the module 22. A pair of end plates 116, only one of which is shown in

FIG. 7, together with the rectangular plates 112, 114, form an outlet for the module exhaust plenum, opening into the inlet portion of the common exhaust plenum 36. The common exhaust plenum, at its inlet has a pair of exhaust inlet forming side plates 118, 120, which are shown in greater detail in FIG. 6, and serve to support the rear portion of the module 22. The pin 108 on the module damper control 100 extends through an aperture 122 formed in the flat upper surface 68. Thus, the pins 106, 108 fix the position of the module damper control 100 while permitting rotation of the damper control to raise or lower the damper 98. To this end, the pin 108 has a recess formed in the extremity thereof for receiving a screwdriver blade to facilitate rotation of the damper control 100.

As will be seen in FIG. 7, the sink 78 is of a size somewhat greater than the work receiving opening 70, as the sink has walls 126 formed within the module and below and recessed from the periphery of the work receiving opening, so that the opening forms an overhanging lip 128 about the sink walls. In the sink 78, immediately below the upper surface 68, there are formed a series of apertures 124 extending through the walls 126.

FIG. 8 is a sectional view of the work module 22 taken along lines 8—8 of FIG. 7, illustrating the manner by which the module damper 98 is disposed within the module 22. Opposite the module damper control 100, the damper 98 rests against the bottom 64 and is held in this position by means of a pivot block 130. The module 22 has a pair of side walls 132, to one of which the pivot block is attached. Thus, the module damper 98 may move vertically along the module damper control 100 while being restrained from other than pivotal movement at its opposite end by the pivot block 130.

FIG. 9 is a view, in section, of another embodiment of work module, illustrating, the work module 20, which is a module particularly adapted for boiling concentrated acid and the like. The work module 20 has a back wall and module damper construction the same as that shown in FIGS. 7 and 8 with respect to the work module 22. The work module 20 has a flat upper surface 138. The flat upper surface 138 has two access openings 140, 142 formed therewithin. The openings are circular in configuration. Within the module 20, a pair of glass beakers 144 rests upon heater elements 146. The heater elements 146 are separated from a heater base frame 148 by insulation 150. The sides of the beakers 144 are enclosed by insulation 152. Electrical leads 154 connect the heating elements 146 to a control switch 156 mounted on a control panel 158 of the work module 20. The heater base frame is supported from the flat upper surface 138 by a bracket (not shown). Beneath each of the access openings 140, 142 is a cylindrical wall 160, 162, respectively, extending into the interior of the module from the flat upper surface 138. These cylindrical walls 160, 162 each have a plurality of apertures 164 formed therein in horizontal alignment.

In the embodiment of work module shown in FIG. 9, the overhanging lip about the cylindrical walls 160, 162 is formed by means of an upper surface cover plate 166 having work receiving openings 168, 170 formed therein so as to be disposed over the heating elements 146. In this embodiment, a depending flange 172, 174 is formed about each of the work receiving openings 168, 170 and extending into the hollow interior of the work module 20. The depending flanges terminate short of the horizontal alignment of apertures 64.

The use and operation of the clean work station of the present invention will now be described. First, the determination is made as to the type of work to be carried out in the module. From this determination, the particular work modules, as to facilities to be provided, can be selected. The individual modules are then installed in the station frame 12, so as to form an array of modules such as that seen in FIG. 1. Obviously, in place of any one of the work modules 18, 20, 22, 24, 26, 28, 30 of FIG. 1, a blank work module, that is, a module having a flat solid upper face with no provision for utilities, may be substituted. Such may be desirable where additional working surface is to be provided. Additionally, the use of blank work modules, rather than functioning work modules, will reduce the exhaust requirements for the clean work station 10 without the necessity of completely enclosing the module exhaust dampers for work modules not being utilized in the particular operation.

When the work modules have been inserted in the desired array in the work station frame 12, appropriate connections are made between the individual work modules and the utilities panel 40. Electrical connections are made by using appropriate insulated wire. Vacuum and fluid supply lines, of conventional flexible construction, are utilized to make the appropriate gas or liquid connections between the couplings 42 and the individual couplings on each of the work modules. The utilities panel control valves are then opened to supply the utilities to the individual control valves on the work modules.

The exhaust applied to each module is controlled, by means of the master damper control 62 to provide, in the common exhaust plenum 36, a minimum exhaust which exceeds the maximum exhaust pressure required by any of the work modules. The common exhaust plenum is then applied to the work modules and the individual ones of the work modules are adjusted, as to actual exhaust utilized, as appropriate to insure that the exhaust requirements of the work to be carried on at the module are met, without utilizing excessive exhaust. By such an individual module exhaust control, it has been found that the exhaust requirements of the work station are reduced a minimum of 75 percent.

Typical dimensions for a work module are 11 inches in depth, 27 inches in length and, for the sink work module 24, 24 inches in width, and 12 inches width for the hot plate module 22. The horizontal alignment of apertures is about 0.75 inches below the flat upper surface of the work module. The overhanging lip is at least 0.75 inches and, if the depending flange is not utilized, should be about 1 inch. The exhaust apertures may typically be one-fourth inch diameter holes. However, as will be obvious, rather than utilizing a plurality of separate holes, a slit-type of exhaust aperture can be utilized, which is, in actuality, an infinite number of holes. Thus, as used herein, the term "plurality of apertures" comprehends both separate, individually spaced circular cross section apertures, apertures of the slit or elongated rectangle type and other obvious varients.

The total volume of the apertures in a given module determines, with the exhaust pressure, the volume of air which is exhausted through the particular module. As it is desirable to reduce this volume of air exhausted, it is preferable to reduce the total area of exhaust apertures to that minimum area which provides for sufficient exhaust. As will be apparent from the foregoing, if, in a given application, the quantity of air exhausted utilizing the preferred 1 inch of water static pressure at the common exhaust plenum, does not provide sufficient exhaust, the quantity of air exhausted can also be increased by increasing the area of the exhaust apertures in the module.

In operation, typical characteristics for the hot plate module **20**, utilizing an exhaust pressure of 1 inch of water at the common exhaust plenum **36**, would be there between 0.25 and 0.4 inches exhaust at the apertures **124**, an exhaust rate of about 22 cubic feet per minute, and an exhaust velocity through the apertures of about 1,300 feet per minute. Corresponding typical characteristics for the sink module **22** would be 1,500 feet per minute exhaust velocity and 42 cubic feet per minute exhaust volume.

It should be understood that the laminar flow air supply to the clean work station according to the present invention is not necessarily reduced. Rather, the reduction occurs in the quantity of air required to be exhausted through the work station exhaust system. Thus, in a particular work module array in which a 75 percent reduction on air exhausted occurs, the air which would have been exhausted in conventional devices but is not required to be exhausted by reason of the present invention, passes out from the work station into the general surrounding atmosphere. Such air then recycles through the air supply of the work station, normally resulting, since the air has already been filtered, in prolonged life of the work station filter units.

Many conventional devices require the exhaust system, in order to avoid the spread of noxious fumes and the like into the surrounding atmosphere, to aspirate air from the surrounding atmosphere into the exhaust system directly, which type of operation is contrary to Federal Standard 209*a*. The clean work station of the present invention functions in accordance with the flow diagram of FIG. **8** of said Standard, providing a true laminar flow clean work station in accordance with paragraph 40.3.5 of said Standard, i.e., without outside air being aspirated into the work area. The improved exhaust performance of the present invention is accomplished by the combination of the work receiving opening, the array of exhaust outlets disposed below the work receiving opening and baffled from the work receiving opening by the overhanging lip and, when desired, the depending flange. Noxious fumes, and the like, which exist in the work module are contained below the work receiving opening, and are exhausted through the lip exhaust, rather than rising through the work receiving opening so as to escape into the surrounding atmosphere. Since the lip exhaust removes only a small percentage of the laminar flow air supplied, the exhaust requirement of the work station is greatly reduced from that of conventional devices, in which the work is carried on directly on the upper surface of the work station, so as to require that all of the laminar flow air will be exhausted through the work station to avoid diffusion of the noxious gasses.

The invention claimed is:

1. In a clean work station, the combination of:
a work station frame;
at least one work module having
1. a generally flat upper surface;
2. a hollow interior;
3. a module exhaust plenum communicating with the hollow interior;
4. an adjustable damper control for said module exhaust plenum; and
5. means forming a work receiving opening in the upper surface;
a common exhaust plenum attached to the frame;
means connecting each module exhaust plenum to the common exhaust plenum, whereby the module damper control controls the flow of air from the hollow interior of the work module to the common exhaust plenum;
wall means formed within said module and below and recessed from the periphery of the work receiving opening so that the opening forms an overhanging lip about said wall means; and
a plurality of apertures formed in said wall means and disposed in horizontal alignment immediately below said overhanging lip.

2. The combination of claim **1**, and including a master damper control and means connecting said master damper control to the common exhaust plenum for controlling vacuum applied to the common exhaust plenum.

3. The combination of claim **1** and in which the overhanging lip has a depending flange attached thereto, said flange terminating short of the aperture alignment.

4. The combination of claim **1**, and in which the apertures are aligned approximately 0.75 inches below the upper surface of the module at the work receiving opening.

5. The combination of claim **1**, and in which the overhanging lip overhangs the wall forming means by at least 0.75 inches.

6. The combination of claim **3**, and in which the overhanging lip overhangs the wall forming means by approximately 1 inch, the apertures are aligned approximately 0.75 inches below the module upper surface, and the depending flange terminates approximately 0.25 inches above the aperture alignment.

7. The combination of claim **4**, and in which the overhanging lip overhangs the wall forming means by at least 0.75 inches.

8. The combination of claim **6**, and including a master damper control and means connecting said master damper control to the common exhaust plenum for controlling vacuum applied to the common exhaust plenum.

9. The combination of claim **7**, and including a master damper control and means connecting said master damper control to the common exhaust plenum for controlling vacuum applied to the common exhaust plenum.

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