

[54] **VENTILATED ACOUSTIC STRUCTURAL PANEL**

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52/620, 98/31, 98/32, 98/33 A, 98/33 R

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[58] Field of Search 52/198, 303, 620; 98/31, 32,
98/33 A, 33 R

[56] **References Cited**

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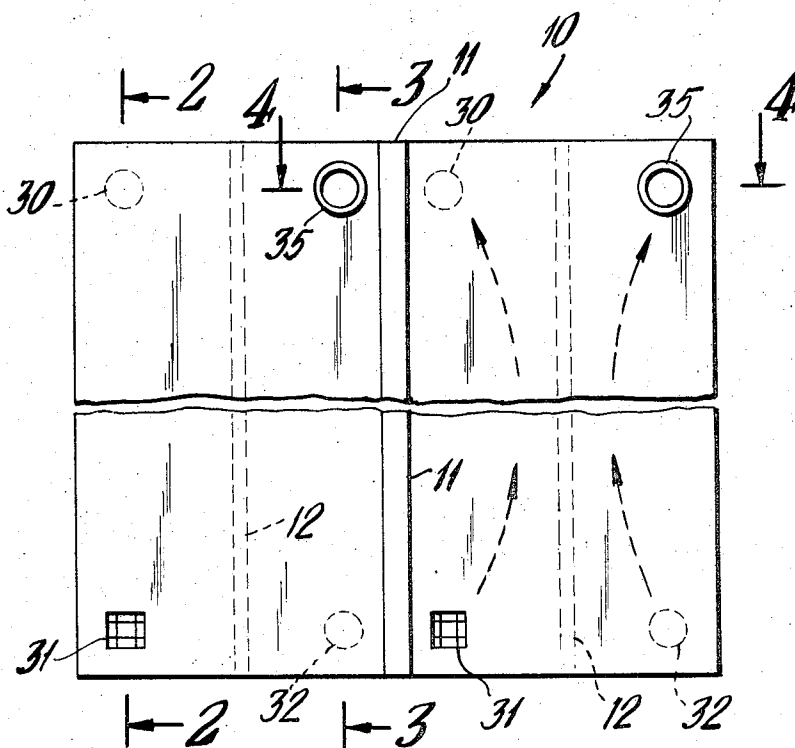
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Primary Examiner—William J. Wye
Attorney, Agent, or Firm—George B. Finnegan, Jr. et al.

[57] **ABSTRACT**

A prefabricated structural wall panel for the modular construction of soundproof enclosures containing layered compartments of shallow depth with the central compartment divided longitudinally into a pair of intake and exhaust ventilation ducts located edge to edge, and these ducts are separated by perforate sheet metal walls from the adjoining interior and exterior compartments of the panel which contain sound absorbing thermal insulation. An air inlet is installed near the lower end of each duct and an air outlet near its upper end; and a fan is enclosed within the air intake system. Fresh air enters near the lower end of the exterior of the panel and is forced upwardly through the intake duct by the fan to the upper part of the panel from which it is discharged into the enclosure, while the air being exhausted from the enclosure enters a conduit near the bottom of the interior face of the panel and passes up through the exhaust duct for discharge through a conduit communicating with the upper exterior face of the panel.

6 Claims, 4 Drawing Figures



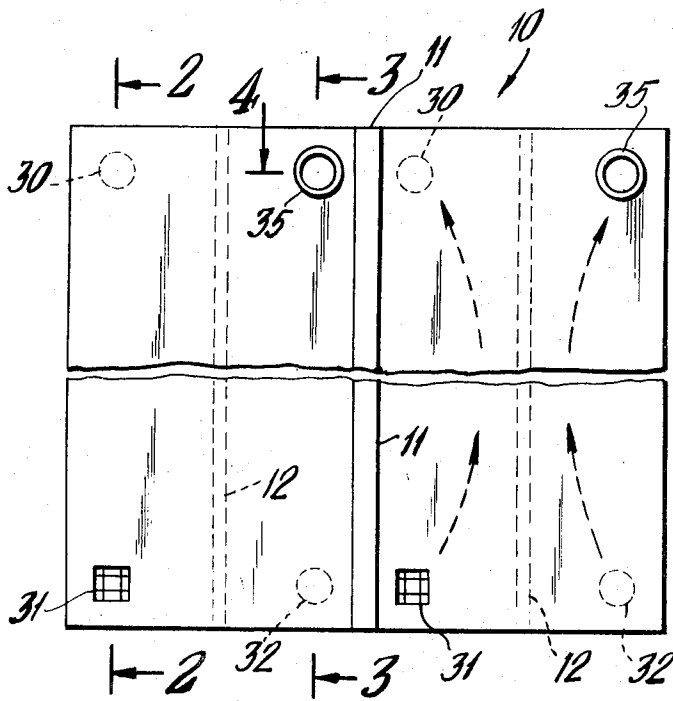


FIG. 1

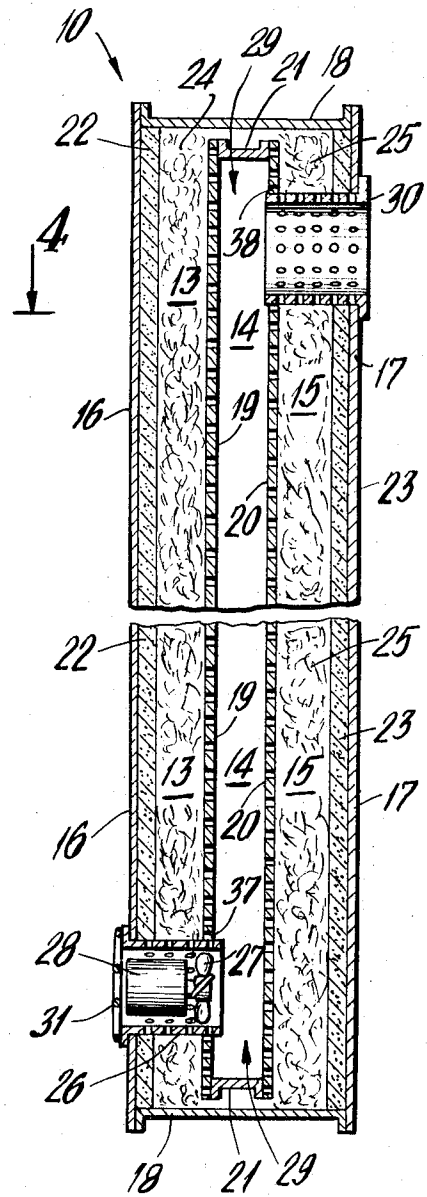


FIG. 2

SHEET 2 OF 2

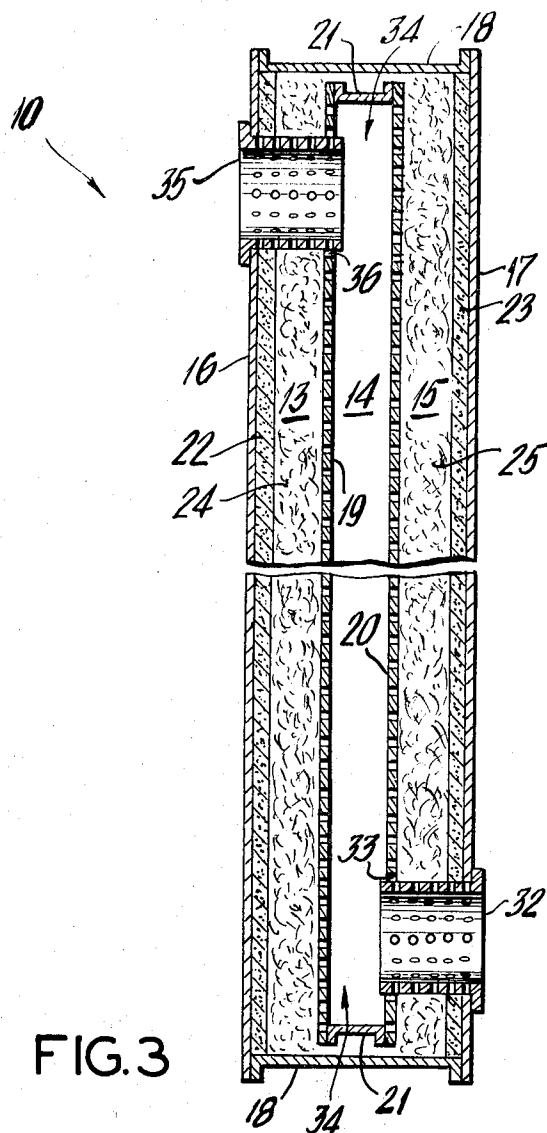


FIG. 3

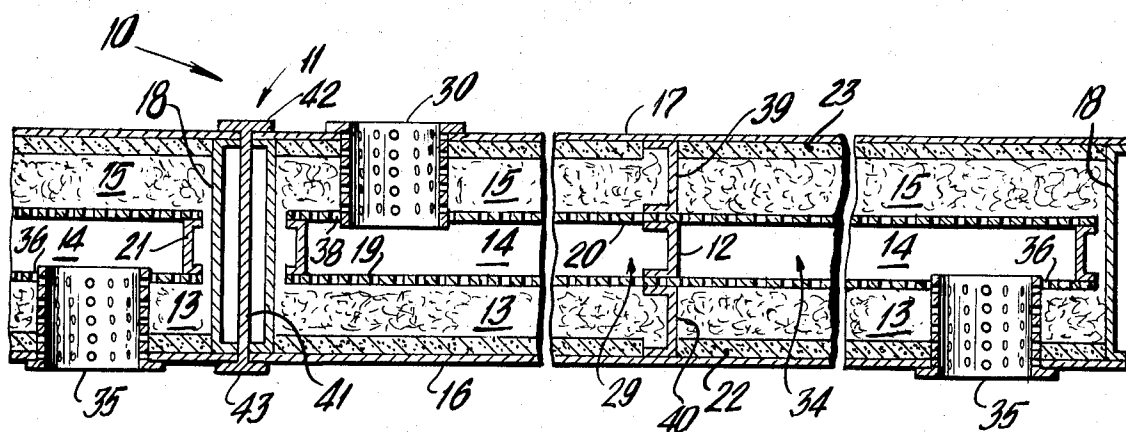


FIG. 4

VENTILATED ACOUSTIC STRUCTURAL PANEL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention is concerned with structural wall or ceiling panels of the modular type that are substantially self-contained and suitable for building temporary or permanent enclosures of varying sizes by reason of each panel incorporating a ventilating system as well as insulation to minimize the transmission of sound and heat.

2. Prior Art

Many proposals have been made for providing prefabricated modular panels for building various structures as exemplified by Claude U.S. Pat. No. 3,049,067, Mahlmeister et al., U.S. Pat. No. 3,115,819 and Wasserman U.S. Pat. No. 3,611,907. In general, such units provided only a limited degree of sound proofing or contained only part of an air circulation system. Even though the units were often of relatively complicated construction, it was often necessary to add additional equipment in the form of fans or blowers or air ducts.

SUMMARY OF THE INVENTION

The present invention relates to a modular acoustic ventilating structural panel containing layered compartments which comprises a series of at least four substantially parallel sheets of rigid material of substantial area and spaced to form relatively shallow compartments containing sound absorbing material and adjoining each side of a relatively shallow central compartment of relatively large side wall area, an imperforate member dividing said central compartment into separate and substantially unobstructed intake and exhaust air ducts, an inlet air conduit adjacent one end of said panel connecting said intake air duct with the exterior face of said panel, an inlet air conduit adjacent said end connecting said exhaust air duct with the interior face of said panel, an outlet air conduit adjacent the opposite end of the said panel for connecting said intake air duct with said interior face of the panel, an outlet air conduit adjacent the opposite end of said panel for connecting said exhaust air duct with said exterior face of said panel and means for forcing air through one of said ducts.

Other aspects of the invention include one or more of such features as employing perforate sheet metal walls between the central compartment and the insulating compartment on each side thereof; constructing the various inlet and outlet conduits of the perforate metal; and so constructing and arranging the elements of the panels that direct metal-to-metal contact is interrupted at least once so that the metal walls do not extend continuously and uninterruptedly for the entire length of the passages of the air intake system or the air exhaust system.

The nature, objects and advantages of the invention and still other aspects thereof will be apparent to those skilled in the art upon consideration of the drawings and the detailed disclosure hereinafter.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevation of two panels according to the present invention joined together at an early stage in the erection of an enclosure employing those modular panels.

FIG. 2 is an enlarged vertical sectional view taken along the line 2—2 of FIG. 1 and depicting the air intake system of the panel.

FIG. 3 is an enlarged vertical section taken on the line 3—3 of FIG. 1 to show the passages in the panel for exhausting air.

FIG. 4 is an enlarged horizontal section taken along the line 4—4 of FIG. 1.

DESCRIPTION OF SPECIFIC EMBODIMENTS

Turning now to the drawings, two panels 10 according to one embodiment of the present invention are shown in FIG. 1 at the beginning of the erection of a small building or enclosure which may be employed as a control room in a noisy factory, or as a toll collector's booth, etc. The upright panels are joined together by an I-beam 11 of sheet metal or other suitable light weight construction. The coupling I-beam 11 is described in detail hereinafter and it, along with correspondingly flanged corner post (not shown), may be used to join a number of similar panels 10 or other appropriately sized modular panels, which may contain a door or window, in forming the desired wall structure.

The dotted line 12 on each of the panels represents a longitudinal internal partition strip, typically in the form of a sheet metal channel, which divides the central compartment into two bays or air ducts located edge to edge, one of which ducts serves as a fresh air intake while the other functions as an exhaust passage as described hereinafter.

FIG. 2 depicts the inner parts of the air intake half of panel 10 with its multilayer or sandwich construction whereby the exterior compartment 13, the central chamber or compartment 14 and the interior compartment 15 (i.e., the compartment adjacent the inside of the enclosure) are formed by spacing four parallel large sheets of sheet metal by means of flanged sheet metal spacing members which may have an L-shaped or channel cross section. Thus the exterior metal sheet 16 constituting the entire external covering of the panel is separated from the sheet metal interior wall 17 of the desired structure by the flanged sheet metal elements 18 which are spot welded at spaced intervals to the sheets 16 and 17 around their entire peripheries. The exterior and interior compartments 13 and 15, respectively, are each separated from the central compartment 14 by the perforate metal sheets 19 and 20, respectively, and these perforated sections of sheet metal which are the main walls of the central compartment are spaced apart by four channel members 21 which are spot welded to the metal sheets 19 and 20 at spaced intervals near all of their four edges. Since each of the three compartments is only about 2 to 3 inches in depth but extends over substantially the entire 8 foot length and 4 foot width of a typical panel, the structure may be described as layered compartments of relatively shallow depth and relatively large side wall area. While the panel may have more than three layers of compartments, the extra cost of such construction is generally greater than any advantages derived from it.

Both of the compartments 13 and 15 contain one or more sound absorbing materials that usually have good heat insulating properties also. One of the many good materials for the purpose is gypsum insulating board, and it is particularly desirable in increasing the rigidity of the panels constructed of light (e.g., 16 gauge) sheet steel and also, to a lesser extent increasing their structural strength. Accordingly the inner faces of metal sheets 16 and 17 have half inch thick insulating boards 22 and 23 secured thereto by a mastic cement. Generally, most or all of the volume of these two spaces is filled with mineral or glass wool, preferably in batt form to avoid any settling problems. Thus, the remaining depth of about two inches in compartments 13 and 15 is filled with one or more batts 24 and 25 of conventional mineral wool insulation.

The fresh air supply system comprises an air inlet conduit 26 of square cross section in which is disposed a fan 27 (schematically shown) driven by an electric motor 28, the intake duct 29 of the central compartment and the air outlet conduit 30 near the upper end of the panel for discharging fresh air into the enclosure. A grill 31 is installed at the entry to the air inlet 26 to prevent injury and also to shield the fan and motor from contact with solid objects. The fan and motor are of a special quiet type, and the air flow desirably amounts to about 75 cubic feet per minute in the case of a typical panel in a conventional installation.

In FIG. 3 is shown the air return or discharge system. There is an air inlet tube 32 constructed of perforate sheet steel with an external diameter about 1/32 inch smaller than the diameter of the aperture 33 for that tube near the bottom of the perforate wall 20 of air exhaust duct 34; thus metal-to-metal contact in this system is interrupted by the gap at aperture 33. Duct 34 leads upward to the air outlet conduit 35 connecting with the exterior sheet metal wall 16 through which the exhaust air is discharged. The outlet sleeve 35 for the exhaust system is also of perforate metal and surrounded by a similar small gap at the slightly larger aperture 36 where it projects through the wall 19; and the inlet and outlet conduits 26 and 30, respectively, in the air intake system have similar gaps at the apertures 37 and 38 in the walls of the duct 29. Accordingly, there is no contact between the perforate metal of the air ducts and that of the air inlets and outlets, and the metal lining of each system is interrupted twice. This contributes to noise reduction in the passages which is particularly desirable in the forced air intake system.

There is also no contact of the channels 21 and walls 19 and 20 of the air ducts with the flanged members 18 which form the edges of the panel, all of which structural members are customarily made of sheet metal; thus, the central chamber 14 with its intake and exhaust air ducts 29 and 34, respectively, may be said to be essentially floating on beds of mineral wool for the only significant direct contact of walls 19 and 20 with other metal surfaces is with the channel spacers 39 and 40 (see FIG. 4). Those channel spacers are necessary to maintain the location of the compartment 14 in its central position; however, even those small areas of contact are of a minimal nature which do not permit much transmission of noise, for the spacers 39 and 40 are not welded or otherwise firmly attached to the perforate metal sheets 19 and 20 as they merely bear against those sheets. The channel member 39 is disposed longitudinally in the panel and it is attached

firmly by spot welding at spaced intervals to the interior face sheet 17 only, and the corresponding channel 40 is spot welded only to the exterior wall 16 of the panel.

A sheet metal channel is employed as the divider 12 within the central compartment 14, not only to divide that compartment into the two air ducts 29 and 34 as shown in FIG. 4, but also to maintain the proper separation between the perforate sheets 19 and 20 for maintaining the designed depth of the ducts. Divider 12 also is fastened by spot welding to only one of the two perforate sheets and it merely bears against the other perforate sheet. Thus, there is only a very small area of direct metal-to-metal contact through the main body of the panel, and this contact involves three unwelded junctions between channel spacer elements and metal sheets; consequently, there is little acoustic energy transmitted through that particular part of the structure.

More importantly, no significant volume of sound is transmitted by reverberation or otherwise through the air circulation system within the panel, especially the air intake system which includes a fan and motor. In addition, extraneous noise is also suppressed or completely eliminated by the structure described herein. This desirable soundproofing is obtained by directing the air for ventilation through a labyrinth path involving two right angle changes of direction in passing through the panel as well as travel up a relatively long duct therein, which incidentally tends to minimize drafts from high winds in the case of outdoor structures constructed from these panels. Another feature which is usually preferred for maximum soundproofing is the particular embodiment described wherein direct metal-to-metal contact does not exist over the entire path of either the air intake system or the air exhaust system, since there are gaps between the air inlet and air outlet sleeves or conduits and the slightly larger apertures in duct walls 19 and 20 for those sleeves. Also, the gaps facilitate fabrication of the panels by providing for the easily fitted assembly of several elements thereof. The fact that the air duct compartment 14 is not supported in direct contact with the metal edges 18 of the panel also contributes to noise reduction.

Construction of the air ducts, inlets and outlets of perforate sheet metal with material capable of absorbing acoustic energy behind the metal is highly desirable, as it is well known how effective are the results of this silencing expedient. Moreover, this effect is maximized by the instant design of shallow air ducts with a very large side wall area per unit length, for this provides more area for absorbing sound waves. While a wide variety of hole sizes and spacings may be employed for the purpose, excellent results are obtainable with a commercial grade of perforate sheet metal which has 3/32 inch diameter perforations on 3/16 inch staggered centers in 22 gage galvanized steel, whereby the open area amounts to 25 percent of the total area.

The circulation of air to and from an enclosure constructed from one or more of the novel panels may be described in connection with FIGS. 2 and 3 as well as the dotted arrows of FIG. 1 illustrate the general path of air movement. Fresh air is drawn into the panel through grill 31 and air inlet conduit 26 of square cross section by means of the fan 27 driven by an electric motor 28 which is operated by electricity from a suitable source (not shown). The fan forces this air into the duct 29 where it moves upwardly between the perforo-

rate walls 19 and 20 and exits through the outlet 30 near the top of the panel into the enclosure. The return circulation of air usually does not require an additional fan because the slight positive (superatmospheric) air pressure in the enclosure created by the air intake fan 27 forces air in the enclosure through the air inlet 32 of the exhaust system and the air return duct 34 to the air outlet 35 from which the air is discharged through the exterior of the panel into the ambient atmosphere.

The sheet metal I-beam 11 is shown in enlarged detail in FIG. 4 wherein it is joining two of the panels 10. Alternatively, this connecting structural member could be employed for joining one of the panels of the present invention with another type of prefabricated structural panel, preferably one of the same thickness or depth. The I-beam is composed of the web 41 and the two flanges 42 and 43. For ease of erecting and of dismantling a building or enclosure employing the present panels, it is desirable to have a depth of web 41 that corresponds closely with the thickness or depth of the panels 10 so that the flanges 42 and 43 fit snugly against the exterior and interior sheets 17 and 16 respectively, of the panel and provide firm engagement for structural purposes. However, it is also contemplated that the I-beam 11 may be fastened securely to the panels 10, whenever necessary or desirable, by the installation of sheet metal screws or bolts in holes drilled in one or more of the flanges and the walls 17 and 16.

From the foregoing description, it is apparent that the panels of this invention display many advantages as self-contained units which combine both intake and exhaust systems for ventilating in a single panel. In addition, they provide soundproofing not only in respect to extraneous noise but also as integral mufflers for the noise created by their internal fans. Easier construction and better appearance result from the fact that their interior and exterior surfaces are essentially flush surfaces even though the panel contains a complete ventilating system of fan and intake and return ducts. These panels lend themselves to many and varied designs of enclosures as they may be employed in any walls or the ceiling, and they may be used in single units along with other wall or ceiling structures, including other types of prefabricated panels, especially those having doors and windows. Also, the new panels may be used in multiple, especially where a high volume of ventilation is required. Ventilating problems may also be alleviated by utilizing a second fan in the exhaust system of the novel panels with that fan preferably being located in the exhaust outlet conduit 35 to keep the noise level in the enclosure down. In the often preferred dimensions of approximately 4 x 8 feet, the panels are readily handled in conventional manner with conventional trucks and an entire portable room 8 feet high and 8 feet wide with a length of 8 feet or more may be transported in ordinary trucks.

It is apparent that the novel panels are of a simple and economical construction. Also, these prefabricated structural units provide great flexibility in use as they may be readily disassembled from a building or enclosure where they are no longer needed and immediately

employed in the construction of another type of enclosure for an entirely different purpose. For example, a large outdoor gate house containing a number of the present panels may be dismantled and two smaller rooms constructed from the same structural elements for indoor use in a large factory as a first aid station and as a control room, respectively. By reason of their soundproofing qualities, the panels are particularly suitable for the construction of a great many types of either temporary or permanent structures, including, inter alia, audiometric test rooms, music practice rooms, control rooms, communication centers, quiet rooms, guard or gate houses, first aid stations, waiting rooms, traffic control centers and marine dredger deck cabins.

From the foregoing disclosure, it will be evident to those skilled in the art that many other modifications and embodiments than the few described herein are within the purview of this invention. Accordingly, the present invention should not be construed as limited in any particulars except as may be recited in the appended claims or required by the prior art.

We claim:

1. A modular acoustic ventilating structural panel containing layered compartments which comprises a series of at least four substantially parallel sheets of rigid material of substantial area and spaced to form relatively shallow compartments containing sound absorbing material and adjoining each side of a relatively shallow central compartment of relatively large side wall area, an imperforate member dividing said central compartment into separate and substantially unobstructed intake and exhaust air ducts, an inlet air conduit adjacent one end of said panel connecting said intake air duct with the exterior face of said panel, an inlet air conduit adjacent said end connecting said exhaust air duct with the interior face of said panel, an outlet air conduit adjacent the opposite end of the said panel for connecting said intake air duct with said interior face of the panel, an outlet air conduit adjacent the opposite end of said panel for connecting said exhaust air duct with said exterior face of said panel and means for forcing air through one of said ducts.

2. A panel according to claim 1 in which the side walls of said central compartment are constructed of perforate sheet material.

3. A panel according to claim 2 in which said air conduits have perforate walls.

4. A panel according to claim 1 in which a fan located within said panel forces air through said intake duct.

5. A panel according to claim 1 in which said rigid material is sheet metal disposed to avoid an uninterrupted metal lining extending continuously along the entire path of air flow through said intake air duct and the connecting air conduits thereof.

6. A panel according to claim 5 in which said air conduits are connected with said intake air duct through apertures in said duct of larger size than said conduits to avoid metal-to-metal contact between said duct and said conduits.

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