April 18, 1967 J. V. KNAB **3,314,353**

VENTILATED FLOOR MODULAR SYSTEM

Filed Oct. 18, 1965 3 Sheets-Sheet 1

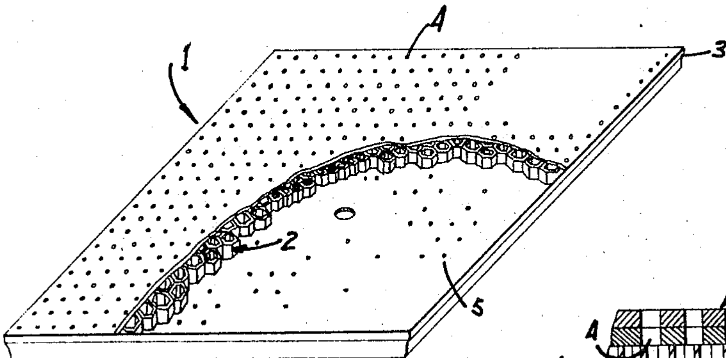

FIG. 1.

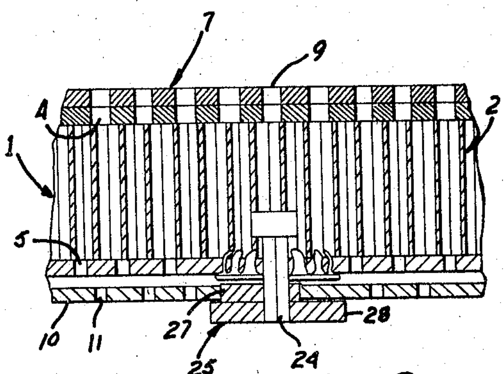

FIG. 3.

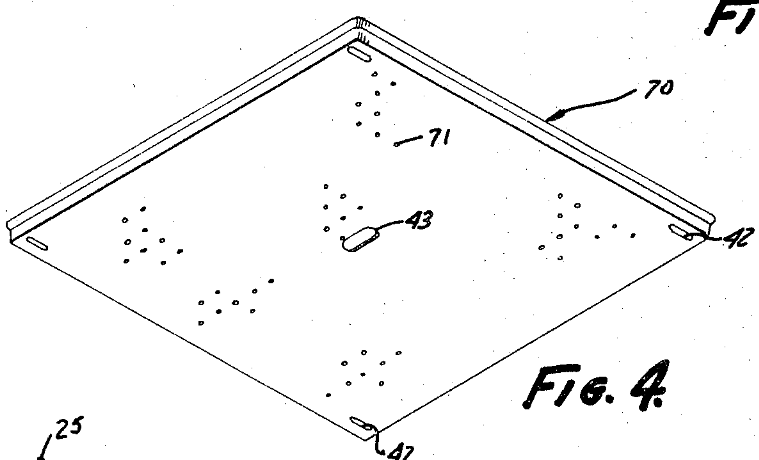

FIG. 4.

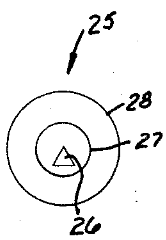

FIG. 5.

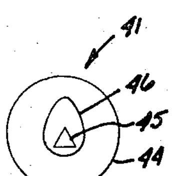

FIG. 6.

INVENTOR.
JAMES V. KNAB

BY Price & Heneveld

ATTORNEYS

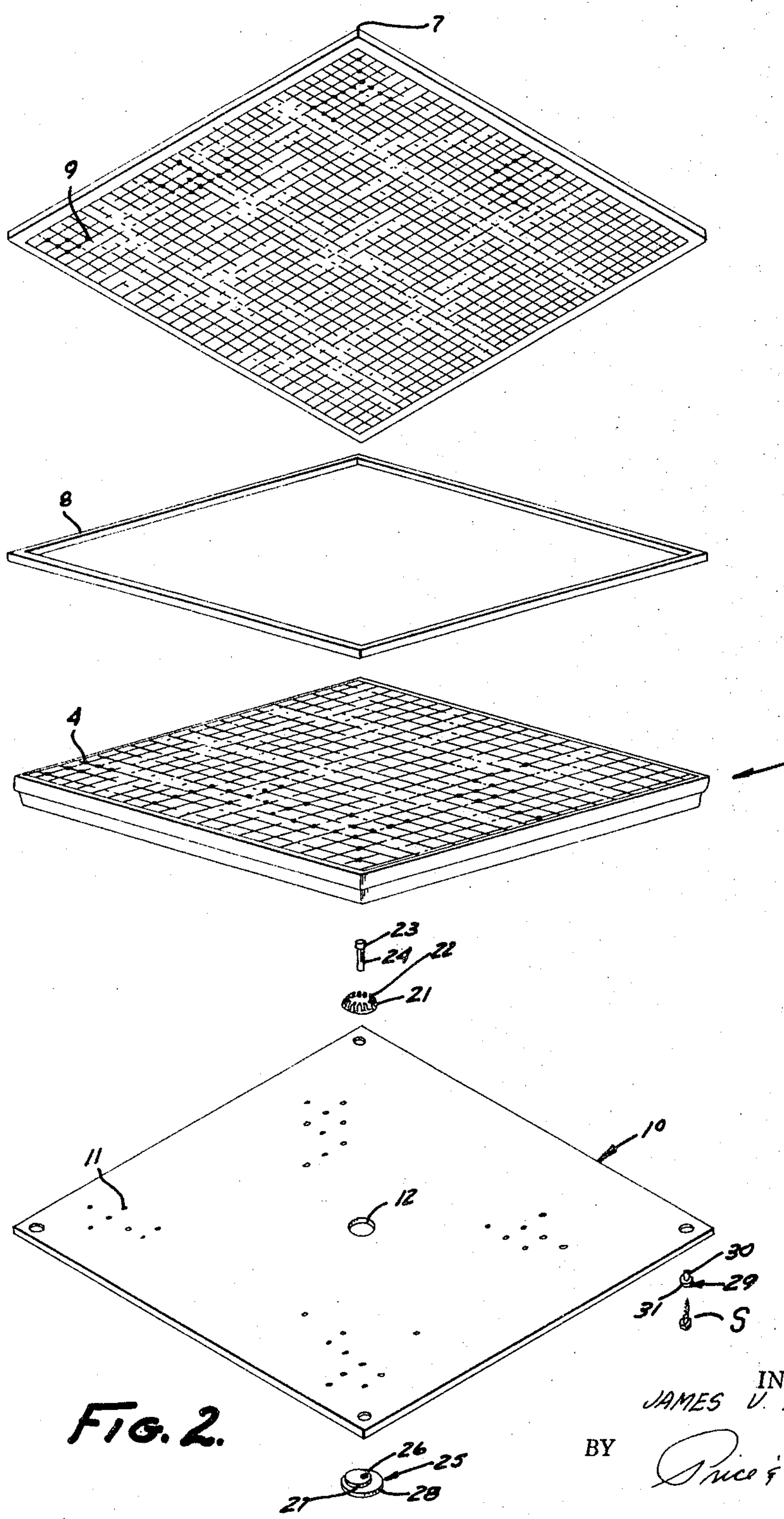

FIG. 2.

INVENTOR.
JAMES V. KNAB

BY Price & Heneveld

ATTORNEYS

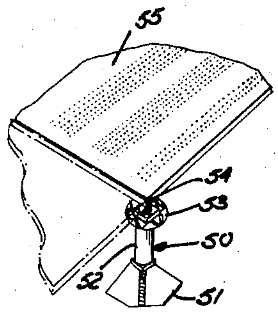

FIG. 7.

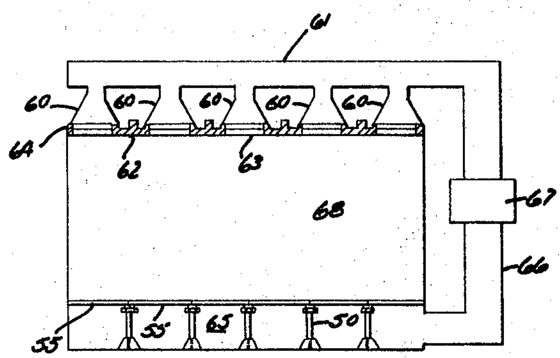

FIG. 8.

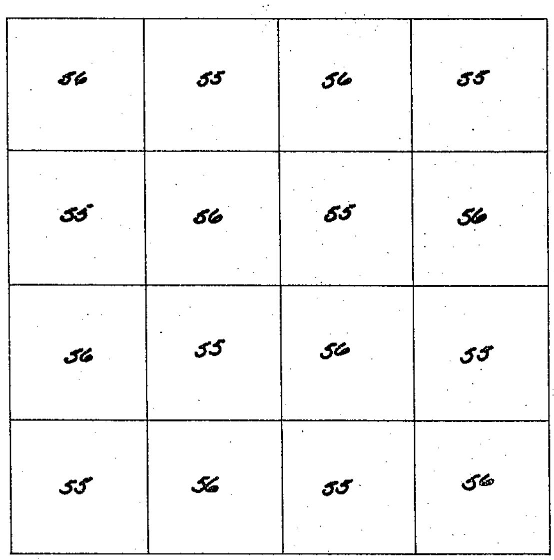

FIG. 9.

INVENTOR.
JAMES V. KNAB

BY Price & Heneveld

ATTORNEYS

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VENTILATED FLOOR MODULAR SYSTEM

James V. Knab, Grand Rapids, Mich., assignor to Weber Showcase & Fixture Co., Div. of Walter Kidde & Company, Inc., Grand Rapids, Mich., a corporation of New York

Filed Oct. 18, 1965, Ser. No. 496,863
11 Claims. (Cl. 98—31)

This invention relates to floor systems and, more particularly, to modular floor systems for use in clean rooms.

Modern electronic manufacturing techniques often require that critical components be assembled and packaged in work areas which have come to be known as clean rooms. Basically, these rooms are enclosures within which temperature and humidity are maintained at desired levels and dust content is kept below prescribed limits. They usually comprise some system for constantly recirculating and processing the air contained within the sealed enclosure.

In clean room construction it is customary to provide one or a plurality of plenum units in the ceiling or walls of the enclosure. A collection chamber is provided beneath the floor or behind one wall of the clean room into which air from the plenum flows after it has passed through the enclosure. A recirculation system is provided for removing the air from the collection chamber, filtering and conditioning it, and recirculating it through the plenum.

The provision of a collection chamber under the floor of a clean room necessitates the utilization of a floor structure which will allow air to flow therethrough into the collection chamber. Current methods for accomplishing this purpose generally provide for cutting away certain portions of the existing floor and fitting prefabricated air flow registers into the cut-away sections. This approach suffers from a number of severe disadvantages. The register units so installed frequently loosen from the cut-away section in the floor and tend to tip when stepped upon. Furthermore, registers are not sufficiently strong to carry the heavy loads which often are required to be moved into and out of the clean room enclosure.

In addition to the incapacity of the register sections themselves to carry heavy loads, the cutting away of portions of the floor also weakens the floor itself. If, for example, the floor has been constructed from a plurality of floor modules there is little bearing surface left within the modules once a section of sufficient size to receive an air register has been cut away.

Aside from the structural inadequacy of the present mode of clean room floor construction, other disadvantages also exist. For example, the register units frequently catch small objects such as women's shoe heels, there is no unified appearance to the enclosure once it has been completed, and excess air flow frequently occurs in certain locations within the clean room resulting in undesirable whistling.

The present mode of clean room floor construction is extremely expensive both with regard to installation and upkeep. A relatively long construction period is necessary to individually cut and fit each register panel. Once installed, countless hours must be expended to keep the grate units and surrounding floor areas free from dust particles. The clean room floor structures generally in use provide no means for adjusting the air flow capacity of certain or all of the registers short of individually removing and replacing them with different sized grates. In short, the present mode of clean room floor construction restricts the usage of floor collection chambers as air flow cavities and often renders their utilization impractical.

It is an object of this invention to provide a clean

room floor structure which does not suffer from the above out-lined disadvantages.

More particularly, it is an object of this invention to provide a floor module for clean room construction which has sufficient structural capacity to handle heavy loads without sagging or tearing loose from the floor frame.

It is an object of this invention to provide a floor module for clean room construction which may be safely utilized without fear of catching the narrow heels of high heeled shoes or other sharp objects.

It is an object of this invention to provide a floor module for clean room construction which allows a faster erection time and which will endure, after installation, for a longer period of time.

It is an object of this invention to provide a floor module for clean room construction which may be easily cleaned and which offers a unified appearance to the entire clean room floor.

Finally, it is an object of this invention to provide a floor module for clean room construction which allows adjustment of the air flow therethrough without removing the modules or any part thereof from the floor support structure.

These and other objects of this invention will be readily understood by reference to the following specification and accompanying drawings in which:

FIG. 1 is a partially-broken perspective view of the support structure which forms one section of the floor module which is the subject of this invention;

FIG. 2 is an exploded view of the overall floor module;

FIG. 3 is a partially-broken cross-sectional view of the floor module showing the assembly details of the air flow adjustment devices of the invention;

FIG. 4 is a perspective view of another embodiment of a damper;

FIG. 5 is a plan view of an eccentric mechanism associated with the device of FIGS. 1–3;

FIG. 6 is a plan view of a cam mechanism associated with the device of FIG. 4;

FIG. 7 is a partially-broken view showing the pedestals and the means of mounting the floor modules thereon;

FIG. 8 is an elevational schematic view of a clean room embodying the floor modules which are the subject of this invention; and

FIG. 9 is a diagrammatic view illustrating an exemplary mode of assembling the clean room floor structure.

Briefly, this invention comprises a support assembly fabricated from a steel lattice or beehive network which is sandwiched between two sheets of metal. Each of the cover sheets for the support lattice have a plurality of relatively small holes drilled in their peripheries. A perforated damper sheet is positioned adjacent the bottom of the support assembly such that it may be moved along the surface thereof but will not drop away therefrom. The perforations in the damper sheets are identically spaced to those in the bottom of the floor support assembly. Means are provided for selectively positioning the damper sheet such that its perforations match those in the bottom of the floor support assembly to such a degree that the desired amount of air may flow through the module structure.

In one embodiment of this invention the adjustment means comprises a cylindrical bearing member which is mounted within a receiving aperture in the damper sheet. The cylindrical bearing member is eccentrically mounted on a shaft affixed to the floor support assembly. Means are provided whereby the shaft may be rotated, and thus the perforations in the damper sheet selectively matched to those in the floor support assembly from the top of the floor module. In another embodiment of this invention the damper sheet adjustment means comprises a cam member which is mounted to a shaft supported within the floor support assembly. A slot is provided within the damper sheet and the cam, when rotated, pushes the damper sheet first in one direction and then in the opposite direction by engaging and bearing against the sides of the slot.

Referring now to the drawings a preferred embodiment of this invention will be discussed in detail. FIG. 1 is a perspective view of the support assembly which bears the structural loads placed upon the floor modules. The support assembly **1** consists of a load lattice **2** which is preferably formed by welding steel straps in a honeycomb or lattice configuration as shown. Such a configuration is capable of supporting large loads and, yet, does not possess an imperforate surface. Around the load lattice **2** is placed a jacket **3**. Jacket **3** functions to insure maintenance of the load bearing configuration of the load lattice **2** and also to provide a relatively smooth surface area on both the top and bottom of the support assembly. Jacket **3** has a series of relatively small upper air perforations **4** and lower air perforations **5** on its opposing surfaces. The sandwich construction of the support assembly shown in FIG. 1 is capable of withstanding relatively large bearing stresses when supported only at the corners while still possessing the capability of allowing air to flow therethrough. A plug receiving aperture **6**, the purpose of which will become apparent hereinafter, is provided in the bottom of the support assembly **1**.

Referring now to FIGS. 2, 3 and 5, the adjustable air damping apparatus which forms a first embodiment of this invention will be described in detail. The upper surface of support assembly **1** is conveniently covered with a finishing sheet **7** having perforations **9** matching perforations **4** in the upper surface of the support assembly. Preferably, finishing sheet **7** takes the form of a section of tile and is flued to the upper surface of support assembly **1** in such a manner that the perforations **4** and **9** are in alignment. To enhance the appearance of the modules and to prevent separation thereof, a series of molding strips **8** may be placed around the edges of finishing sheet **7**.

A damper sheet **10**, preferably of polyethylene, is placed adjacent the lower surface of support assembly **1**. Damper sheet **10** has a plurality of apertures **11** which are spaced identically to those apertures **5** in the bottom of support assembly **1**. The damper sheet **10** is held in this position by a plurality of corner supports **29** each of which have guide collars **30** and support shoulders **31**. The corner supports **29** are passed through support apertures **13** in the damper sheet **10** andf affixed to the support assembly **1** by means of screws or some other type of well known fastening device. The support apertures **13** are larger than guide collars **30** and thus, in reality, the damper sheet is held in place by support shoulders **31**. This allows damper sheet **10** to be moved with respect to support assembly **1** while remaining in relatively close proximity thereto. This movability, of course, necessitates that the guide collars be of slightly greater length than the thickness of the damper sheet.

A plug receiving aperture **6** is provided in the bottom surface of support assembly **1**. Generally aligned with plug aperture **6** is an eccentric aperture **12** in the surface of the damper sheet **10**. An Allen head stud **23** having a shaft **24** passes through an aperture in hole plug **21**, through aperture **12** in damper sheet **10**, and into a mating aperture **26** in eccentric **25**. Eccentric **25** is provided with a bearing cylinder **27** which fits into the eccentric receiving opening **12** of damper sheet **10**. A support shoulder **28** is provided to aid in retaining damper sheet **10** adjacent support assembly **1**. As seen best in FIG. 5, aperture **26** in bearing cylinder **27** is off center, preferably being positioned adjacent one edge of the bearing cylinder. The shaft **24** is press fitted into the mating shaft receiving aperture **26** in the eccentric **25**. The shaft of stud **23** and the mating aperture **26** are preferably triangular in shape such that a positive fit may be obtained

between the shaft and the eccentric. If extra securing means are deemed advisable, the end of shaft **24** may be keyed or have a screw and washer inserted into the end thereof under shoulder **28**.

The damper sheet sub-assembly is then placed adjacent support assembly **1** and the hole plug **21** inserted into hole plug receiving aperture **6** such that the shoulder **22** secure the eccentric mechanism and the damper sheet to the support assembly. The spacing between damper sheet **10** and support assembly **1** has been somewhat exaggerated in FIG. 3 for purposes of clarity. Note that in order for the shoulder of hole plug **21** to effectively lock into support assembly **1** the hole plug receiving aperture **6** must be drilled at an open spot in the load lattice **2**. Once the hole plug has been secured to the support assembly the guide collars **30** are attached to support the corners of the damper sheet.

In order to adjust the damper sheet **10**, and thus control the amount of air flowing through a particular section or module of flooring, an Allen wrench is passed through an aperture in finishing sheet **7** and into support assembly **1** until it mates with and engages the Allen head lug **23**. As the lugs is rotated the eccentrically mounted bearing cylinder **27** causes each aperture **11** in damper sheet assembly **10** to rotate in a small circle. The support apertures **13** are sufficiently large to permit this movement. As the damper sheet is rotated the holes or perforations **11** therein approach and recede from completely matching relationship with the perforations **5** in the bottom of support assembly **1** and thus restrict or increase the amount of air flowing through the floor module.

Referring now to FIGS. 4 and 6 of the drawings a second embodiment of the damper adjustment assembly will be described in detail. A damper sheet **70** having a cam slot **43**, a series of guide slots **42**, and a series of perforations **71** spatially matching those perforations **5** in support assembly **1** is affixed adjacent support assembly **1** in a manner identical to that described with regard to damper sheet **10**. The guide collars mate with guide slots **42** in such a manner as to allow movement in two directions only. A cam mechanism **41** (FIG. 6) is positioned within cam slot **43** in the same manner as shown in FIG. 3. Cam mechanism **41** is provided with a camming surface **46**, a support shoulder **44**, and a shaft receiving aperture **45**.

The assembly of the embodiment shown in FIG. 4 and 6 is identical to that described with regard to FIGS. 2, 3 and 5 except that cam mechanism **41** is substituted for eccentric member **27**. The same type of lug and shaft may be utilized. As lug **23** is engaged and rotated by the Allen wrench, cam surfaces **46** moves first into abutting relationship with one side of cam slot **43** forcing the damper sheet in longitudinal fashion to one extremity of the cam reach. As rotation is continued cam surface **46** then contacts the opposite side of the cam slot **43** and forces damper sheet **10** in the opposite direction. The guide slots **42** prevent damper **70** from moving in all but two directions. It will be apparent that during this process the perforations **71** in damper sheet **70** will intermittently come into and recede from complete alignment with the perforations **5** in the bottom of support assembly **1**. This, of course, is utilized to control the amount of air which is allowed to flow through the floor modules.

Referring now to FIG. 7 a system for mounting the floor modules above the enclosure surface will be described. A plurality of pedestals **50** are positioned at predetermined locations within the enclosure. These pedestals have a base **51**, an upstanding support member **52** and a planar corner retaining and support plate **53**. The corners **54** of the floor modules **55** mate with the corner sections of planar corner retaining and support plates **53** and are thus supported above the floor. Each pedestal supports the corners of four different modules. It is, of course, necessary at the side of the enclosure to provide pedestals having only two corner receiving quarters.

Referring now to FIG. 8 the clean room **68** is shown schematically comprising a plurality of overhead plenum units **60** which may conveniently be manufactured in accordance with the teachings of co-pending application No. 481,249 filed Aug. 20, 1965, and entitled, Filter System. A plurality of these plenum units are connected to a supply duct **61**. The plenum units are supported by a grid network of I-beams **62** and **63**. Some means such as the seal **64** are necessary to insure that unfiltered air does not leak into the room through the plenum units. A plurality of floor module units **55** are then placed between the pedestals **50** as indicated generally in FIG. 8. The space beneath the floor modules form an air collection chamber **65** into which the air passes as it flows through the floor modules **55**. As is well known in the art, the air from collection chamber **65** is collected in a collection duct **66**, reprocessed in a compressor, prefiltering, and conditioning unit **67**, and fed back into plenum unit **60** via supply duct **61**.

It has been found that it is not necessary to provide an adjustable floor module for each location in the floor of the clean room enclosure. Rather, such floor modules in about half the location in the clean room floor are sufficient to allow the air to pass into the collection chamber without creating undesirable drafts or whistling noises. As shown in FIG. 9, the floor module of this invention is particularly adapted to this situation. The floor module **55** may be interspersed with ordinary floor modules **56**. The ordinary floor modules **56** may, for example, take the form of merely a support assembly **1** having a section of unperforated tile and accompanying molding affixed thereto. In this case it is not necessary that any perforation be made within the support assembly.

After the clean room apparatus has been installed the individual floor modules are adjusted to permit the desired degree of air flow therethrough. Note that this invention allows different sections of the room to be adjusted for a different flow rate. Such ability is often desirable when different types of operations or different types of equipment are being utilized at different locations throughout the room. After the desired adjustments have been executed the clean room is ready for use.

Thus it will be seen that this invention has provided a floor module for a clean room which may be completely prefabricated before reaching the assembly site. All that is necessary for the workmen to do in assembling the clean room is to position the pedestals and selectively place adjustable flow floor modules and blank floor modules at desired intervals. If necessary, some sort of gasket or ceiling material may be placed between the individual floor modules as they are being installed. This is seldom necessary, however, since there is little tendency for dust particles to flow upward from the collection chamber into the room. The module floor structures are of sufficient strength to bear heavy loads without failing and may be individually adjusted to provide the prescribed amount of air flow through any section of the clean room.

While several preferred embodiments of this invention have been described together with minor modifications, it will be recognized that other modifications may be made without departing from the scope and spirit of the invention. Such modifications are to be deemed as included within the scope of the following claims unless these claims, by their language, expressly state otherwise.

What is claimed is:

1. In a clean room having means in the ceiling for supplying filtered and conditioned air, a floor system comprising:

a plurality of pedestals, each said pedestal having a quadratured planar corner retaining and support plate elevated above its base;

a plurality of floor modules suspended between said pedestals such that each support plate supports the corners of four separate modules at least some of said modules having a support assembly with a plurality of upper and lower air apertures in the top and bottom thereof;

a damper sheet with a plurality of damper apertures matching the lower air apertures in said support member;

means for movably mounting said damper sheet adjacent the bottom surface of said support member;

a shaft mounted in said support assembly, said shaft protruding out of the bottom of said support assembly;

a bearing cylinder eccentrically mounted on said shaft around which is positioned a bearing cylinder receiving aperture in said damper sheet; and

means for rotating said shaft whereby the airflow capacity of said floor module may be adjusted.

2. The combination as set forth in claim **1** wherein said means for rotating said shaft comprises a tool receiving portion affixed to its upper extremity, said tool receiving portion being generally aligned with one of said upper apertures whereby a tool inserted through said one upper aperture may engage said receiving portion.

3. In a floor module for a clean room adapted to be supported at its peripheral edges and bear floor-loads across its entire surface having a structural core sandwiched between upper and lower generally planar parallel cover sheets, said sheets having a plurality of communicating air apertures therein whereby air can flow through said module, the improvement comprising:

a damper sheet having a plurality of damper apertures matching the air apertures in said lower cover sheet;

means for movably mounting said damper sheet adjacent the bottom surface of said module such that said damper sheet is movable to bring said damper apertures into and out of general registry with said lower air apertures; and

means central the side extremities of said module for adjusting the postion of said damper sheet with respect to said lower cover sheet to selectively register said damper apertures with the apertures in said lower cover sheet whereby the capacity of air flow through said module may be selectively controlled.

4. The combination as set forth in claim **3** wherein said cone comprises:

a support lattice having a plurality of multi-sided, open faced metallic members affixed in side by side relationship.

5. In a clean room having means for supplying filtered and conditioned air thereto, an exit surface for said air comprising:

a plurality of apertured panels positioned over said exit surface;

a plurality of damper sheets, each having apertures matching the apertures in each said apertured panel;

means for movably mounting each said damper sheet adjacent one surface of each said apertured panel; and

a shaft mounted in said panel, said shaft protruding out of the back of said panel;

a bearing cylinder eccentrically mounted on said shaft, said bearing cylinder being rotatably encased by a bearing cylinder receiving aperture in said damper sheet; and

means for rotating said shaft whereby the airflow capacity of said panels may be adjusted.

6. In a clean room having means for supplying filtered and conditioned air thereto, an exit surface for said air comprising:

a plurality of apertured panels positioned over said exit surface;

a plurality of damper sheets, each having apertures matching the apertures in each said apertured panel;

means for movably mounting each said damper sheet adjacent one surface of each said apertured panel; and a shaft mounted in said panel, said shaft protruding out of the back of said panel;

a cam mounted on said shaft;

a slot in said damper sheet within which said cam is positioned; and

means for rotating said shaft whereby the airflow capacity of said panels may be adjusted.

7. In a clean room having means in the ceiling for supplying filtered and conditioned air, a floor system comprising:

a plurality of pedestals, each said pedestal having a quadratured planar corner retaining and support plate elevated above its base;

a plurality of floor modules suspended between said pedestals such that each support plate supports the corners of four separate modules at least some of said modules having a support assembly with a plurality of upper and lower air apertures in the top and bottom thereof;

a damper sheet with a plurality of damper apertures matching the lower air apertures in said support member;

means for movably mounting said damper sheet adjacent the bottom surface of said support member;

a shaft mounted in said support assembly, said shaft protruding out of the bottom of said support assembly;

a bearing cylinder eccentrically mounted on said shaft around which is positioned a bearing cylinder receiving aperture in said damper sheet; and

means for rotating said shaft whereby the capacity of airflow through said module may be selectively controlled.

8. In a clean room having means in the ceiling for supplying filtered and conditioned air, a floor system comprising:

a plurality of pedestals, each said pedestal having a quadratured planar corner retaining and support plate elevated above its base;

a plurality of floor modules suspended between said pedestals such that each support plate supports the corners of four separate modules at least some of said modules having a support assembly with a plurality of upper and lower air apertures in the top and bottom thereof;

a damper sheet with a plurality of damper apertures matching the lower air apertures in said support member;

means for movably mounting said damper sheet adjacent the bottom surface of said support member;

a shaft mounted in said support assembly, said shaft protruding out of the bottom thereof;

a cam mounted on said shaft;

a slot in said damper sheet within which said cam is positioned; and

means for rotating said shaft whereby the capacity of airflow through said modules may be selectively controlled.

9. A floor module for clean rooms comprising:

a support assembly having a plurality of communicating upper and lower air apertures in the top and bottom thereof;

a damper sheet having a plurality of damper apertures matching the lower air apertures in said support member;

means for movably mounting said damper sheet adjacent the bottom surface of said support member; and

a shaft mounted in said support assembly, said shaft protruding out of the bottom thereof;

a cam mounted on said shaft;

a slot in said damper sheet within which said cam is positioned; and

means for rotating said shaft whereby the airflow capacity of said floor module may be adjusted.

10. In a room having means for supplying filtered and conditioned air thereto and an exit surface for said air at the floor of said room said exit surface having a plurality of floor modules adapted to be supported at peripheral extremities thereof and bear floor loads across their entire surface, at least certain of said modules having a structural core sandwiched between upper and lower generally planar parallel cover sheets, said sheets having a plurality of communicating air apertures therein whereby air can flow therethrough, the improvement comprising:

a plurality of damper sheets having a plurality of damper apertures therein matching the air apertures in said lower cover sheets;

means for movably mounting said damper sheets adjacent the bottom surfaces of said certain modules such that said admper sheets are movable to bring said damper apertures into and out of general registry with the air apertures in said lower cover sheet; and

means for adjusting the position of said damper sheets with respect to their associated lower cover sheets whereby the capacity of air flow through said certain modules may be selectively controlled.

11. In a room having means for supplying filtered and conditioned air thereto and an exit surface for said air suspended above the floor of said room in generally parallel relationship therewith to form an air collection cavity between said surface and said floor, the improvement in said exit surface comprising:

support and damper members positioned adjacent and slidable with respect to one another, said support member being positioned above said damper member, said support member having a plurality of air apertures therein arranged in a predetermined pattern, said damper member having a plurality of damper apertures therein positioned such that as said damper member is slid with respect to said support member, said damper apertures come into progressively increasing and decreasing registry with said air apertures, said support member being formed of structural material capable of supporting floor loads imposed thereon when supported only at the peripheral edges thereof; and

means for selectively sliding said damper member with respect to said support member.

References Cited by the Examiner

UNITED STATES PATENTS

2,251,663	8/1941	Darbo	98—41 X
2,576,848	11/1951	Mercier et al.	98—41
2,814,242	11/1957	Marini et al.	98—41
3,200,734	8/1965	Burns et al.	98—40
3,252,400	5/1966	Madl.	

ROBERT A. O'LEARY, *Primary Examiner.*

MEYER PERLIN, *Examiner.*

W. E. WAYNER, *Assistant Examiner.*