Nov. 21, 1967 J. W. LEE ET AL 3,353,472

DROPPED CEILING VENTILATOR APPARATUS

Filed May 13, 1965 4 Sheets-Sheet 1

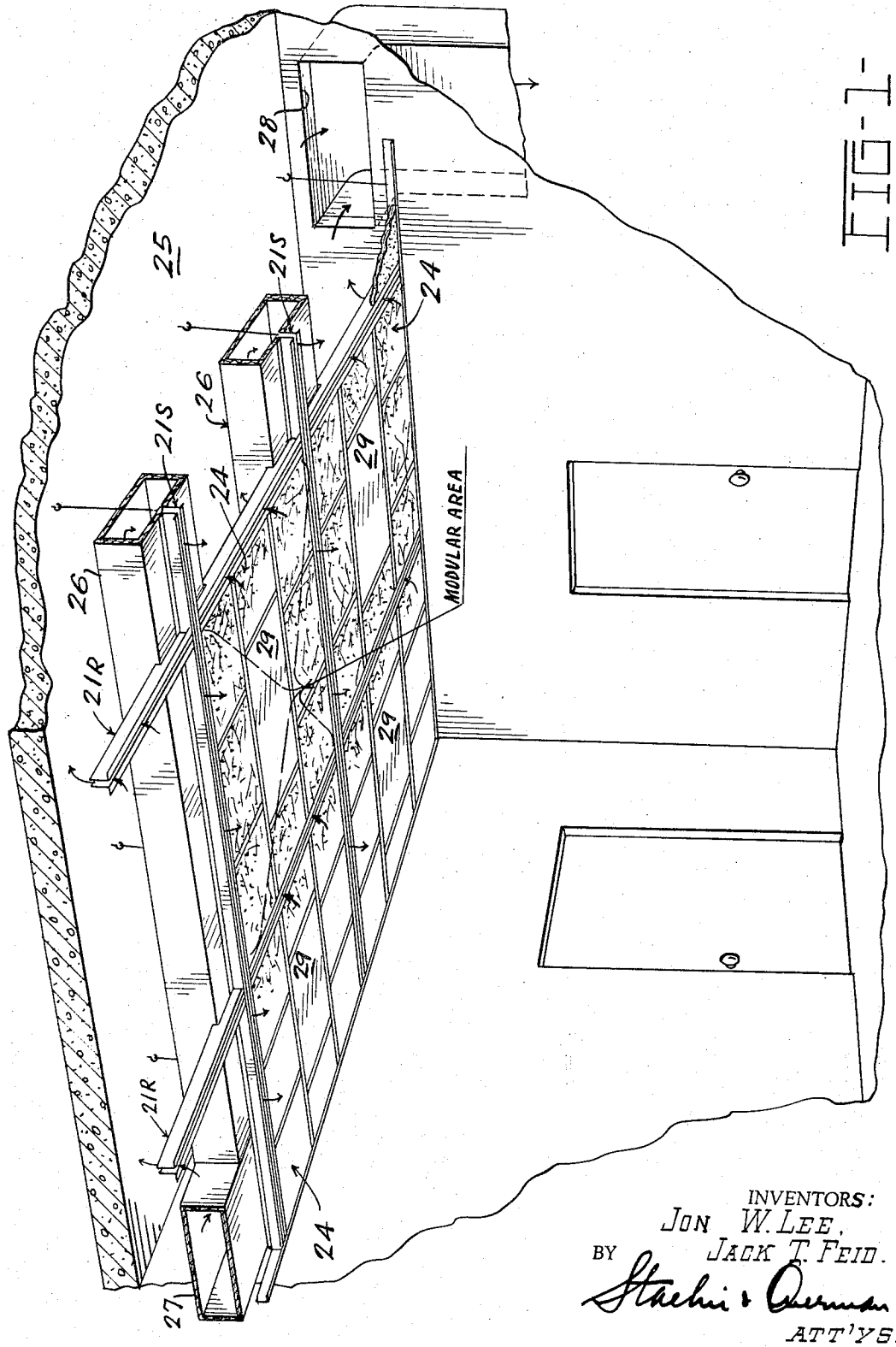


FIG-1-

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DROPPED CEILING VENTILATOR APPARATUS

Filed May 13, 1965 4 Sheets-Sheet 2

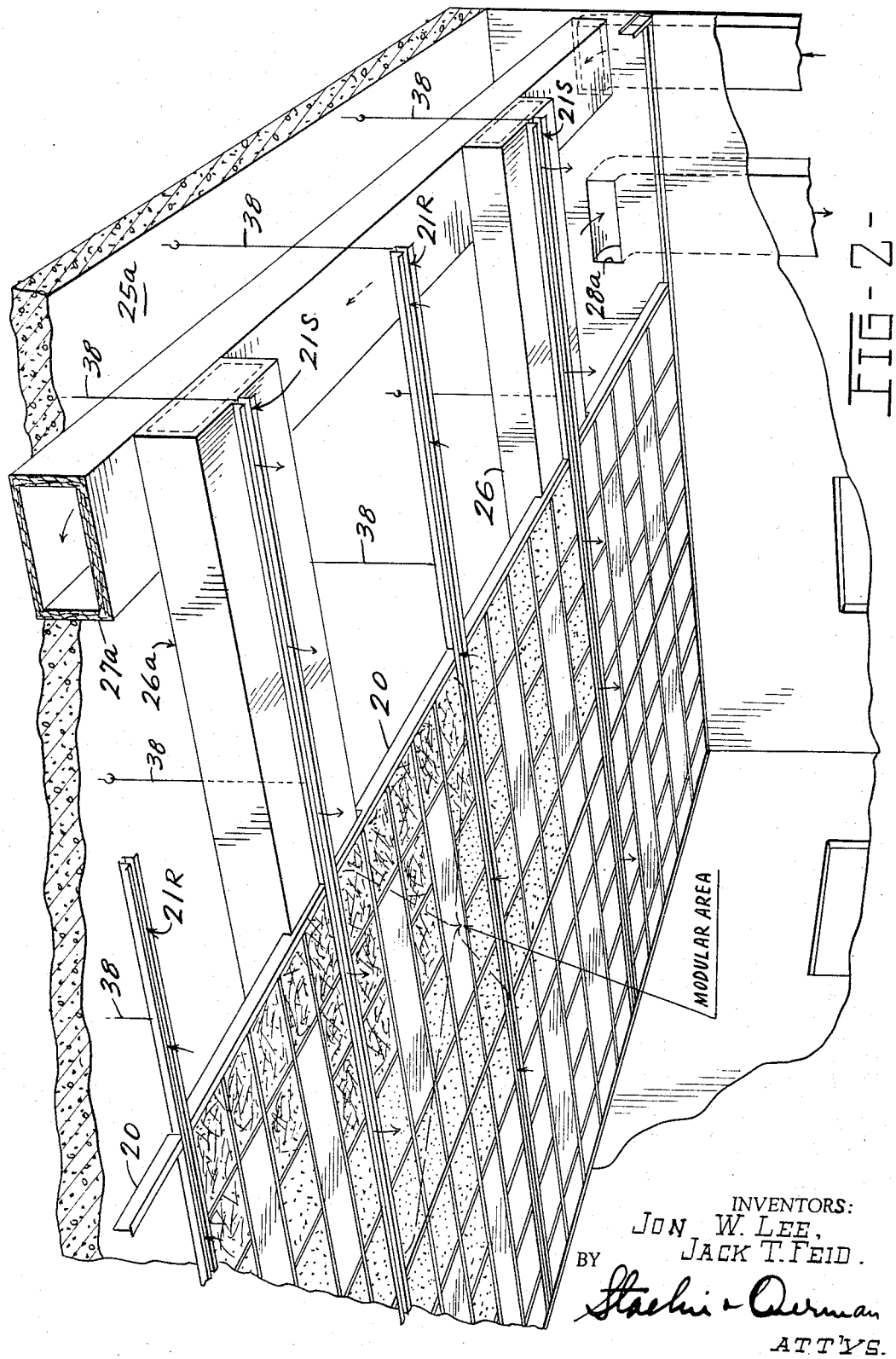


FIG-2-

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DROPPED CEILING VENTILATOR APPARATUS

Filed May 13, 1965 4 Sheets-Sheet 3

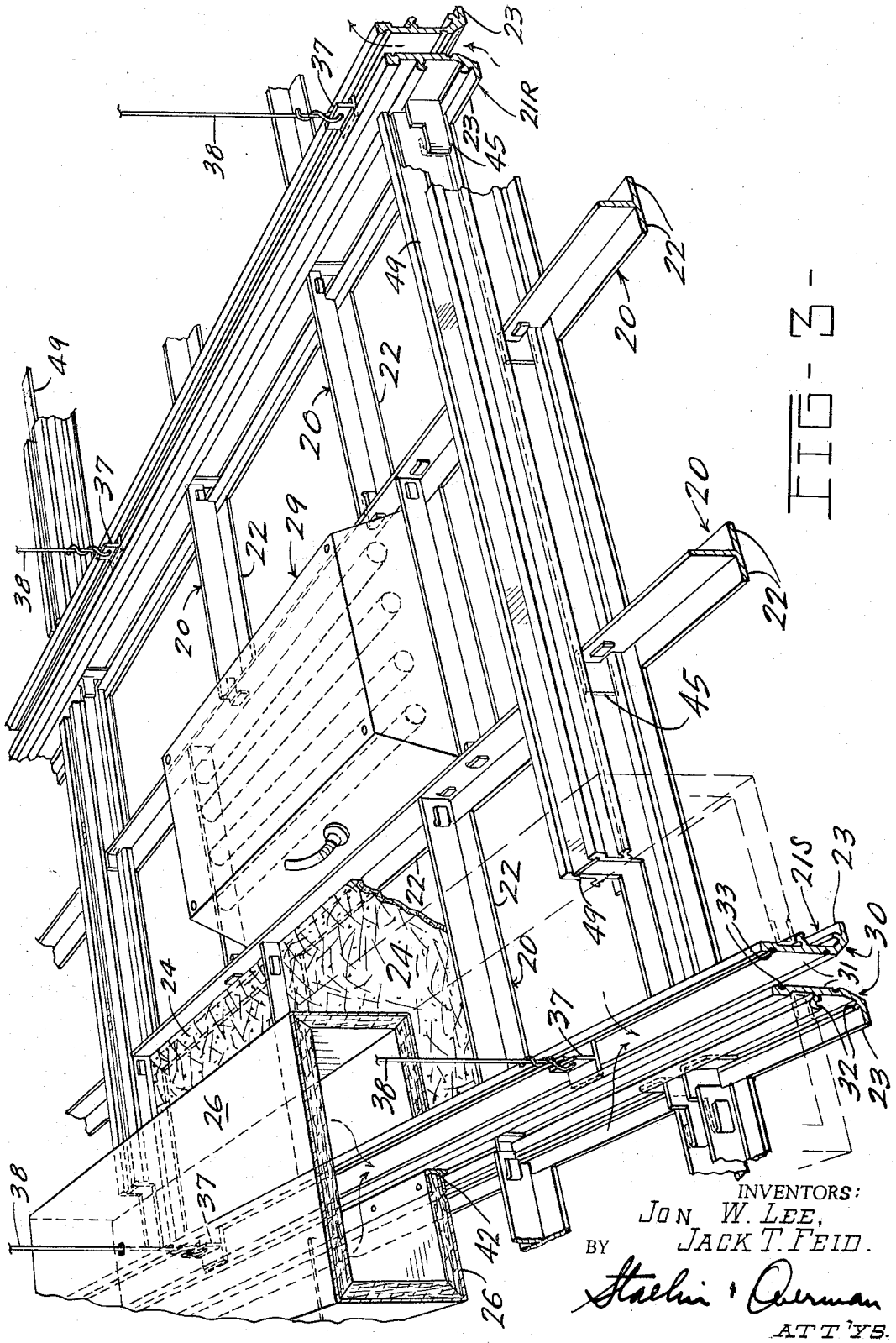


FIG. 7

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DROPPED CEILING VENTILATOR APPARATUS

Filed May 13, 1965 4 Sheets-Sheet 4

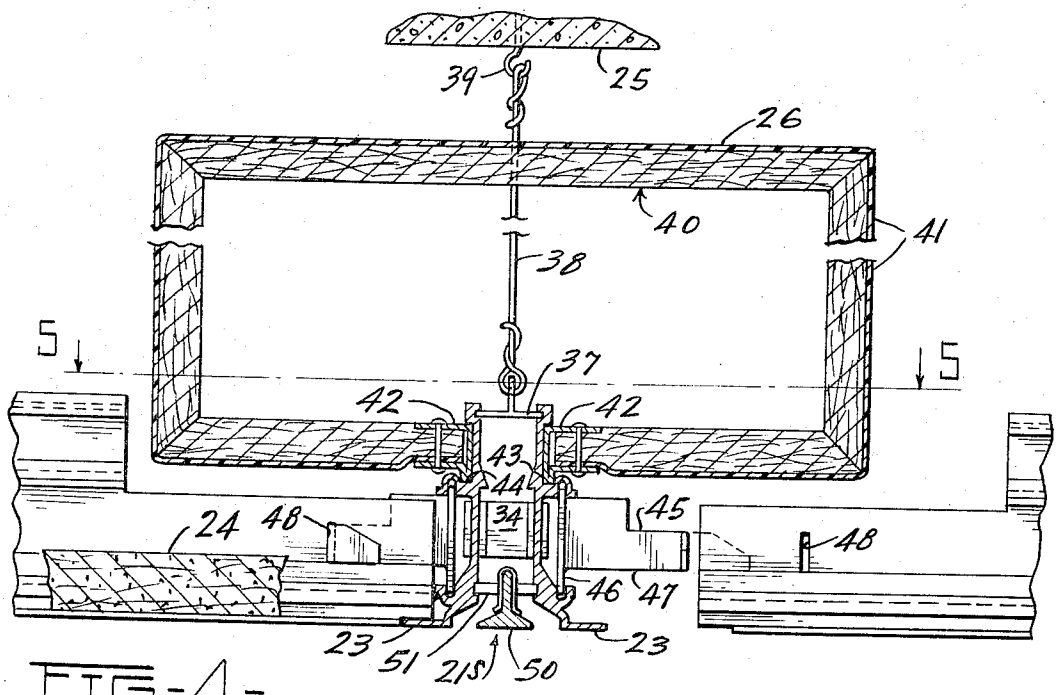


FIG-4-

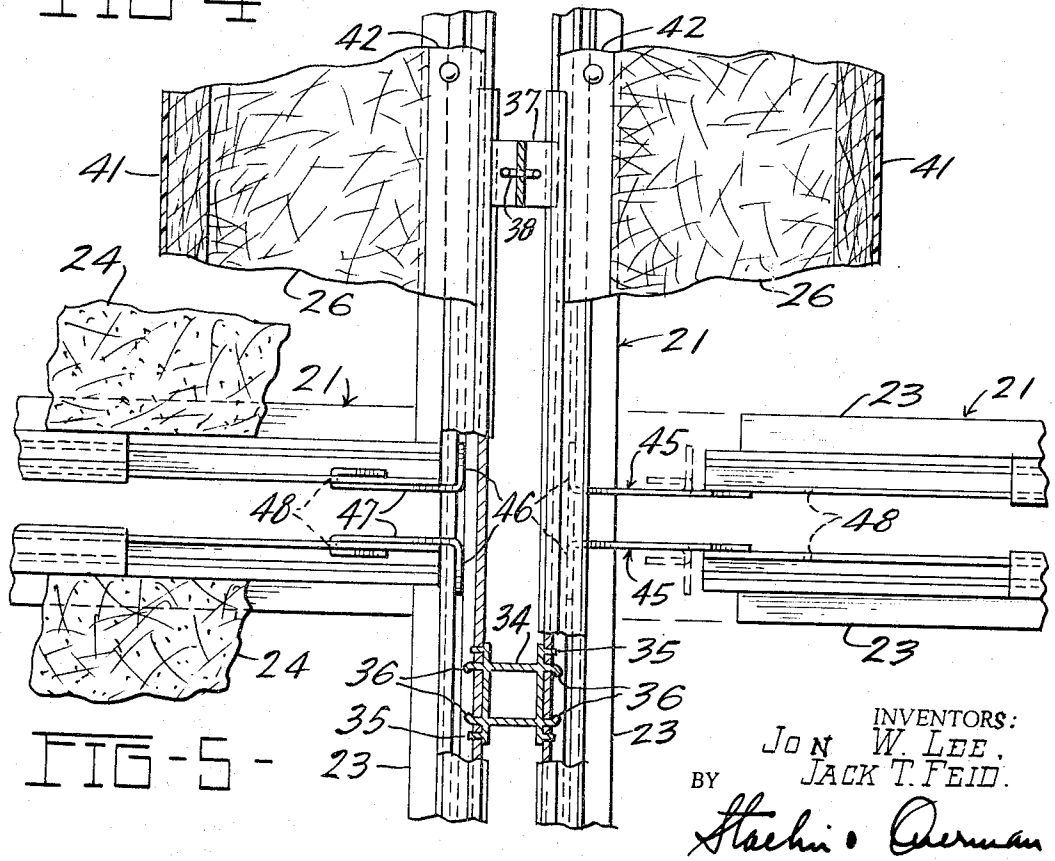


FIG-5-

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United States Patent Office

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DROPPED CEILING VENTILATOR APPARATUS

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7 Claims. (Cl. 98—40)

ABSTRACT OF THE DISCLOSURE

A dropped ceiling construction having a rectilinear supporting grid for ceiling modules. Conditioned air is supplied to the room from ductwork through some of the supporting grid elements. Return air flows through others of the supporting grid elements to the plenum space above the dropped ceiling, from which it is exhausted. The modules are subdivided with elongated, inverted, T-shaped grid elements. The ceiling modules comprise ceiling boards and lighting fixtures all supported by the grid elements.

This invention relates to dropped ceiling constructions and, more particularly, to the supporting members for such a dropped ceiling construction, by which the ceiling is supported in position beneath the structural ceiling of the building in which it is located, in such a fashion as to form modular areas in the ceiling with support elements for the ceiling boards such as acoustical tile or the like, and also for lighting components and air-flow ducts by which conditioned air may be brought into and taken away from the inhabited space located beneath the dropped ceiling.

The use of inverted T-shaped support bars having opposed horizontal flanges for the support of ceiling boards such as acoustical tile is well known. These T-bars are suspended from the structural ceiling of a building and extend across the spaces therein, usually running parallel to each other and being intersected by transversely extending bars to form small squares, diamonds, triangles and the like sometimes measuring one foot by one foot, one foot by two feet, etc. Ceiling boards of acoustical material are laid on the flanges of the T-bars to constitute the dropped ceiling.

It has also been suggested that, in some cases, the conventional inverted T-bars should be replaced by air-flow bars which are of the same general configuration but which have air passageways extending through the central portions of their bodies by which air may be delivered into the space beneath the ceiling from related air supply ducts. Such ducts sometimes extend along the full lengths of these air-flow bars, from end to end, and are open to the air-flow passages throughout their lengths so that a controlled supply of conditioned air may be fed into the space beneath the ceiling.

The present invention consists of a dropped ceiling construction which comprises an arrangement of elongated, inverted, generally T-shaped elements providing the outwardly turned horizontal flanges for the support of ceiling boards, lighting components, and the like, with some of the inverted T-shaped elements actually having hollow air passages through their vertical portions and all of the elements being arranged and assembled to provide for modular ceiling areas. Each of the modular ceiling areas, in a construction according to the present invention, is defined by at least two of the T-shaped elements and at least one of those two is an air-flow element by which air is fed into the space beneath the ceiling or returned from the space beneath the ceiling to the so-called plenum space above the ceiling or to a return air duct. For example, if the modular areas of the ceiling are triangular in

shape, then a modular area adjacent a wall of the room is formed by supporting structure extending along the wall and two of the T-shaped elements one of which would be an air-flow bar. In such a ceiling modular areas remote from the walls are defined by three T-shaped elements at least two of which are air-flow elements, one supplying air to the space beneath the ceiling and one providing for the return of air from the space beneath the ceiling to the plenum space above the ceiling. Similarly if the modular areas are square or rectangular, modular areas adjacent the walls of the room are defined by three T-shaped elements at least two of which are air-flow elements to supply and return air and modular areas remote from the walls are defined by four T-shaped elements, again two of the elements functioning to supply air to or return air from the space beneath the ceiling. In some arrangements according to the invention, the air-flow elements extend parallel to each other, for example across the room, and alternate elements function to supply air to and return air from the occupied space. In these instances the transverse elements may be simple T-bars without air-flow passages or they may be air-flow bars with the air-flow passages sealed, as for example by strips of metal which close off the air passages or by other means.

It is therefore the principal object of the present invention to provide a ceiling construction which defines modular areas of a dropped ceiling, each of the areas being defined by support means for ceiling boards, lighting components and the like, as well as by air supply and return means.

This and other more specific objects and advantages of the instant invention will be better understood from the specification which follows and from the drawings in which:

FIG. 1 is a fragmentary view in perspective of a portion of an enclosed space in a building provided with a dropped ceiling construction embodying the invention and illustrating one arrangement of the elements making up the construction;

FIG. 2 is a view similar to FIG. 1, but on a smaller scale, and illustrating another construction embodying the invention;

FIG. 3 is a fragmentary view in perspective taken from a position above a dropped ceiling construction embodying the invention and illustrating how the elements of the construction are assembled one to the other and function to provide support for ceiling boards, lighting components, air supply means and air return means;

FIG. 4 is a fragmentary, vertical, sectional view on an enlarged scale illustrating a junction of structural elements and showing an air supply duct assembled therewith; and

FIG. 5 is a fragmentary, horizontal, sectional view taken along the line 5—5 of FIG. 4.

A dropped ceiling construction according to the invention comprises a support grid consisting of various arrangements and assemblies of elongated, inverted, generally T-shaped elements of several types. Among these are simple T-bars such as the T-bars indicated by the reference number **20** (FIG. 3) and more complex T-shaped elements such as the air-flow elements indicated by the reference number **21**. All of the inverted T-shaped elements have outwardly turned flanges **22**, on the simple T-bars **20**, or **23** on the air-flow elements **21**. The flanges **22** and **23** cooperate to support the edges of ceiling boards **24** which may be of any conventional type such as compressed glass fiber boards, wood fiber boards and the like. The entire ceiling construction formed by the T-shaped elements **20** and **21** is suspended beneath a structural ceiling, generally indicated by the reference number **25**, of the building in which the dropped ceiling is to be positioned to form the apparent ceiling for the

occupied portion of the space in the building and to provide a plenum space above the dropped ceiling between the dropped ceiling and the structural ceiling **25**.

In modern building constructions dropped ceilings of this general type finish off the occupied portions of the building and the plenum spaces there above are utilized for the supply of various utilities such as electric power and conditioned air, as the location of main heating ducts or water supply lines, and the like. In a construction according to the invention the plenum space above the dropped ceiling is utilized for both the supply of conditioned air to the occupied spaces beneath the dropped ceiling, and the return of air from those spaces.

In FIG. 1 there is shown a dropped ceiling construction according to the invention and there are fragmentarily illustrated two air ducts **26**, extending parallel to each other across the room, and shown as being connected to a main conditioned air supply duct **27**. Air at selected temperature and humidity is fed from a central source through the main supply ducts **27** and then to the air ducts **26** and into the space beneath the ceiling. In the embodiment of the dropped ceiling construction illustrated in FIG. 1 the individual air ducts **26** are associated with supply air-flow elements **21S** through which the conditioned air is fed into the space beneath the dropped ceiling. Air is returned from the space beneath the dropped ceiling in this arrangement through return air-flow elements **21R** which are illustrated as running perpendicularly to the air-flow elements **21S** by which the air is supplied. Return air flowing through the return air-flow elements **21R** into the plenum space above the dropped ceiling is exhausted therefrom through a main exhaust duct **28** fragmentarily illustrated in FIG. 1 which would return such air to the central air conditioning system.

In general, in the arrangement of FIG. 1, each of the modular areas of the ceiling is defined by a pair of air-flow supply elements **21S** which are spaced from and extend parallel to each other on opposite sides of a module and by a pair of air-flow return elements **21R** which are similarly spaced from each other and extend perpendicularly to the supply air-flow elements **21S** to define the other two sides of the module. In the arrangement of FIG. 1 a modular area is defined on all four sides by similar appearing, air-flow elements **21R** or **21S** so that the modular area of the ceiling extends over the area indicated in FIG. 1 by the brackets labeled "Modular Area." The ceiling of a large room would consist of a plurality of these modular areas defined in the same fashion as that just described to give the ceiling an overall uniformity of pattern.

In the construction illustrated in FIG. 1 it will also be observed that each of the modular areas includes within its borders and individual lighting fixture **29** having a glass pane. While the light fixture **29** is shown as being centrally located in each of the modular areas in the construction illustrated in FIG. 1 it will be appreciated, of course, that the number of lighting fixtures to be installed in the modular areas in any given room is determined by the quantity of light necessary to properly illuminate the room and it may thus be that lighting fixtures will be located not in every modular area of the ceiling of such a room but only in alternate modular areas or that more than one lighting component might be located in each modular area. As will be better understood as this description continues, the ceiling construction embodying the invention possesses flexibility of arrangement of the inverted T-shaped elements of both types, i.e., not only may the sizes and shapes of the modular areas themselves be changed, but also the division of each modular area by the simple T-bars may be changed at will to accommodate larger or smaller ceiling boards **24** and larger or smaller lighting components, such as the fixtures **29** or the presence or absence of such lighting components. In the construction of FIG. 1 each modular area might measure six feet long by four and one-half feet wide, utilizing a lighting fixture three feet long by one and one-half feet wide and ceiling boards one and one-half feet square at the ends of the fixture **29** and one and one-half feet by two feet at its sides.

In the ceiling construction illustrated in FIG. 2 each of the modular ceiling areas is defined by only a pair of air-flow elements comprising one supply air-flow element **21S** which defines one side of the modular area and one return air-flow element **21R** which is parallel thereto and defines the opposite side of the modular area. In this arrangement the two other sides of each modular area are defined by simple T-bar elements **20** which extend perpendicularly to the air-flow elements **21S** and **21R**. In such an arrangement, of course, the identical appearing air-flow elements **21S** and **21R** provide a parallel pattern and the slightly different appearing, simple T-bar elements **20** extend in a pattern at right angles thereto. As in the case of the construction illustrated in FIG. 1, however, each of the modular areas is defined by at least two of the air-flow elements and, even at the sides of the room adjacent the walls, each modular area is defined by several of the inverted T-shaped elements including at least one air-flow element. A modular area thus defined, is indicated by the brackets labeled "Modular Area." In this case, the area might be ten feet by seven and one-half feet wide and containing two lighting fixtures, the fixtures each measuring six feet long by one and one-half feet wide and all the ceiling boards measuring one and one-half feet by two feet. Again as in the construction illustrated in FIG. 1, each of the air-flow supply elements **21S** has an associated air duct **26*a*** which supplies conditioned air to the associated air-flow supply element **21S** and which are provided with conditioned air from a main air supply duct **27*a***. Air returned through the return air-flow elements **21R** from the occupied space beneath the dropped ceiling to the plenum space above the dropped ceiling beneath the main structural ceiling **25*a***, is exhausted from the plenum space by a main exhaust duct **28*a***.

While the precise details of the size, shape and configurations of the elements forming a dropped ceiling construction according to the invention do not constitute the heart of the present invention, illustrative details are disclosed in FIGS. 3, 4 and 5. Each of the air-flow elements **21S** (supply) and **21R** (return) consists of a pair of identical extruded bars **30**. Each of the bars **30** comprises a vertically extending body **31**, at the lower end of which is located the outwardly extending support flange **23**, and a pair of outwardly extending vertically spaced lips **32**. Near their upper ends each of the bars **30** has a groove **33** in its inner surface. The two bars **30** are assembled to each other to form an air-flow element **21S** or **21R** by a plurality of cross clips **34** (FIGS. 4 and 5). Each of the cross clips **34** has oppositely extending pairs of shorter and longer tabs **35** and **36** which extend through vertical slots cut in the bodies **31** of the bars **30**, the longer tabs **36** being crimped over tightly against the outer surfaces of the bodies **31** to retain the two bars **30** in their spaced parallel relationship as illustrated in FIGS. 4 and 5.

Hangers **37** (see also FIG. 3) are slid into the grooves **33** and spaced from each other along the lengths of the elements **21S** and **21R**, being engaged by the hook ends of hanger wires **38**, the upper ends of which are engaged with eyes **39** set into the main structural ceiling **25** or **25*a*** for supporting the entire gridwork at the selected level beneath the structural ceiling **25** or **25*a***.

Each of the supply air-flow elements **21S** has an associated air supply duct **26** or **26*a*** illustrated in some detail in FIGS. 4 and 5. An air supply duct **26** is shown as being fabricated with an inner layer **40** of an insulating material, such as compressed glass fiber wool, folded into a rectangular cross section and encased with a thin sheet **41** of plastic material. Other materials may be used for

the ducts and circular, square or oval ducts, as desired, may be employed.

The bottom of the air supply duct **26** has a central slot throughout its length into which protrudes the upper end of the respective supply air-flow element **21S**, as is best illustrated in FIG. 4. Each edge of the glass fiber wool layer **40** is illustrated as being protected by a bent sheet metal channel **42** for protection against damage and to provide a means for assembly and retention of the air supply duct **26** with its respective air-flow element **21S**. The channel **42** has a downwardly turned lip **43** which recesses in an upwardly open groove **44** formed in the outer side of the respective bar **30** of the air-flow element **21S**. By this arrangement the glass fiber wool **40** with its protective covering **41** may be shipped flat to the place of installation and folded into rectangular shape by a workman, one of the channels **42** being first inserted into the respective groove **44** at the outer side of the associated supply air-flow element **21S**; the duct **26** being then folded around over the upper end of the element **21S** and its opposite channel **42** being inserted in the groove **43** at the opposite side of the air-flow element **21S**. Of course, if the duct **26** or the outer sheath **41** is fabricated from sheet metal that metal itself may be bent to form the assembly channels **42**.

Assembly of all of the inverted generally T-shaped elements which form a dropped ceiling construction according to the invention is accomplished through the use of assembly clips **45**. Each of the clips **45** has a base leg **46** of such width as to fit between the lips **32** at the outer sides of the bars **30** and can be slid along the respective bar **30** to the selected position for joining with an abutting T-bar **20** or air-flow element **21S** or **21R**, depending upon the particular arrangement being installed. Each of the assembly clips **45** also has an engaging leg **47** which extends perpendicularly to its base leg **46** and is inserted through a vertical slot **48** punched at an appropriate distance from the end of the vertical element of the simple T-bars **20** (see FIG. 3) or through the respective bar **30** of an air-flow element **21S** or **21R**. When the engaging legs **47** of the respective assembly clips **45** have been bent over and inserted through the respective cooperating slots **48** of the other T-shaped elements being assembled, their ends are bent around to retain the gridwork thus formed in its assembled relationship.

In any arrangement where a supply air-flow element **21S** crosses a return air-flow element **21R** it is necessary that the upper portions of the bars **30** of the return air-flow element **21R** be cut away to accommodate the duct **26**. Such a situation is illustrated in FIGS. 3, 4 and 5. In FIG. 3 the general arrangement of the construction comprises a supply air-flow element **21S** and a parallel spaced return air-flow element **21R** with dummy air-flow elements extending perpendicularly thereto and forming the other two sides of any modular area. Such an arrangement might be designed to particularly control the flow of air through the room according to the desires of the particular heat or air conditioning engineer designing the system. When it is desired that an air-flow element **21** shall be a dummy, in the sense that no air is to flow therethrough, the otherwise open air-flow space through its center may be closed off by inserting a sealing plate **49** into the grooves **33** which are otherwise utilized for mounting of the hangers **37**. Such a sealing plate **49** is illustrated in position in FIG. 3.

When the supply air-flow element **21S** intersects a return air-flow element **21R** the necessity for cutting away the uppermost parts of the bars **30** of the return air-flow element **21R** does not interfere with the flow of return air therethrough because, as can be seen in FIG. 4, the passageway in the element **21R** is open into the plenum space above the dropped ceiling throughout the length of the return air-flow element **21R** and remains open even where cut away to accommodate the duct **26**.

When desired the supply air-flow elements **21S** may be provided with diverter bars **50** retained in their throats by suitable resilient clips **51** engaged in horizontal grooves **52** formed in the inner surfaces of the bars **30**.

FIG. 3 also illustrates the manner of arrangement of what has been called simple T-bar elements of the ceiling construction within any one of the modular areas. In this illustration the modular area is divided into nine smaller rectangular areas, eight of the areas forming a border around a central rectangular area in which there is shown a lighting fixture **29**. Depending upon the particular size of the lighting fixture **29**, inverted T-bars **20** extend between the T-shaped elements which define the modular area and support ceiling boards **24** of proper sizes as well as supporting the lighting fixture **29**. As earlier mentioned, the arrangement illustrated in FIG. 3 is merely illustrative of arrangements which can be provided for by constructions according to the invention and is not intended to limit the invention or to constitute any part of the invention.

We claim:

1. A dropped ceiling construction having a rectilinear support grid for ceiling elements, air supply means, air return means and lighting fixtures and suspension means for supporting said grid at a selected level beneath the structural ceiling of a building, in which said support grid consists of (1) a plurality of elongated, inverted, generally T-shaped elements, each of said elongated elements having an outwardly turned flange at each side of its bottom edge, said elongated elements being spaced to define rectilinear modular areas of said dropped ceiling, some of said elongated elements being air-flow elements and having vertically extending air-flow passageways through the central portions thereof, each of said modular areas adjacent one of the walls of the ceiled room being defined by structure adjacent such wall and at least two of said elongated elements at least one of which is an air-flow element and each of said modular areas remote from such walls being defined by at least three of said elongated elements at least two of which are air-flow elements, at least one of said air-flow elements defining each of said modules having a continuous air duct extending therealong above the level of said flanges and communicating along its length with the vertical passageway in the associated air-flow element for the flow of air between the space below said ceiling structure and said air duct, (2) additional elongated, inverted, T-shaped elements extending between and generally transverse to said module defining elements for cooperation therewith in supporting ceiling panel boards, light fixtures and the like within each of said modules, and (3) retaining means for connecting said elongated elements to each other.

2. A ceiling construction according to claim **1**, in which each of the modular areas of the ceiling remote from the walls is at least in part defined by two air-flow elements, one of which is a supply air-flow element which includes a continuous supply air duct extending therealong and thereabove for supplying air to the space beneath said ceiling and the other of which is a return air-flow element which is open for the return of air from such space beneath said ceiling to the space above said ceiling.

3. A ceiling construction according to claim **2**, comprising additional, simple, elongated, inverted T-shaped elements arranged in minor rectangular patterns within the modular area and spaced from each other for supporting ceiling boards and the like on the flanges thereof, and cooperating assembly means on the sides of said air-flow elements and the ends of said simple T-shaped elements for assembling said elements in selected spacing within the modular area.

4. A ceiling construction according to claim **3**, in which the air-flow elements are perpendicular to each other and the return air-flow element is cut away at the intersections of the two air-flow elements for accommodating the air ducts of the supply air-flow elements.

5. A ceiling construction according to claim 3, in which the air-flow elements are parallel to each other and define opposite sides of the modular areas.

6. A ceiling construction according to claim 5, and sealed-off nominal air flow elements extending between the supply air-flow elements and the return air-flow elements for defining opposite sides of the modular areas.

7. A dropped ceiling construction for a room having a rectilinear support grid for ceiling panels and air supply and return means and suspension means for supporting said grid at a level beneath the structural ceiling of a building, in which said support grid comprises a plurality of elongated, inverted, generally T-shaped elements all of generally the same form, said elements being arranged to define polygonal modular areas of said dropped ceiling, some of said elements being air-flow elements and having vertically extending air-flow passageways through the central portions thereof, at least one of said air-flow elements having an air duct extending continuously therealong and above the level of said panels and communicating along its length with the vertical passageway in the associated

air-flow element for the flow of air between the air duct and the space below said dropped ceiling, the other of said air-flow elements having openings for the return of air for reconditioning from the space beneath said dropped ceiling to the space above said dropped ceiling, sound absorbing ceiling panels within each of said modular areas and supported by said elements, and retaining means for connecting said elongated elements to each other.

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