

United States Patent

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Continuation-in-part of application Ser. No. 689,033, Dec. 8, 1967, now abandoned.

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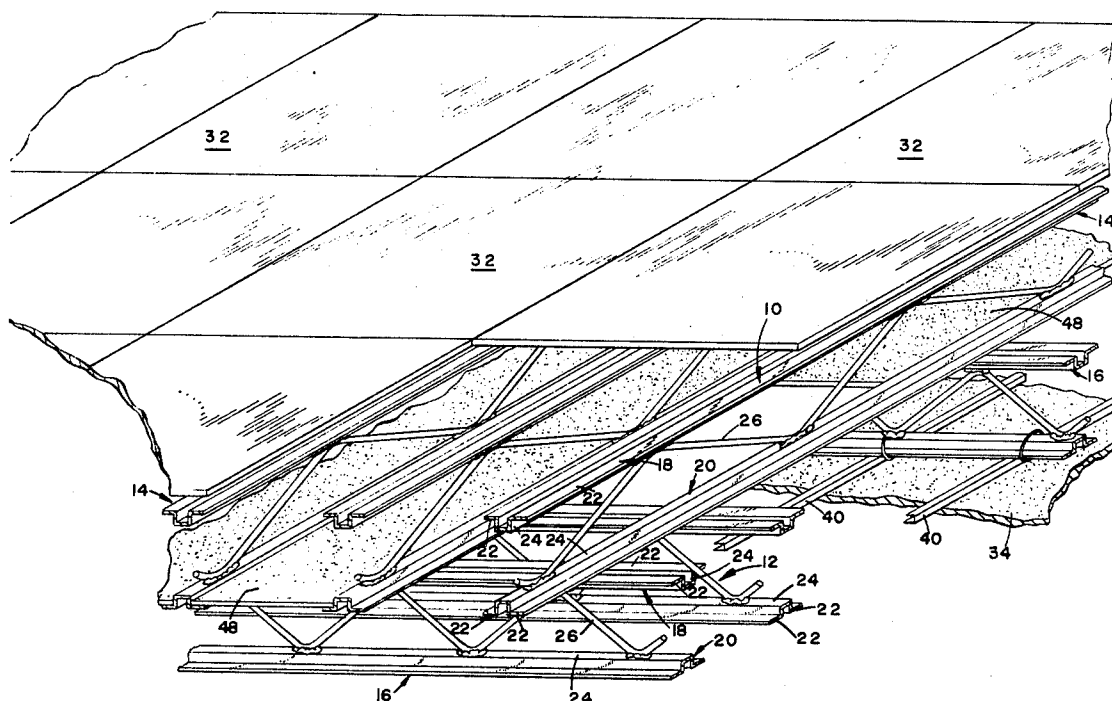
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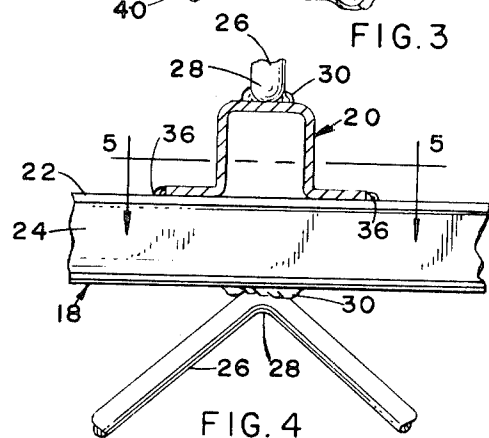
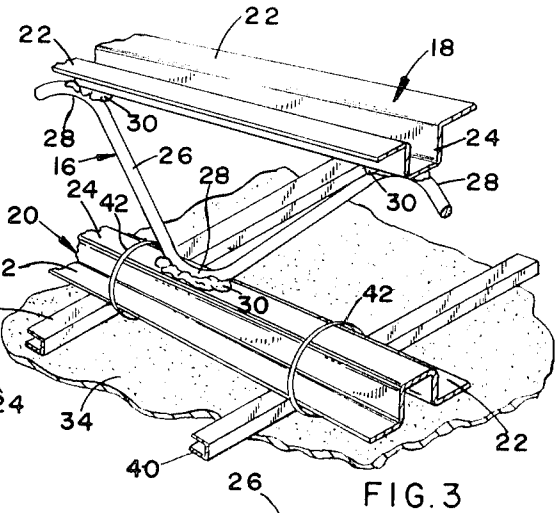
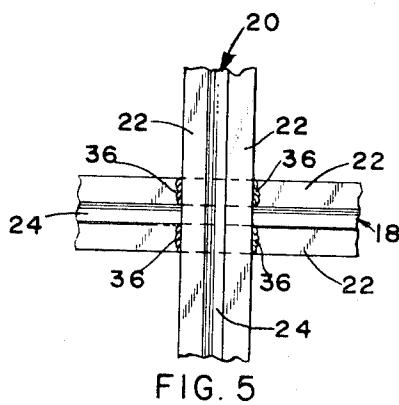
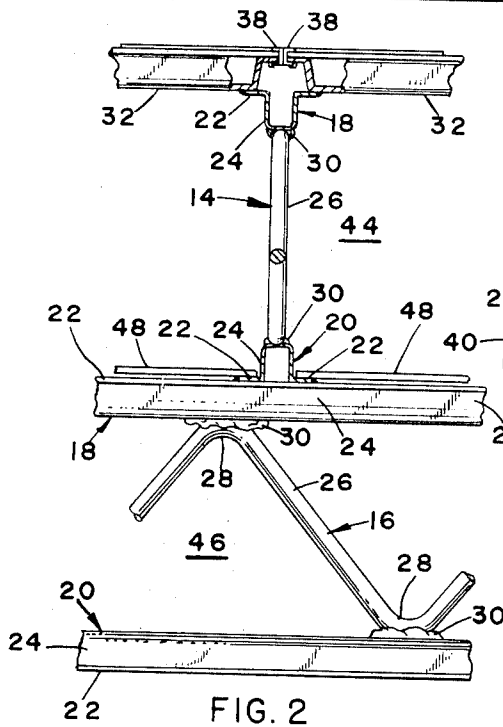
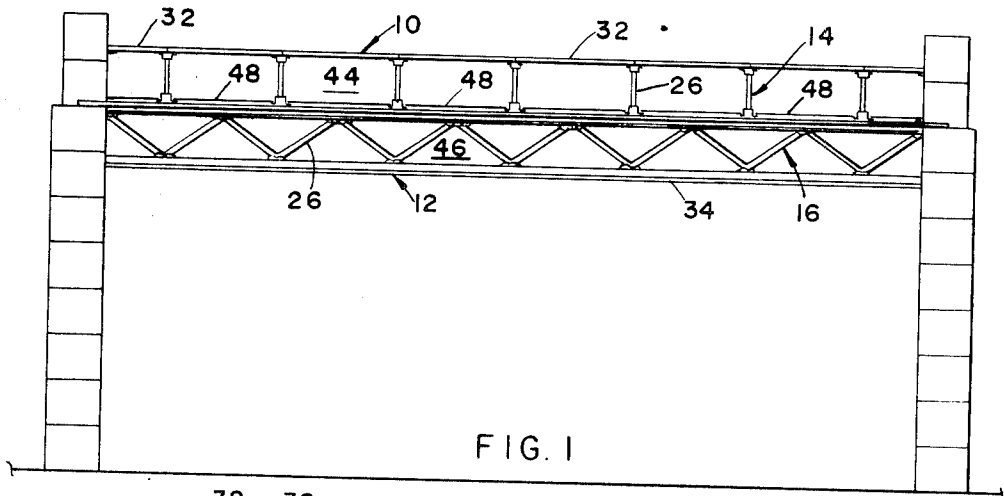
[54] RIGID RETICULATED BAR JOIST SYSTEM 3 Claims, 6 Drawing Figs.

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52/303, 52/488, 52/648, 52/694
[51] Int. Cl..... **E04b 5/14,**
E04b 5/55
[50] Field of Search..... **52/303,**
648, 694, 483, 488, 481

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ABSTRACT: A rigid bar joist system reticulated in plan view and comprising two sets of bar joists, the joists of each set being in vertical planes, parallel, spaced transversely and said sets being respectively arranged in overlying transverse crossover relationship to each other and fixedly connected at each crossover portion to form a rigid gridlike reticulated structure. The bar joists have substantial areas of open spaces between the upper and lower stress members of each joist, and impervious panel means are supported horizontally between the two sets of joists to form a plurality of plenum chambers respectively above and below said panel means when floor panels and a ceiling are supported respectively by the uppermost and lowermost stress members of said bar joist system.





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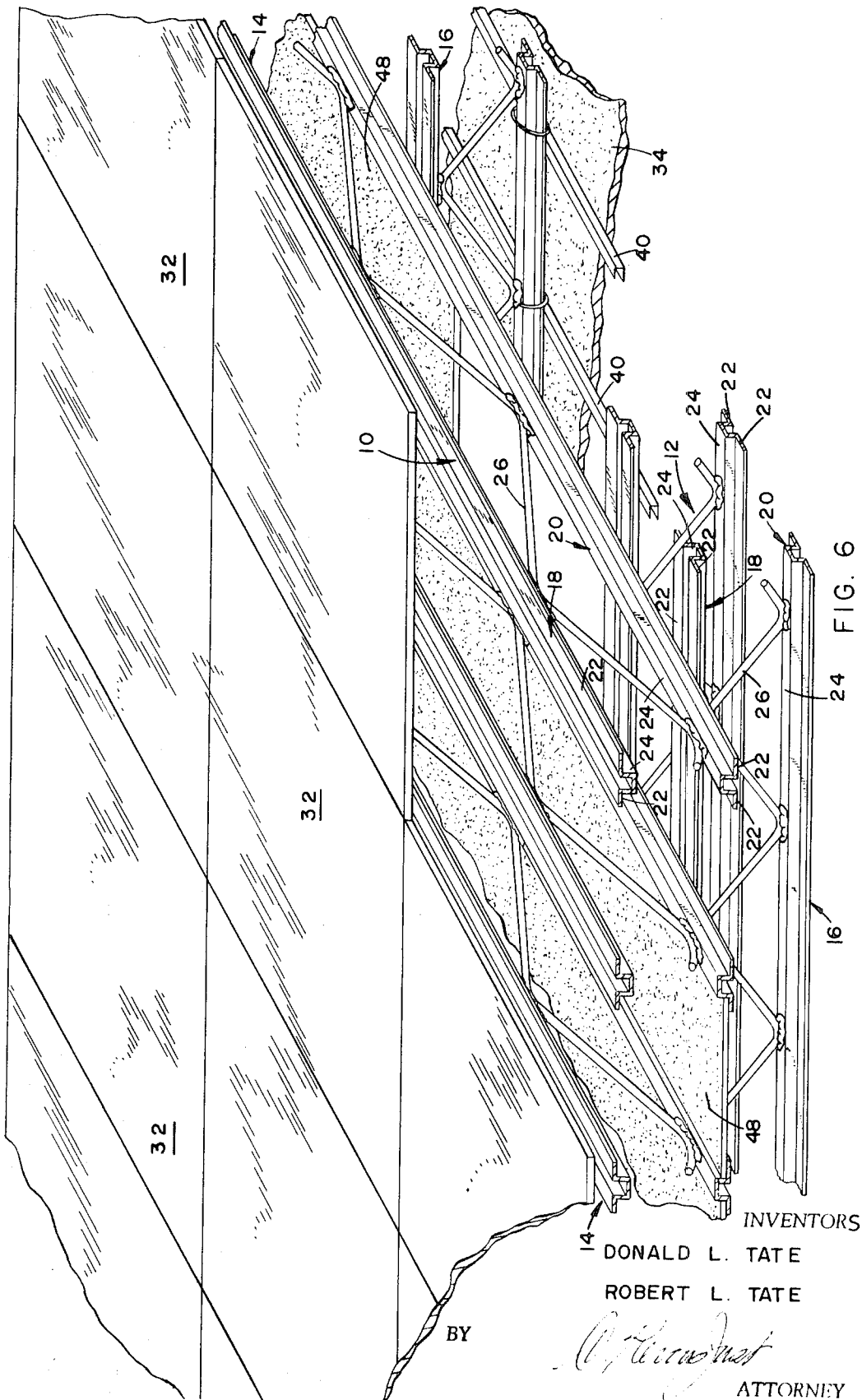


FIG. 6

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RIGID RETICULATED BAR JOIST SYSTEM

This application is a continuation-in-part of Ser. No. 689,033, filed Dec. 8, 1967 and now abandoned.

BACKGROUND OF THE INVENTION

Bar joists comprising upper and lower stress members which are spaced vertically apart in use and are interconnected by a zigzag arrangement of a cylindrical structural bar member extending between and connected at the crests thereof by weldments to the stress members have been employed for a number of years, particularly in building structures to support floors, and the like. Such bar joists are much lighter in weight than other structural beams such as I-beams affording comparable resistance to vertical flexure, whereby a saving in the overall cost of steel is achieved as well as, under normal circumstances, a decrease in the total dead weight of the structure. However, one of the deficiencies of bar joists is the fact that they are not readily capable of sustaining concentrated loads of appreciable magnitude at given locations without permitting or being subject to an undesirable amount of vertical flexing of the joist.

In an effort to provide relatively rigid beam structures capable of adequately supporting for example, floor loads and roof loads in building structures, various rather complex, heavy and expensive arrangement have been resorted to, certain of these structures also being suitable for decking for bridges and the like. In the main, however, these prior structures have not been found to be satisfactory in modern buildings where overall cost and especially the cost of steel tonnage are essential factors and particularly where maximum useful load upon the floor is desired with minimum flexure as distinguished from dead load of the building structure per se. Further, particularly where structural members comprising imperforate vertical webs are employed circulation of air or other gases in directions parallel to the beam structure is restricted to one direction only as distinguished from circulation in substantially all horizontal directions being possible.

Typical of prior beam structures for supporting floor and roof loads of the type referred to above, are the following U.S. Pat. Nos. 2,112,949, Bunker, 1938; No. 2,142,640, Rocht, 1939; No. 2,781,703, Nagin, 1957; No. 3,302,361, Oudheusden, Jr. et al. 1967; and British Pat. No. 882,912, of 1961.

The U.S. Patents listed above generally show I-beams in separate layers disposed at right angles to each other in an effort to provide rigidity but resulting in an excessively heavy and correspondingly costly structure. The British Patent shows a series of bar joists extending transversely across a very widely spaced series of supporting beams having a far greater vertical dimension than the bar joists. Where lengths of the joists are to be connected in end-to-end relationship, such connection is made at a point where the two ends rest upon one of the supporting beams. At that point only, the ends of the bar joists are interconnected to supporting beams but, otherwise, the bar joists merely rest by gravity upon the supporting beams where they pass over the same. Thus, in general, the bar joists and supporting beams are free to flex independently of each other.

SUMMARY OF THE INVENTION

The principal purpose of the present invention is to provide a rigid bar joist system comprising as the essential components thereof two sets of bar joists, which are sometimes referred to as open web beams or joists, the joists of each set being parallel and within vertical planes, and said sets respectively being arranged in transverse, crossover relationship to each other, said sets preferably being disposed substantially at 90° with respect to each other, and fixedly connected together at each of the crossover portions to provide a rigid reticulated bar joist system capable of sustaining concentrated loads of appreciable magnitude with minimum deflection of the system and, in function, resembling a rigid, composite horizontal panel for supporting purposes.

Another object of the invention is to provide bar joists in the aforementioned system which have appreciable open space areas between the upper and lower stress members of each bar joist, whereby ample circulation of air and other gases both along and through said bar joist may occur freely substantially in all horizontal directions without restriction to any particular direction.

A still further object of the invention ancillary to the foregoing objects is the provision of impervious panel means extending horizontally between the two sets of parallel bar joists whereby, when floor and ceiling structures respectively are supported by the uppermost and lowermost surface areas of said sets of bar joists, a pair of superimposed, horizontal plenum chambers are afforded which respectively are arranged for substantially free circulation of air and other gases substantially in all horizontal directions therethrough.

Still another object of the invention is to provide impervious panel means of the type referred to above which preferably are fireproof in nature.

A still further object of the invention ancillary to certain of the foregoing objects is additionally to provide bar joists of the type having oppositely extending substantially planar flanges projecting in opposite directions from the uppermost and lowermost surface portions of the stress members of the joists and readily capable of comprising supporting surfaces respectively for ceiling and floor panels or pedestals to support floor panels, the flanges on the lower stress members of the uppermost set of bar joists also comprising supporting means readily capable of receiving the opposite edge portions of said impervious panel means and normally support the same solely by gravity to form said aforementioned plenum chambers.

Details of the foregoing objects and of the invention, as well as other objects thereof, are set forth in the following specification and illustrated in the accompanying drawings comprising a part thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exemplary vertical elevation of a typical building structure utilizing a rigid bar joist system embodying the present invention.

FIG. 2 is an enlarged, fragmentary section of the bar joist system illustrated in FIG. 1, the same being partly sectioned and broken away to illustrate details of the structure.

FIG. 3 is a fragmentary, perspective view of the lower set of bar joists illustrated in FIGS. 1 and 2 and showing a typical means for supporting a ceiling from the same.

FIG. 4 is a fragmentary sectional view illustrating crossover portions of two of the bar joists illustrated in FIGS. 1 and 2 and illustrating particularly one means of fixedly connecting the stress member thereof together.

FIG. 5 is a fragmentary top plan view of the structure shown in FIG. 4 as seen on the line 5-5 thereof and illustrated on a smaller scale than employed in FIG. 4.

FIG. 6 is a fragmentary perspective view of a typical building insulation employing the bar joist system comprising the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the figures of the drawings, in which similar reference characters are applied to similar parts, attention is directed particularly to FIGS. 1 and 6 in which there is illustrated a typical arrangement of a bar joist system embodying the principles of the present invention and comprising two sets of parallel bar joists, sometimes referred to as open web beams or joists, the joists of said sets being respectively disposed preferably substantially at 90° to each other and the joists of each set being spaced transversely apart substantially in parallel relationship to each other. In these figures, the uppermost set 10 of bar joists are arranged in exemplary manner to support floor or roof panels or means by the upper surfaces thereof, while the lowermost set 12 of bar joists are arranged to support a ceiling relative to the lower surfaces thereof. It is

to be understood, however, that the rigid bar joist system comprising the present invention is not to be restricted specifically to supporting either a floor or roof structure across the upper surface thereof, or a ceiling across the lower surface thereof, notwithstanding the fact that the arrangement is especially capable of being used for these purposes.

The individual bar joists 14 and 16 respectively employed in the upper and lower sets 10 and 12 thereof preferably are disposed within vertical planes and are of the type which preferably have unitary and similar upper stress members 18 and lower stress members 20 which are continuous between the opposite ends thereof and are formed of suitable steel. These members are pressed or rolled in accordance with conventional practice from sheet steel material of appropriate gauge and width to form substantially U-shaped channels having lateral flanges 22 extending in opposite directions from the channels 24, said channels and flanges being integral.

In use, the upper and lower stress members 18 and 20 are spaced apart vertically in parallel relationship to each other and the same are interconnected by a zigzag configuration 26 formed from appropriate bar stock such as cylindrical rod material. The crests 28 preferably are connected to the exterior surfaces of the intermediate web or wall of the channels 24 of the upper and lower stress members 18 and 20 by weldments 30. Various types of end structures for each of the individual bar joists 14 and 16 may be employed in accordance with conventional arrangements pertaining to bar joists of this type.

It also is to be understood that the invention is not to be restricted to the use of the specifically illustrated channel-type upper and lower stress members 18 and 20 because other configurations are suitable and possible. However, particularly in view of the provision of the oppositely extending side flanges 22 of said stress members, they are particularly suited for adapting the present invention to the support of appropriate roof and/or floor panels 32 and ceiling panels or structures 34, as well as other items to be described hereinafter. Further, the upper stress members 18 are well suited to support suitable pedestals in spaced relationship to each other to support floor panels and/or stringers for floor panels, if desired, in a manner, for example, such as shown in U.S. Pat. No. 3,396,501, issued Aug. 13, 1968.

It also will be understood that the upper stress member 18 of each of the bar joists 14 and 16, at least in normal use, is a compression member, whereas the lower stress members 20 of each of said bar joists 14 and 16 under similar normal operating conditions is a tension member. Under such normal conditions of use, bar joists of the type referred to have been adopted widely in building structures of many types for supporting floor and roof means, particularly where it is not contemplated that concentrated loads of substantial magnitude shall be sustained thereby. Hence, the use of bar joists of this type is not recommended in building designs for use in installations where concentrated loads of appreciable magnitude are to be supported and only minimum normal flexing can be tolerated.

In accordance with the principles of the present invention, it has been found that by arranging upper and lower sets of bar joists 10 and 12, each comprising a plurality of transversely spaced and substantially parallel bar joists, in overlying crossover arrangement in such manner that the lower stress member of the upper set of bar joists rest upon and are rigidly connected to the upper stress members of the lower set of bar joists at each location whereby they cross over each other, such as by the use of weldments 36 which are best shown in FIGS. 4 and 5, a very rigid, composite reticulated composite panellike structure or system of bar joists is provided which is highly capable of sustaining concentrated loads of appreciable magnitude with minimum deflection of the entire system.

Due to such rigid connection of the two sets of joists at all crossover locations, a far more rigid structure is provided than if no such connection is employed. As a result, either lighter weight joists may be used to obtain the same or better rigidity

than comparably joists which are not connected or joists the same as such unconnected ones, when connected, afford far greater rigidity and load-sustaining ability with minimum flexing. Such rigid fabricated bar joist structure or system may be supported by any appropriate wall structure or otherwise. One example is illustrated in FIG. 1, wherein only the ends of the upper or lower sets of bar joists 10 and 12 are anchored relative to the walls or otherwise, where required, for support thereby. Otherwise, if desired, the ends of said bar joists may be disposed upon appropriate transverse support means of any required strength and configuration, including I-beams and the like, not shown in detail in the drawings.

Bar joist systems of the type illustrated herein and described above are especially appropriate for use in supporting, for example, floor panels 32 which, as shown especially in FIG. 6, are either square or of appropriate rectangular configuration, all of the panels preferably being of uniform size and the same also preferably being supported solely by a pair of opposite side edges thereof respectively engaging suitably spaced bar joists. Other arrangements are possible, however, such as by the use of relatively short and preferably vertically adjustable pedestals such as referred to above, especially where precise leveling of the floor panels is desired.

The floor panels are of rigid construction, certain details of which are illustrated in the upper portion of FIG. 2 wherein it will be seen that the opposite sides of the panels 32 respectively may be supported on said aforementioned pedestals, not shown, which may be positioned in spaced locations along the upper stress members 18, or said floor or roof panels may be supported directly upon the lateral flanges 22 of the illustrated upper stress member 18 of the upper bar joist 14.

The panels 32, for example, preferably are provided with peripheral sealing members 38 formed, for example, from material having limited compressibility such as certain forms of synthetic resins, rubber compounds and the like, whereby a substantially impervious seal may be arranged between the engaging side edges of adjoining panels for the useful purpose explained hereinafter. For further details of the structure of desired and preferred types of floor panels which are especially useful with the bar joist system comprising the present invention, attention is directed to U.S. Pat. No. 3,236,018 and U.S. Pat. No. 3,396,501. However, it is to be understood that other types of either floor panels as well as suitable types of roof structures may be supported by the uppermost set of bar joists 10 in systems of the general type illustrated in exemplary manner in FIG. 1.

In the preferred construction of a composite rigid bar joist structure or system embodying the principles of the invention, especially if the same is to support such rigid floor panels, for example, as described above, the transverse spacing of the lower set of bar joists 16 should be no greater than about twice the transverse spacing of the upper set of bar joists 14. Such arrangement affords adequate rigidity even when relatively lightweight bar joists are employed. This is due to the fact that the interconnection of the two sets of bar joists at all crossover locations or points causes a substantially pinpointed load of substantial magnitude imposed at one point upon one bar joist of the upper set to be distributed to and absorbed by all of the other joists of both upper and lower sets in the vicinity of the point where the load is applied, and through the assembly.

Further, it is obvious that if the transverse spacings of the joists of the lower set is less than twice the spacing of the upper set and especially if the transverse spacings of both the upper and lower sets is approximately equal, substantial increases in rigidity result without an abnormal increase in the overall dead weight of the entire system over one in which the lower set of joists are spaced transversely approximately twice as much as the upper set of joists. Solely for exemplary purposes, it is indicated that a popular size of floor panels of the type referred to above, in regard to which the joist system of the present invention is especially suited to support, is approximately 2 feet square. Accordingly, the upper set of bar joists 14 should be spaced transversely a distance of 2 feet, under

such circumstances, the joists 16 of the lower set preferably should be spaced transversely no more than about 4 feet. The spacing of the upper set should be governed by the width of the floor panels, for example, to be supported thereby. The lower set of joists is not so restricted as to spacing, however.

In regard to supporting a ceiling 34 from the lower stress members 20 of the lower bar joist 16, attention is directed to FIGS. 3 and 6 which it will be seen, especially from FIG. 3, that a suitable type of commercial stringer members may be arranged in transversely spaced parallel relationship to each other and all of them being transverse to the lower stress members 20 of the lower bar joist 16. They may be supported from the latter members 20 by means of any appropriate wire tie members 42, or other appropriate means. The stringer members 40, for example, may if desired be of the type to receive the support attaching flange means on opposite side edges of acoustical tile, not shown, or the same may be used to support prepared ceiling panels or the like of appropriate material and attached to the stringers 40 in any appropriate manner, depending upon the nature of such panels.

Another important advantage made possible by the composite type of bar joist system described hereinabove comprises the ready means for forming a plurality of superimposed plenum chambers respectively comprising upper plenum chamber 44 and lower plenum chamber 46 shown in exemplary manner in FIG. 1. It can be appreciated that these chambers respectively may be either of the same height or of different heights, if desired, depending upon the height selected for the individual bar joists 14 and 16 which respectively determine the vertical dimension of such plenum chambers. Although the upper and lower plenum chambers 44 and 46 have been illustrated in FIG. 1 as being substantially of equal height, it is to be understood the invention is not to be restricted to such an arrangement.

The plenum chambers are defined in part and are separated from each other by means of a plurality of exemplary impervious panels 48 which are sufficiently wide to extend between the rest for support upon the flanges 22 of the channels 24 of the lower stress member of the lowermost set of floor joists 12. Such panels are best illustrated in FIG. 2 but also are shown in FIGS. 1 and 6. Preferably, the panels 48 are formed from fireproof material such as being made of asbestos-cement composition or, if preferred, the same may be formed of appropriate sheets of metal such as galvanized sheet iron which is capable of resisting rusting satisfactorily.

Essentially, it is only necessary to rest the opposite edges of the panels 48 upon the flanges 22 of successive bar joists in a manner described above, whereby gravity will be adequate under certain conditions of operation to maintain the panels in operative position. However, particularly if the lower plenum chamber 46 is to contain air or gas under pressure, or the upper plenum chamber 44 is subjected to negative pressure, it is preferred that the supporting edges of the panels 48 be anchored appropriately to the flanges 22 by any suitable means such as cement, bolts, or the equivalent. The upper plenum chamber is defined at the top by a floor or roof means and the lower plenum chamber is defined at the top by a ceiling, for example.

Particularly from FIG. 1, it can be appreciated that the upper and lower plenum chambers 44 and 46, for example, are highly suited to be used respectively for the distribution of heated air in conjunction with providing a heating system for a building and with cooled and appropriately dehumidified air for use in conjunction with an air conditioning system for use in warm weather. Discharge may be through suitable discharge vents, not shown. The gaseous fluid such as heated or cooled air or the like respectively distributed through said plenum chambers will not intermix with each other, especially under certain conditions where, for example, it may be desirable or necessary to use both plenum chambers simultaneously for such desired purposes or for any purposes other than those specifically referred to above. Such simultaneous use readily can be undertaken without any appreciable interference in the

effectiveness of the respective purposes. However, under certain situations, it may be necessary to utilize panels 48 which are of a heat-insulating nature such as appropriate cellular-type material and the like, whereby heat transfer therethrough may be of a minimum amount.

The plenum chambers 44 and 48 are of a particularly effective nature in that the very substantial amount of open spaces between the upper and lower stress members 18 and 20 of each of the bar joists of the upper and lower sets 10 and 12 thereof comprise by far the vast majority of the space between each of the parallel and opposing upper and lower stress members 18 and 20. Accordingly, no appreciable interference with the movement or distribution of air or other gaseous fluids occurs within the plenum chamber while moving horizontally in any direction desired, thereby offering a vast improvement over the restricted movement now possible for similar purposes by means of conventional ducts installed beneath the floors or above the ceilings of existing building structures, or along spaces between parallel beams having imperforate vertical webs, for example, such as I-beams.

From the foregoing, therefore, it will be seen that the present invention provides two important and highly useful benefits over floor or roof and ceiling-supporting beam systems designed heretofore and now used in building structures. One of these comprises the highly rigid nature of the bar joist system of the present invention which is capable of withstanding concentrated loads of substantial magnitude imposed thereon, with minimum deflection, even though formed of relatively lightweight joists. Among other appropriate uses, and without restriction thereto, floors supported by said bar joist systems are particularly useful to support heavy equipment such as computer units and similar mechanisms now commonly in use.

Units of the type referred to which are supported by bar joist systems of the invention require extensive cables which, not infrequently, must be rearranged or extended from time-to-time and to accomplish this, the floor panels 32 must be in elevated position above a supporting structure so as to provide a space beneath the floor panels within which such cables may be arranged. Accordingly, the panels 32 are of such nature that they may readily be removed at intervals, as required, to effect any desired rearranging of the cables within the space therefor which, in accordance with the illustrations shown in the attached drawings will comprise, for example, the plenum chamber 44. Under ordinary circumstances, heavy equipment of the type referred to could not be appropriately supported by a single set of transversely spaced, parallel bar joists of the type illustrated and described herein because such a single set would not be capable of affording the rigidity required for the normal operation of mechanism of this type.

By employing the double set of bar joists described above which are respectively disposed in transverse relationship to each other, which is gridlike in plan view, and particularly by securely connecting the joists at the crossover portions of the respective sets thereof, fully adequate rigidity is provided for completely satisfactory use of equipment of the type referred to when supported thereon. Further, the upper plenum chamber 44, for example, or the lower chamber 46 if desired, provide adequate space in all horizontal directions within which to support the required cabling for purposes of furnishing power to the mechanism. If the cables are arranged in the lower chamber 46, however, the plenum-forming panels 48, or at least some of them, should be eliminated.

The second important benefit of the present invention is the provision of plenum chambers 44 and 46. It also will be understood, however, that in addition to carrying gaseous fluid, the plenum chambers 44 and 46 respectively afford space within which to accommodate various types of additional conduits and conductors such as plumbing, lighting circuit conduits, telephone conduits, compressed air and/or vacuum lines, and the like. In view of the ready accessibility to the spaces 44 and 46 and further in view of the lack of restriction to access within said spaces in any desired horizontal

direction, a wide latitude of use of said spaces for any of the aforementioned purposes, either singly or in combination, is possible.

While the invention has been described and illustrated in its several preferred embodiments, it should be understood that the invention is not to be limited to the precise details herein illustrated and described since the same may be carried out in other ways falling within the scope of the invention as described and illustrated.

We claim:

1. A rigid composite lightweight bar joist structure supported horizontally by spaced supports to support floor and ceiling structures and the like and loads thereon and comprising in combination, a set of substantially parallel bar joists arranged in even transversely spaced relationship, another set of substantially parallel joists similar to said first-mentioned set arranged in even transversely spaced relationship to each other, said joists of both sets each having continuous upper and lower stress members and said sets being substantially vertical and respectively positioned transversely in crossover juxtapositioned overlapping relationship to each other to provide an assembly of upper and lower joists, the lower stress members of the upper set of joists being rigidly connected to the upper stress members of the lower set at all crossover overlapping portions of said sets of joists by weldments to provide a rigid reticulated bar joist system which is gridlike in plan view and capable of supporting concentrated loads of substantial magnitude with minimum deflection in comparison with

the dead weight of the bar joist structure, the spacing of the joists in the lower set being substantially no greater than twice the spacing of the joists in the upper set, at least the lower stress members of the upper set of joists having horizontal flanges extending longitudinally along opposite sides thereof and outwardly therefrom in opposite directions, and then rigid panels of impervious material extending horizontally between and resting by gravity upon the flanges of adjacent pairs of lower stress members of said upper set of joists for sole support thereby to form separate plenum chambers above and below said sheets of material.

2. The rigid bar joist structure according to claim 1 in which said bar joists are provided with parallel upper and lower lateral flange surfaces respectively formed on both the upper and lower stress members of both sets of joists and said surfaces on said crossover overlapping portions of said joists flatly abutting each other and being integrally connected by said weldments, and said connecting weldments being applied to the edges of said flange surfaces at said overlapping portions of said stress members which abut each other in crossover relationship.

3. The rigid composite beam structure according to claim 1 in which said impervious panels are formed from sheetlike fireproof material and the lower stress members of said lower set of joists having ceiling-supporting stringers connected thereto to provide a lower plenum chamber below said rigid panels when a ceiling is connected to said stringers.

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