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[54] **MONOLITHIC STRUCTURAL MEMBER AND SYSTEMS THEREFOR**

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Related U.S. Application Data

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[52] **U.S. Cl.** **52/265,** 52/309, 52/380

[51] **Int. Cl.** **E04c 1/00,** E04b 1/16

[58] **Field of Search** 52/274, 264, 265, 52/309, 144, 220, 221, 615, 380, 414

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[57] **ABSTRACT**

A structural member suitable for diverse applications including foundation and ceiling systems comprises a lightweight, monolithic body particularly strong in compression and preferably composed of a synthetic resin that may be readily shaped by vacuum forming, expansion molding or other suitable techniques. Aligned rows of hollow, tapered support elements project from a uniform lattice and present spaced, load-supporting surfaces. In a foundation or ceiling system, the lattice is the base of the body and the load-supporting surfaces define the mounting centers for the overlying floor or roof. Accordingly, the base of the body presents a grid of surfaces on its underside at the mouths of the cavities formed by the hollow support elements. In a foundation system, the base grid directly overlies a pad of sand, silt or gravel chips to seal each individual cavity and thereby trap air therein to establish air pockets of resistance to load. A single chamber is formed beneath the overlying floor between the upstanding support elements to provide a network of intercommunicating mechanical chases which also serves as a duct for heating and air-conditioning. One embodiment of the member is specially shaped to spread a nonuniformly applied load throughout its body.

11 Claims, 8 Drawing Figures

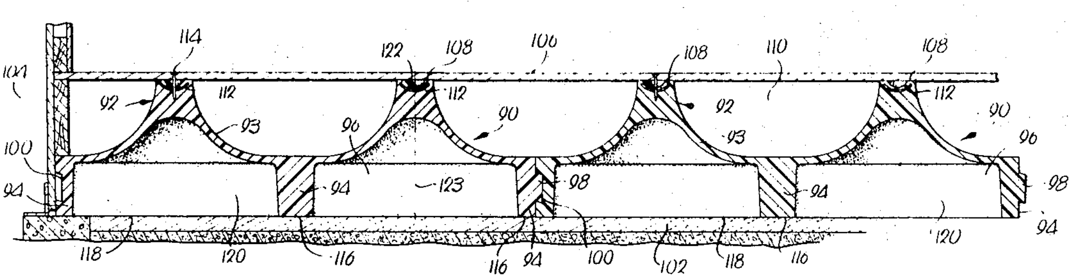


Fig.1.

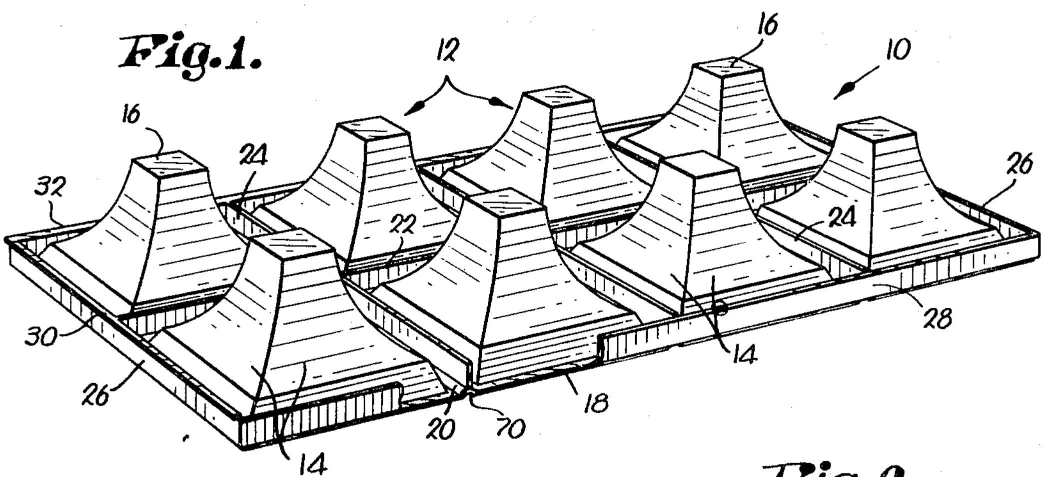
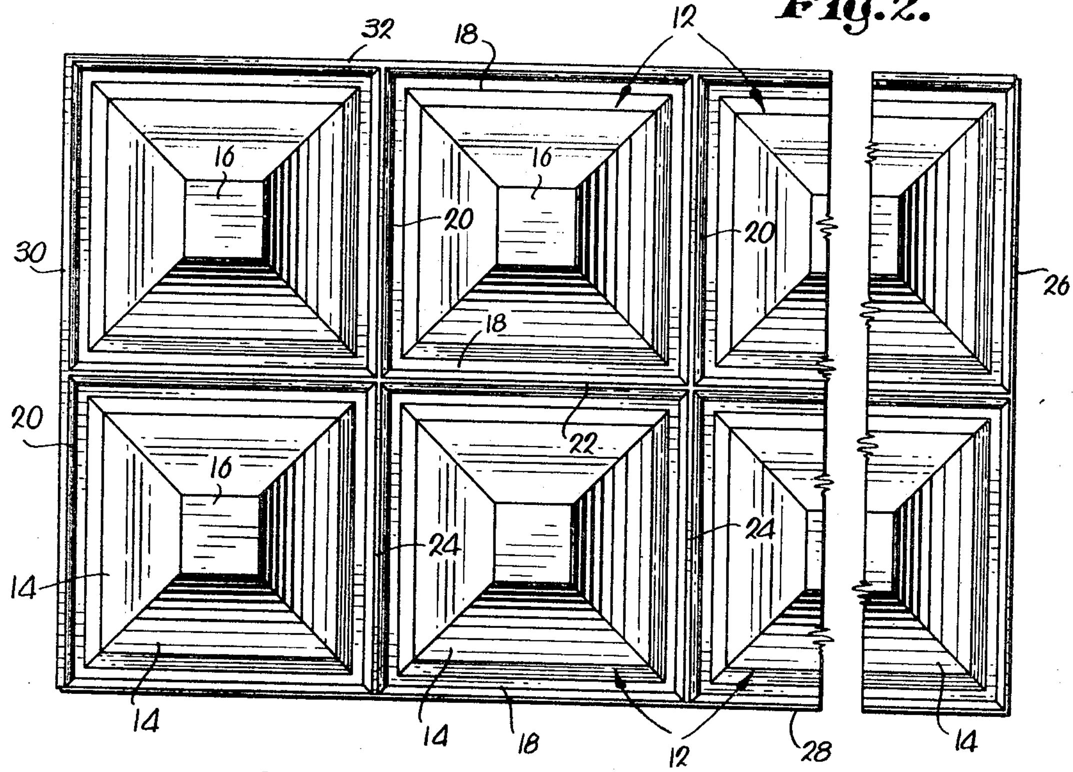


Fig.2.



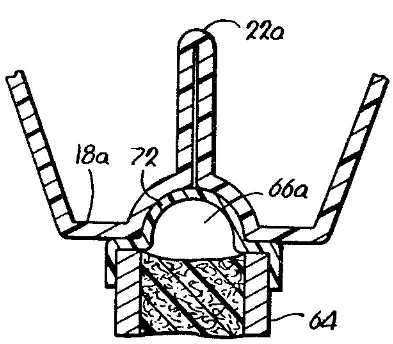


Fig.4.

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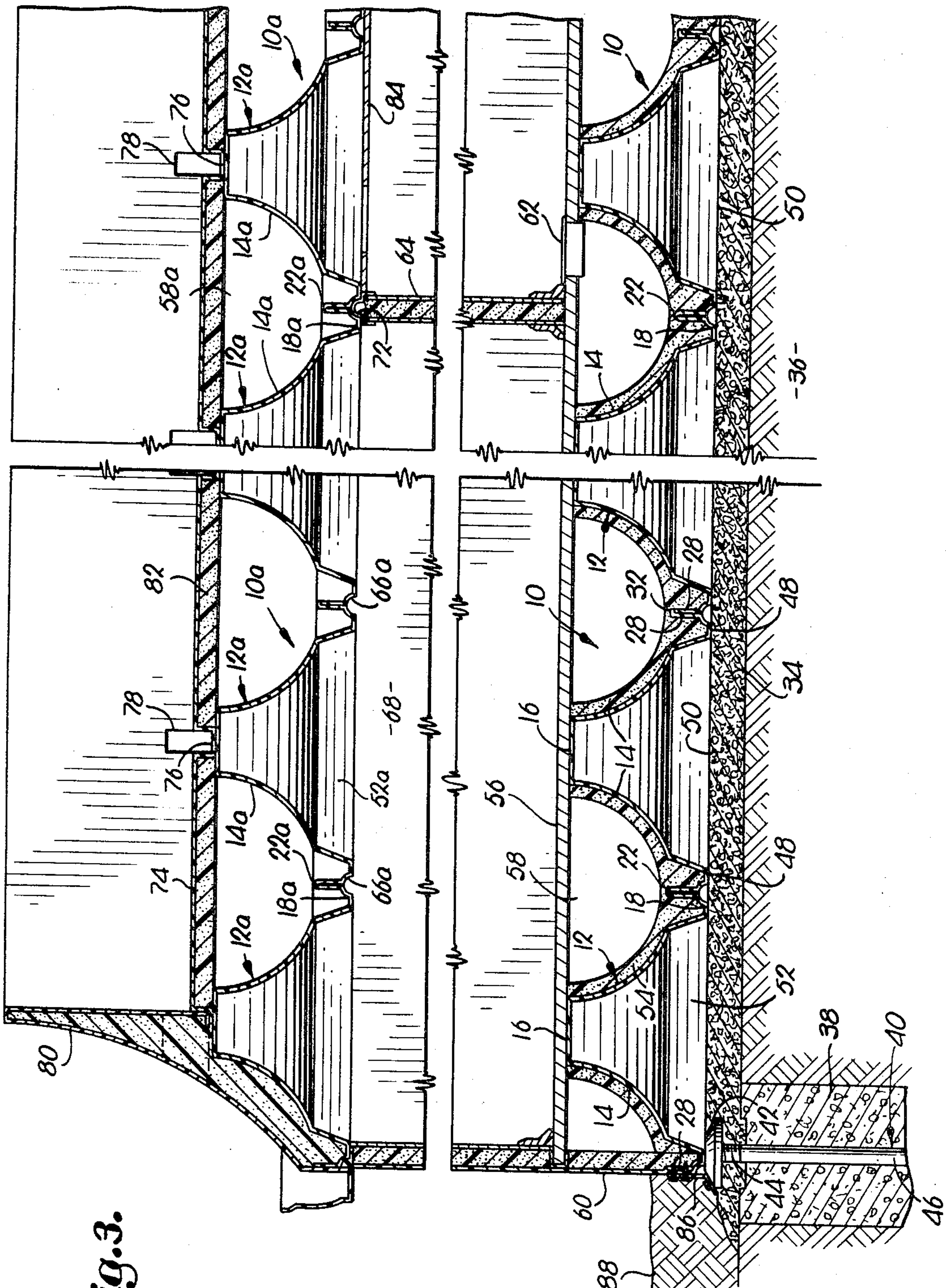

Fig.3.

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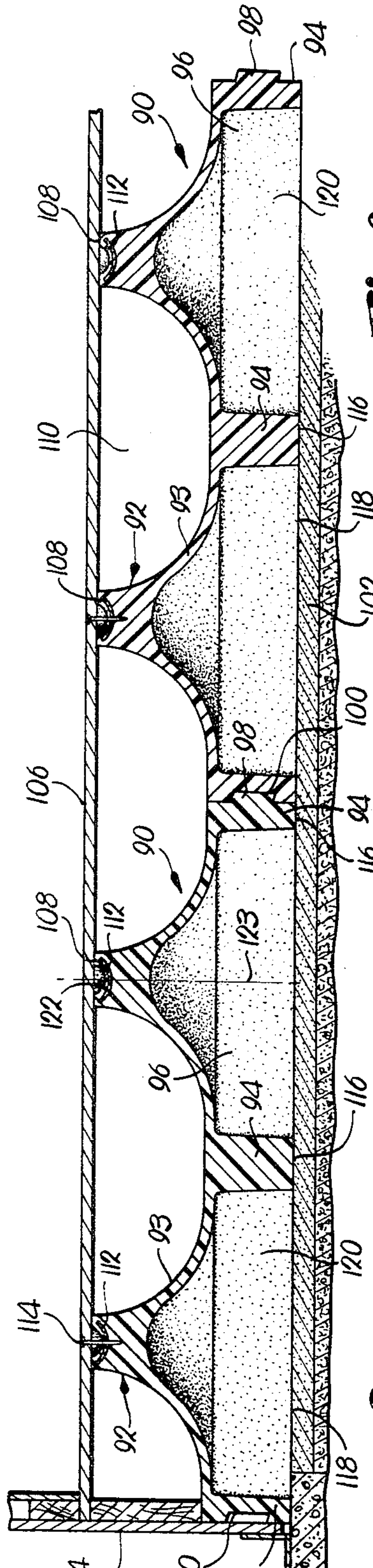

Fig. 6.

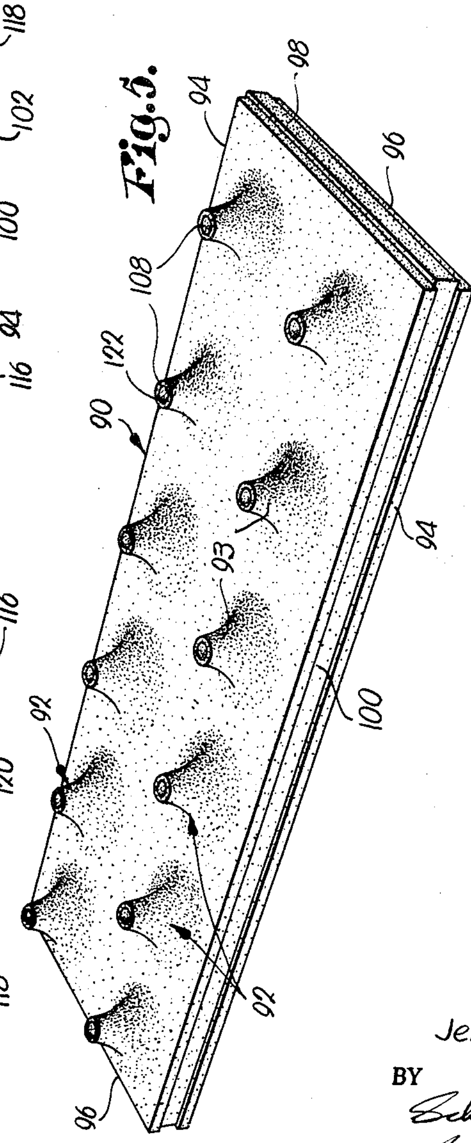

Fig. 5.

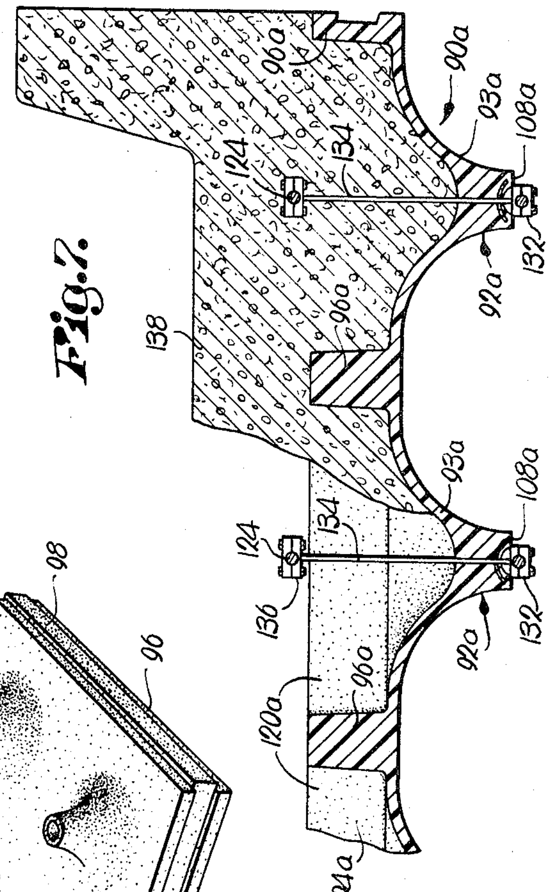

Fig. 7.

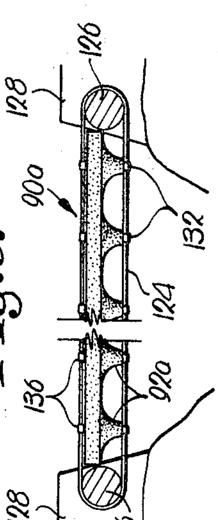

Fig. 8.

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MONOLITHIC STRUCTURAL MEMBER AND SYSTEMS THEREFOR

CROSS-REFERENCES

This application is a continuation in part of my copending application, Ser. No. 861,009, filed Sept. 25, 1969.

This invention relates to structural systems for facilitating the rapid construction of structural foundations and complete dwellings and buildings, and also to a monolithic structural member comprising the load-bearing component of foundation and ceiling systems and useful in other applications requiring structural members that are particularly resistant to compressive loads.

At the present time, it is common practice in the mobile home industry to utilize poured concrete foundations for mobile home installations, much in the same manner as for permanent dwellings. This necessarily requires that the site be excavated, forms set in place, and the concrete poured all at a substantial cost relative to the cost and often transitory nature of a mobile home. Furthermore, weather conditions and the availability of labor, as well as the actual time required to complete the job, place severe limitations on the speed at which such foundations can be constructed.

Furthermore, with the availability of housing becoming increasingly acute due to an insufficient number of housing starts relative to the rate of population expansion, it is imperative that structural systems be available for permanent dwellings and permanent building applications that both facilitate rapid construction and are relatively inexpensive. Certain steps have been taken in the past to alleviate the situation, such as module design and the use of prefabricated structural components wherever possible. However, still the basic design of most permanent structures in the housing field has not changed radically in centuries, and certainly not in proportion to technological advancement in the mechanical and electrical arts and materials technology.

It is, therefore, an important object of the present invention to provide structural systems capable of significantly deceasing the time required to erect a dwelling or building and at a reduced cost as compared with existing construction techniques.

Another important object of this invention is to provide a foundation system for a mobile home or permanent structure wherein excavation of the site is not required, nor the setting of forms or the driving of piles or other time consuming and expensive construction techniques, and yet which is fully capable of supporting the overlying load structure.

Still another important object of the invention is to provide a foundation system as aforesaid which allows excessive loading on unsubstantial soil and which may be utilized in the permafrost region or in marshy areas.

Still another important object is to provide a foundation system as aforesaid which establishes load-resisting air pockets to prevent settling.

Furthermore, it is an important object of this invention to provide a foundation system as aforesaid which provides a network of intercommunicating chases beneath the floor to facilitate rapid implacement of plumbing and electrical runs and carry warm or cool air to suitable registers in the structure without the need for elaborate and expensive ductwork.

Yet another important object of the invention is to provide a monolithic structural member for a foundation or ceiling system or the like which comprises a load-bearing component thereof and may be readily installed, and which is specially shaped for a number of purposes which will become clear as the detailed specification proceeds.

Still further, it is an important object of this invention to provide a monolithic, lightweight structural member which is capable of spreading a nonuniformly applied load throughout its body, thereby enabling the member to carry greater loads than would otherwise be possible.

Additionally, it is an important object of this invention to provide a monolithic, lightweight structural member useful in other systems requiring structural components having high resistance to compressive loads, such as in the building of bridges to eliminate the need for temporary scaffolding and provide a permanent casting bed that remains in place for protection against weather.

In the drawings:

FIG. 1 is a perspective view of one form of the structural member of the invention;

FIG. 2 is an enlarged top plan view of the member of FIG. 1;

FIG. 3 is a fragmentary, vertical sectional view of a home, apartment or similar structure embodying the concepts of the present invention, showing the member of FIG. 1 in foundation and ceiling systems;

FIG. 4 is a greatly enlarged, detail view showing the intersection of the interior wall and one of the ceiling members illustrated in FIG. 3;

FIG. 5 is a perspective view of a second form of the structural member;

FIG. 6 is a fragmentary, vertical sectional view of a home, apartment or similar structure and shows the member of FIG. 5 in a foundation system;

FIG. 7 is a fragmentary, vertical sectional view showing the member of FIG. 5 utilized in a structural system for bridges; and

FIG. 8 is a diagrammatic view showing the system of FIG. 7 in a complete span.

FIGS. 1–4

Referring initially to FIGS. 1 and 2, one form of the structural member of the present invention is broadly denoted **10** and comprises a monolithic body of formed sheet material. The member **10** illustrated in FIGS. 1 and 2 is of rectangular configuration and is provided with two rows of four hallow, raised, tapered elements **12**, each of the elements **12** being of quadrilateral, generally frusto-pyramidal configuration. The four sidewalls **14** of each element **12** thus converge toward the flat top of the element, and have major concave portions which are arcuate in the direction of the taper. If it were not for the presence of the arcuate portions of the sidewalls **14**, each of the elements **12** would comprise a frustum of a right, regular, quadrilateral pyramid. Accordingly, the bases of the elements **12** are square, and a square, load-supporting surface **16** is presented by the flat top of each of the elements **12**. It should be noted that the perimeter and area of each surface **16** is small relative to the base area of the element **12**.

As is especially evident in FIG. 2, the elements **12** are regularly spaced in each row and with respect to elements of an adjacent row, thus the center-to-center spacing of the top surfaces **16** is uniform throughout. It may also be appreciated in FIG. **2** that the member **10**, when viewed in plan, appears as a uniform grid enclosing the individual elements **12**. The grid is formed by longitudinal base portions **18** and intersecting, orthogonal, transverse base portions **20**. in the embodiment illustrated where two rows of four elements **12** are utilized, there are three such longitudinal base portions **18**, two at the longitudinal edges of the member **10** and one presenting a longitudinally extending central strip between the two rows of elements **12**. Accordingly, the base grid is completed by five transverse base portions **20**, two at the ends of the member **20** and three crossing the rows of elements **12** between adjacent pairs of elements. For purposes of reinforcement, a center, longitudinal rib **22** projects upwardly and extends the length of the center longitudinal base portion **18**, and transverse ribs **24** project upwardly from the inside base portions **20** and extend the length thereof.

The ends of the rectangular member **10** are provided with upstanding, continuous end portions **26** which merge with upstanding, continuous longitudinal edge portions **28**, thereby reinforcing the entire periphery of member **10**. One of the end portions **26** is provided with a continuous, laterally projecting lip **30**, and one of the longitudinal edge portions **28** is provided with a similar continuous lip **32** which is integral with the lip **30** at the common corner.

In FIG. **3** the member **10** is employed as the compressive load-bearing component of a foundation system and is shown in vertical cross section. The section is taken transversely of the member **10** in a central plane through the elements **12**. As illustrated, several members **10** are disposed in side-by-side relationship with adjacent edge portions **28** abutting each other such that the lip **32** overlaps the edge portion **28** of the adjacent member **10** to interlock the side-by-side members. The members **10** are preferably vacuum formed from a structurally strong thermoplastic synthetic resin material. Possible alternatives include fiber glass reinforced synthetic resins and galvanized sheet steel. A thermoplastic that can be readily vacuum formed or blow molded is preferable from the standpoints of cost and ease of fabrication and, in foundation systems, synthetic resins are particularly desirable due to their resistance to the effects of moisture, acids and fungus and extreme variations in ambient temperature. Plastic sheet members **10** are readily joined to provide a monolithic composite unit by the use of a solvent or other suitable adhesive techniques at the abutting edge portions **28**.

The foundation members **10** in FIG. **3** rest directly on a pad **34** comprising a layer of sand, silt, or gravel chips of a fine grade such as used as asphaltic topping for highways. The earth **36** underlying the pad **34** is graded to at least a rough grade (not more than approximately 5 percent) before the pad **34** is laid thereover. A concrete pier **38** is shown underlying one corner of one of the members **10**, a tubular leveler **40** being set in the concrete pier **38** and provided with an adjustable head **42**. As illustrated, the head **42** is provided with a depending, threaded shank **44** which is threadably received within the embeded tube **46** of the leveler **40**. The longitudinal base portions **18** of the members **10** are shown in cross section in FIG. **3** and present longitudinally extending, lower surfaces **48** in direct contact with the pad **34**. Furthermore, the transverse base portions **20** present elongated, transversely extending, lower surfaces **50** which lie in a common plane with the surfaces **48** and thus also directly contact the pad **34**. The undersurface network thus formed comprises a grid of intersecting surfaces **48, 50** that cooperates with the substance of the pad **34** to seal each of the downwardly facing cavities **52** defined by the individual elements **12**. The mouth of each cavity **52** is completely circumscribed by segments of the base grid surfaces **48, 50**, thus each of the cavities **52** is individually sealed to form an air pocket therewithin that is isolated from adjacent cavities **52** and from the ambient atmosphere.

The top side of the base portions **18** and **20**, together with the surfaces of the sidewalls **14**, are covered with a layer of insulation **54**, such as a polyurethane foam. A subfloor **56** spans the load-supporting surfaces **16** of the elements **12** and is secured thereto by a suitable adhesive, it being appreciated that a single chamber **58** is thereby formed beneath the subfloor **56** between the spaced elements **12**. This chamber **58** is closed at its sides as illustrated by the provision of an outer wall **60** secured to the outside edge portion **28** and extending upwardly therefrom to the subfloor **56**. Therefore, the chamber **58** comprises a network of wide, unobstructed, intercommunicating chases or channels extending in a grid pattern between the upstanding elements **12**.

A floor register is illustrated at **62** communicating with the underlying chase of chamber **58**, and forms a part of the heating and air-conditioning system (not shown) of the structure.

An interior wall **64** and the outer wall **60** extend upwardly to a ceiling and roof system utilizing structural members **10*a*** identical in form and configuration to the members **10** previously described. It should be noted that the longitudinal base portions **18*a*** of the members **10*a*** ae configured to present raceways **66*a*** of semi-cylindrical configuration, such raceways **66*a*** facing downwardly and communicating with the interior space **68** between the floor and ceiling of the structure. In FIG. **1**, it may be seen that a raceway **70** is similarly formed in the transverse base portions **20**, but these are not visible in FIG. **3**. Although not normally utilized in the foundation system, the raceways are advantageously employed in the ceiling system as illustrated in FIG. **3**, the upper edge of the wall **64** being received within one of the raceways **66*a***. This is shown in detail in FIG. **4** where it may be seen that the upper edge of the wall **64** is provided with a track insert **72** that is complementally received within the raceway **66*a***.

A roof skin **74** spans the top surfaces **16*a*** of the ceiling members **10*a*** and is formed with drainage gutters **76** communicating with openings **78** in decorative roof facia **80** that surrounds the roof skin **74**. Layers of insulation **82** underlie the skin **74** between the gutters **76**, thus forming a simple and efficient roof arrangement supported by the members **10*a***. The downwardly facing cavities **52*a*** formed by the upstanding elements **12*a*** may be left open for a decorative ceiling effect, or closed by ceiling tile or the like as illustrated at **84**. Whether open or closed, the cavities **52*a*** conveniently provide for the recessed mounting of lighting fixtures, and the sidewalls **14*a*** may be apertured at such fixtures to provide ventilation necessary for heat dissipation. As in the foundation system, the single chamber **58*a*** provides a network of intercommunicating chases for electrical and mechanical runs and return air flow (or supply, as the case may be) in the heating and air-conditioning system.

The structure illustrated in FIG. 3 may be rapidly erected, primarily due to the use of the monolithic members **10** and **10***a* as the load-bearing components of the foundation and ceiling systems. At the outset, the site is graded as discussed above and the piers and levelers **38** and **40** are emplaced at the four corners of each foundation member **10.** The piers do not serve a load-supporting function, but are utilized in conjunction with the levelers **40** to assure that the members **10** are level and to anchor such members to the ground as a safeguard against possible shifting under high winds. Leveling is accomplished by adjusting the head **42** of each leveler **40,** a suitable bracket and fasterners as indicated at **86** being utilized to secure the member **10** and associated wall **60** to the head **42** once the proper level attitude is obtained. As indicated at **88,** the perimeter grade around the structure can be raised to hide the head **42** and bracket **46** from view.

When the compressive load of the overlying structure is ultimately applied to the foundation members **10,** the load is distributed by the grid of intersecting undersurfaces **48, 50** to prevent the members **10** from sinking any significant distance into the pad **34.** Furthermore, air pockets of resistance to load are formed by the sealing of the individual cavities **52** at the interface of the undersurface network and the pad **34.**

The load-supporting surfaces **16** presented by the square tops of the elements **12** lie in a common plane parallel to the above-mentioned interface. The center-to-center spacing of the surfaces **16** is only slightly larger than the maximum width between the elements **12** of the chases formed by the chamber **58.** Therefore, with the relatively small area of the surfaces **16,** the chamber **58** is available beneath the floor **56** except at areas directly around the mounting centers presented by the surfaces **16.** This renders it possible to communicate through the floor **56** to an underlying chase without special attention to the location of floor joists or other interfering structure. This is important not only for mechanical and electrical runs, but also for convenience in locating registers such as illustrated at **62.** Since the entire chamber **58** becomes a warm or cool air duct, the registers for the heating and air-conditioning system may be located virtually wherever desired without regard to cost or pressure loss considerations. Furthermore, an added feature of this arrangement is that the floor remains at a constant temperature selected by the inhabitant. Possible freezing of water lines in winter is positively prevented since plumbing runs will, of course, lie in the chases in the heated air environment.

Due to the structural footing spread provided by the base grid, excessive loading of the members **10** is possible on the unsubstantial soil such as fill, sand, tundra, and ground of bog type consistency. Furthermore, as discussed above, the air pockets formed within each of the cavities **52** contribute to the load resistance of the members **10** and, in particular, provide resistance to settling when moist conditions are present in the underlying earth **36.**

Fabrication of the structure above the foundation system is facilitated by the monolithic ceiling members **10***a* and the raceways provided for the convenient and rapid installation of interior walls, such as illustrated with respect to the wall **64** (FIG. **4**). The interior wall **64** is of a sandwich construction and utilizes a foam core faced with paneling. This same general construction is employed for the outer wall **60,** except that a weather resistant substance would be utilized for the outer skin, such as a sheet of suitable synthetic resin material. The same general constructional approach is utilized for the roof in that, here again, plastic sheet material is advantageously employed for the roof skin **74.** However, it should be understood that the members **10** and **10***a* may be employed with conventional wall and roof designs as well as the preformed wall and roof panels illustrated, in order to also realize a cost advantage and a material increase in the speed and ease of construction.

FIGS. 5 AND 6

The second form of the structural member of the present invention is broadly denoted **90** and is shown from above in perspective in FIG. **5.** In FIG. **6,** two members **90** are shown in transverse cross section in a foundation system. Rather than being formed of sheet material as in the first embodiment described hereinabove, the member **90** is a monolithic body of structurally strong, rigid, light density synthetic resin foam material, such as polyurethane foam having a free rise core density of 5.5 pounds per cubic foot. This provides a structural member that is lightweight yet particularly stong in compression. It may be noted that the overall configuration of the member **90** is similar to the previous embodiment in that two rows of hollow, raised, tapered elements **92** are provided projecting upwardly from a base lattice that presents a uniform grid, but the elements **92** are of generally frusto-conical shape rather than frusto-pyramidal.

Each element **92** has a continuous, concave sidewall **92** which is arcuate in the direction of taper of the element **92.** The bottoms of the sidewalls **93** merge with components of the lattice comprising longitudinal base portions **94** and intersecting, orthogonal, transverse base portions **96.** In the member **90** illustrated herein having two rows of six elements **92,** it is to be understood that there are three longitudinal base portions **94** (one at each longitudinal edge and the third extending longitudinally between the two rows) and seven transverse base portions **96,** two of which are at the opposed ends of the member **90.** The other five transverse base portions **96** cross the rows of elements **92** between adjacent pairs of elements, thereby providing a complete and uniform base grid. One of the end base portions **96** and one of the longitudinal edge portions **94** are provided with a tongue **98.** The opposite end portion **96** and longitudinal edge portion **94** have a groove **100** therein; accordingly, adjacent members **90** are interlocked by a tongue and groove connection as illustrated in FIG. **6.** The tongues **98** project downwardly at an angle of about 15°, and the grooves **100** are configured to mate therewith to prevent horizontal separation of the members **90.**

In FIG. **6** it may be seen that the members **90** rest directly on a double layer pad **102** of sand overlying gravel, similar to the single layer pad **34** previously discussed with respect to FIG. **3.** THe foundation system illustrated in FIG. **6** embodies the same concepts and teachings as the system shown in FIG. **3** except for the differences in the members **90.** An outer wall **104** closes the foundation, and a subfloor **106** spans the load-supporting surfaces **108** of the elements **92.** Accordingly, a single chamber 110 is formed beneath the subfloor 106 between the spaced elements 92 and, as in the previous embodiment, comprises a network of wide, unobstructed, intercommunicating chases or channels extending in a grid pattern between the upstanding elements 92. A dish-shaped steel anchor 112 may advantagesously be embeded in each of the elements 92 just beneath the surface 108 to serve as a fastener for screws or nails 114 used to secure the subfloor 106 to the elements 92.

The longitudinal base portions 94 of the members 90 present longitudinally extending, lower surfaces 116 in direct contact with the pad 102, while the transverse base portions 96 present elongated, transversely extending, lower surfaces 118 which lie in a common plane with the surfaces 116 and thus also directly contact the pad 102. Accordingly, an undersurface network is formed comprising a grid of intersecting surfaces 116, 118 that cooperates with the substance of the pad to seal each of the downwardly facing cavities 120 defined by the individual elements 92 and their surrounding base portions. As in the previous embodiment, the mouth of each cavity 120 is completely circumscribed by segments of the base grid surfaces 116, 118, thus each of the cavities 120 is individually sealed to form an air pocket therewithin that is isolated from each of the cavities 120 and from the ambient atmosphere.

The supporting surfaces 108 of the elements 92 present mounting centers for supporting the overlying load structure. It may be appreciated that each of the elements 92 has a flat top provided with a central recess 122, thus the surface 108 presented thereby is of annular configuration. One purpose of the recess 122 is to further reduce the area of the surface 108 to facilitate uniform contact with the overlying subfloor 106 or other load structure. Another purpose is to impart the annular configuration to surface 108 so that an applied load will be uniformly distributed throughout the sidewall 93. All other aspects of the surfaces 108, such as their location in a common plane parallel to the interface of the network of surfaces 116, 118 and the pad 102, and the small perimeter and area of each relative to the area enclosed by the circumscribing base portion therebelow, are the same as discussed with respect to the surfaces 16 of the member 10 of FIGS. 1–4.

The members 90 are formed by expansion molding, i.e., activating the resin while confined in a mold having a mold cavity of the same shape as the finished member. In use, the members 90 are joined edge to edge and interlocked by the tongues 98 and grooves 100, a suitable solvent being employed at the joints to form a permanent seal. The composite unit thus formed functions in the same manner as the first embodiment of the invention set forth hereinabove in that air pockets of resistance to load are formed by the sealing of the cavities 120, and a network of wide, unobstructed, intercommunicating chases is provided for mechanical and electrical runs and air flow for heating and air conditioning. Furthermore, it should be understood that the embodiment of FIGS. 5 and 6, like the embodiment of FIGS. 1–4, is equally well adapted to ceiling systems and the like where a lightweight, compressively strong structural member is desired having the advantageous characteristics discussed hereinabove.

In addition to the common characteristics of the two embodiments of the structural member, the member 90 of FIGS. 5 and 6 has an important load bearing characteristic which enhances its ability to readily carry heavy loads even though the member 90 is relatively light in weight and contains the numerous voids presented by the cavities 120. It may be noted that the lattice components consisting of segments of the base portions 94 and 96 defining an individual square present a structural unit from which an individual element 92 projects. Viewing two adjacent elements 92 in cross section as in FIG. 6, it may be seen that the segment of base portion 94 is a common component of the two units, and that the sidewalls 93 of both elements 92 merge with this common component.

The sidewall 93 of each element 92 is arcuate in the direction of taper, and the merger of the sidewall 93 with the square structural unit is along tangents extending in the plane of the lattice. (It should be understood that the term "plane" of the lattice is used herein with recognition that the lattice is a three-dimensional structure, thus the term is intended to denote the two dimensions of major expanse of the lattice, e.g., the directions of horizontal expanse in the foundation system illustrated in FIG. 6.) The significance of this may be appreciated when it is considered that each of the square structural units circumscribes the axis of projection 123 of the corresponding element 92, such axis comprising the central axis of the element 92 which extends in the direction (vertical) that the element 92 projects away from the lattice. Accordingly, a force applied to the surface 108 of the element 92 by a load thereon is directed along the axis 123 and is transmitted by the sidewall 93 to the square structural unit which is in surrounding relationship to the axis 123. However, instead of vertically directed, the direction of the applied force is changed by the sidewall 93 to horizontal directions radiating from the axis 123. The net result of this action is that the force of a load applied to any of the elements 92 is directed into the plane of the lattice for transmission by the lattice components 94, 96 to lesser loaded regions of the monolithic body. Thus, the force of a load applied to one of the elements 92 is spread throughout the lesser loaded regions of the body, resulting in effective dissipation of an area of load concentration since the entire monolithic body is made available as a load bearing member. In this regard, the sidewalls 93 of elements 92 adjacent the heavily loaded element 92 also receive the load force as well as the lattice since all of the sidewalls 93 merge with the lattice components along tangents extending in the plane of the lattice, as is clear in FIG. 6 where it may be seen that adjacent sidewalls 93 form a continuous skin integral with the common component of the two respective structural units. Therefore, this skin is also available for dissipation of concentrated loads.

FIGS. 7 AND 8

Use of the member of FIGS. 5 and 6 in a structural system for a bridge is shown in FIGS. 7 and 8, where it may be seen that the member 90*a* is inverted with respect to the orientation of member 90 depicted in FIGS. 5 and 6. Accordingly, the elements 92*a* depend from the lattice of the member 90*a* formed by the intersecting, longitudinally and transversely extending lattice components 94*a* and 96*a* respectively. In FIG. 7, the member 90*a* is shown fragmentarily in longitudinal cross section, the member 90*a* extending transversely of the direction of the span of the bridge.

A number of endless members in the nature of high tension cables **124** are trained around cylinders **126** anchored in buttresses **128** on opposite banks of the river or stream bed **130** (FIG. **8**). The cables **124** are spaced along the cylinders **126** in the usual fashion, the upper stretches of the cables **124** extending above the member **90***a* (joined together to form a composite unit extending from bank to bank) while the lower stretches thereof extend beneath the members **90***a* and underlie the load-supporting surfaces **108***a* of the elements **92***a*. The surfaces **108***a* bear against clamps **132** on the cables **124** to which the lower ends of upright tie rods **134** are secured, each of the tie rods **134** extending centrally through a corresponding element **92***a* to a clamp **136** which affixes its other end to the upper stretch of cable **124**. Thus, the upper and lower stretches of the cables **124** are interconnected by the tie rods **134** with the lower end portions of the tie rods **134** being rigid with the corresponding elements 92a. Accordingly, the lower stretch of each of the cables **124** interconnects the elements **92***a* under which it passes in spanning relationship to their load-supporting surfaces **108***a*.

As is clear in FIG. **7**, the members **90***a* of the bridge span present a support bed for an overlying load structure, in this instance a casting bed for poured concrete **138** which forms the road surface and curb of the bridge. The casting bed is defined by the lattice and the upwardly facing cavities **120***a* of each of the members **90***a*, the concrete **138** being poured directly into the cavities **120***a* without the use of additional underlying forms. Once the concrete has set, the members **90***a* remain in place for protection against weather.

It may be appreciated that the structural system of FIGS. **7** and **8** eliminates the need for float supported scaffolding and temporary forms for the bridge floor, thereby greatly simplifying construction. Being strong in compression, the weight of the concrete **138** is readily borne, particularly since such weight is transmitted to the load-supporting surfaces **108***a* and then distributed by the sidewalls **93***a* of the elements **92***a* to the lattice **94***a*, **96***a*. Therefore, the inverted member **90***a* is as effective as the member **90** of FIGS. **5** and **6** in resisting compressive loads. Furthermore, tensile forces (tending to spread adjacent elements 92a spaced longitudinally of the span) are carried by the lower stretches of the cables **124** since the latter interconnect the elements 92a. Accordingly, the structural system resists both the compressive and tensile forces induced by the overlying load.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A structural member comprising:

a structurally strong, rigid, monolithic body having a lattice of integral, intersecting structural components capable of bearing a substantial load and presenting a plurality of closed structural units, and a plurality of spaced, discrete support elements projecting from corresponding units out of the plane of the lattice,

each of said units circumscribing the axis of projection of the corresponding element,

each of said elements presenting a load-supporting surface spaced from said lattice for receiving the force of an applied load directed generally axially of the element toward said lattice,

each of said elements being of circular cross-sectional configuration transversely of said axis from said load-supporting surface thereof to said lattice to thereby effect uniform distribution of said force to said unit, and having sidewall structure converging toward the load-supporting surface to present a tapered element configuration,

said sidewall structure of each element adjacent said lattice being arcuate in the direction of taper of the element and merging with the corresponding unit along tangents extending in directions radiating from said axis substantially in the plane of said lattice to transmit said force to the unit and to the sidewall structures of adjacent elements and change the direction of said force to said directions substantially in the plane of said lattice, whereby the force is dissipated throughout lesser loaded regions of the body.

2. The member as claimed in claim **1**,

said elements being arranged in aligned rows,

said lattice defining a grid, whereby said units are rectangular,

said sidewall structure of each element being of generally frusto-conical configuration, tapered toward the load-supporting surface,

said load-supporting surface of each element being annular and disposed to effect uniform distribution of said force thereon to said sidewall structure.

3. The member as claimed in claim **1**, said body being composed of a light density synthetic resin foam material.

4. In combination with the member as claimed in claim **1**,

a second member resistant to tensile load spanning said load-supporting surfaces and interconnecting said elements.

5. The combination as claimed in claim **4**,

said lattice being generally horizontally disposed,

said elements depending from said lattice,

said second member being in underlying engagement with said load-supporting surfaces.

6. The combination as claimed in claim **4**,

said lattice being generally horizontally disposed,

said elements depending from said lattice,

said units cooperating with said elements to define a plurality of upwardly facing cavities,

said second member being endless and having a lower stretch in underlying engagement with said load-supporting surfaces, and an upper stretch above said body; and

means extending through said cavities and tieing said stretches together at each of said elements.

7. The combination as claimed in claim **4**,

said lattice being generally horizontally disposed,

said elements depending from said lattice,

said units cooperating with said elements to define a plurality of upwardly facing cavities,

said lattice and said cavities presenting a bed; and

a load structure overlying said body and received within said bed.

8. The member as claimed in claim **1**,

said elements projecting from said lattice in one direction generally perpendicular to the plane of the lattice, and said components having substantial thickness and presenting a network of intersecting surfaces spaced from said tangents in the opposite direction, said units defining openings in the lattice presenting cavities extending therewithin having mouths defined by said intersecting surfaces.

9. The member as claimed in claim 8,

said elements providing a network of intercommunicating chases extending therebetween adjacent the side of the lattice opposite said network of intersecting surfaces; and

a load structure secured to said load-supporting surfaces of the elements and spanning said load-

supporting surfaces in nonobstructing relationship to said chases.

10. The member as claimed in claim 8,

said body being composed of a light density synthetic resin foam material.

11. The member as claimed in claim 10,

there being a continuous skin over the lattice presented by said sidewall structures and the portions of said components with which they merge.

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