Nov. 9, 1971 T. J. WATERS 3,618,277

HYPERBOLOID BUILDINGS

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FIG. 1.

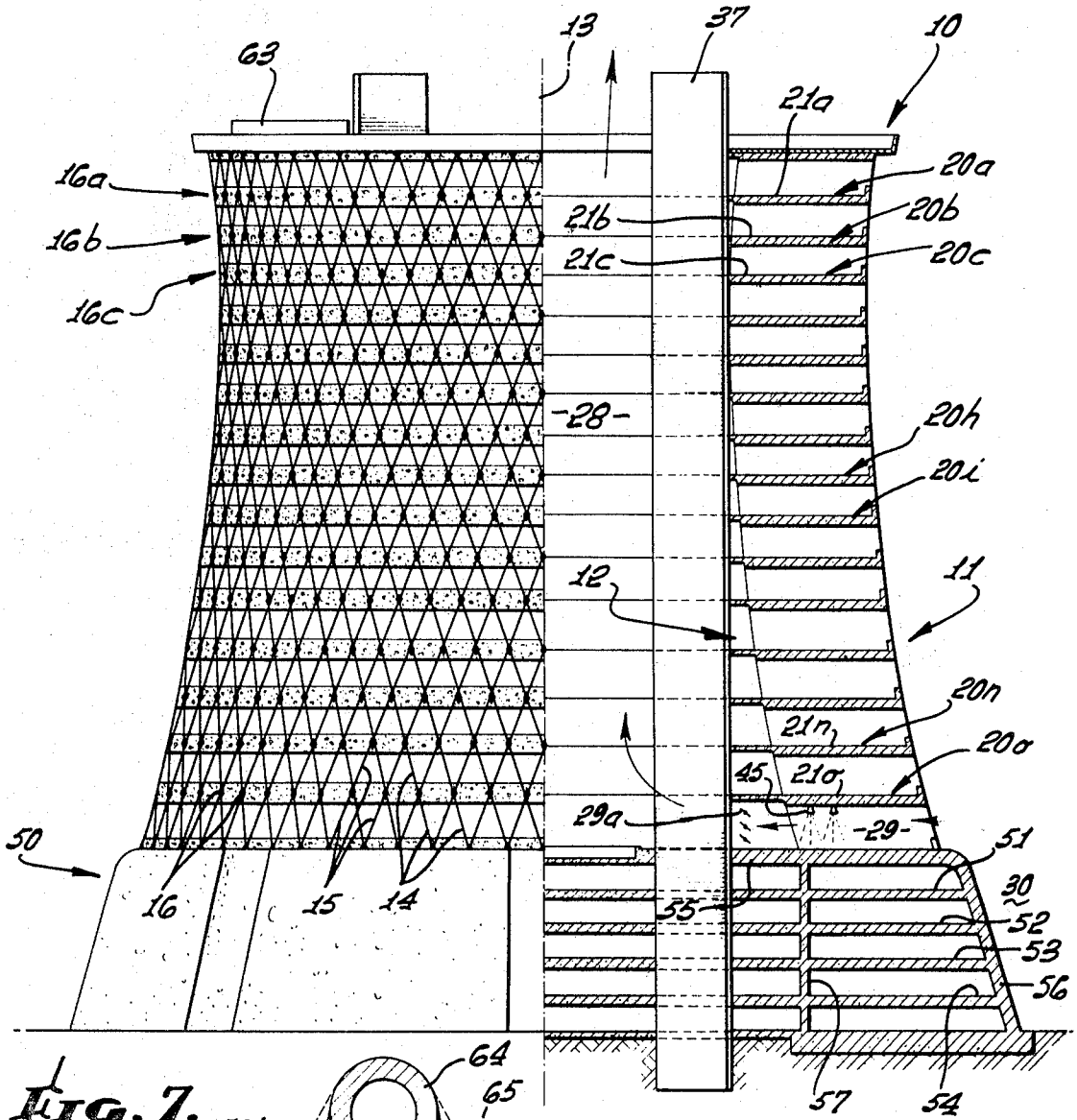
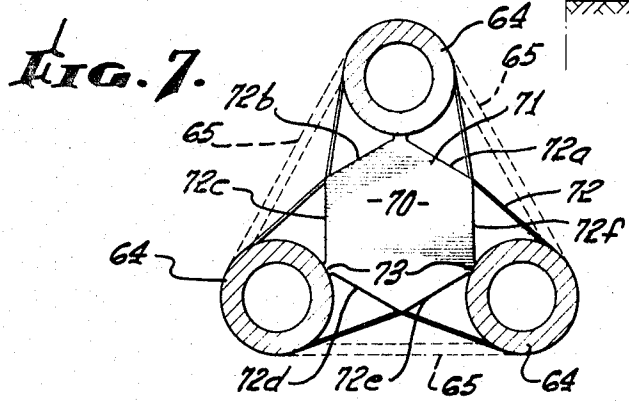


FIG. 7.



INVENTOR.
TERRANCE "J" WATERS
By White & Haefliger
ATTORNEYS.

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FIG. 2.

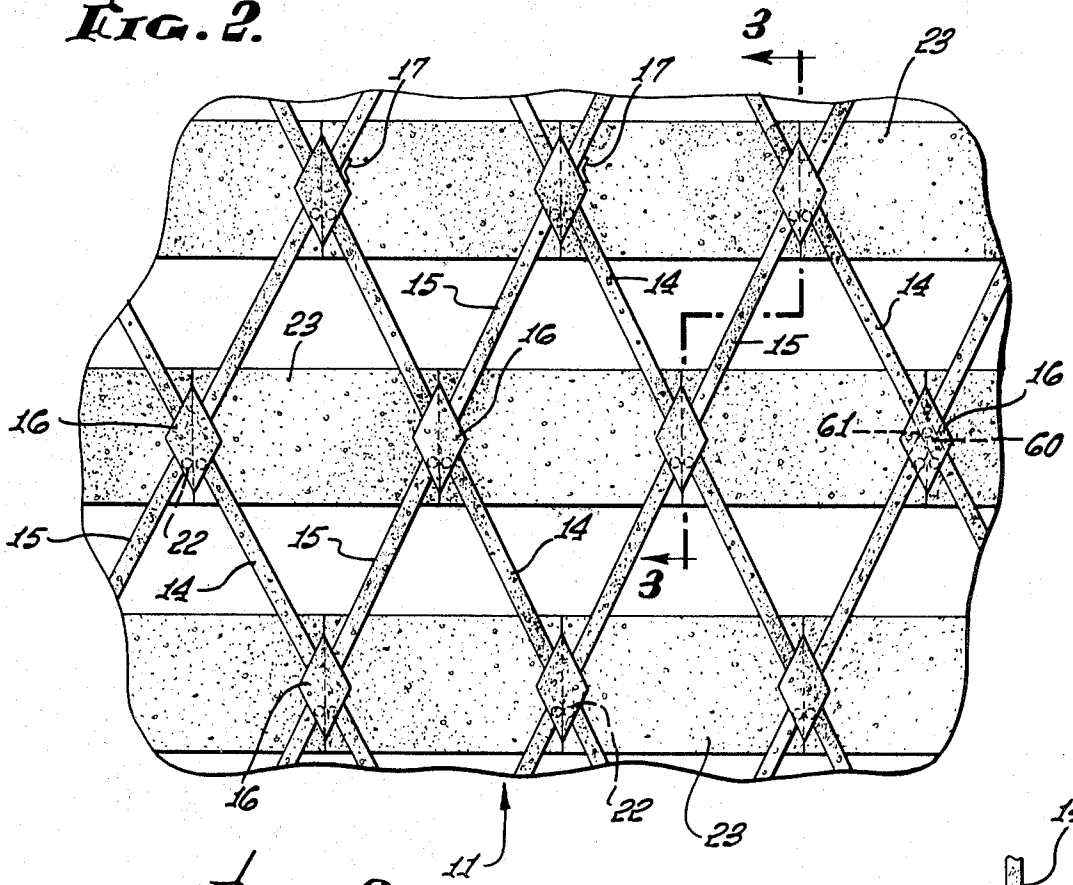


FIG. 3.

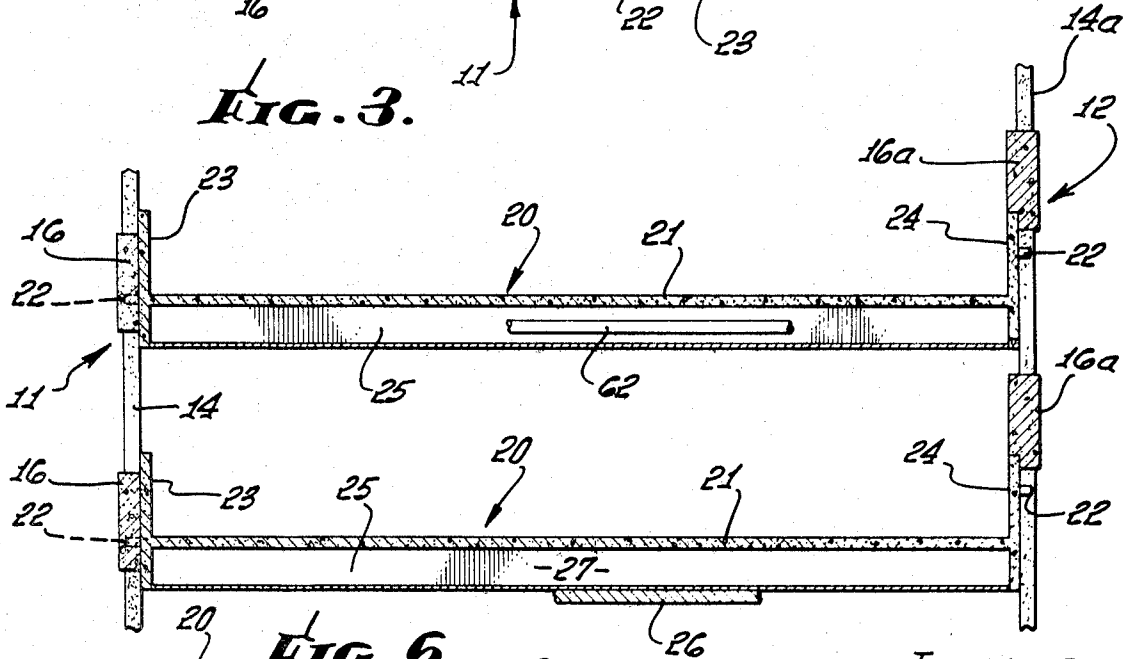
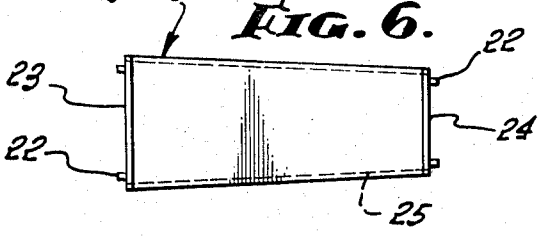


FIG. 6.



INVENTOR.
TERRANCE "J" WATERS
By White & Haefliger
ATTORNEYS.

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FIG. 4.

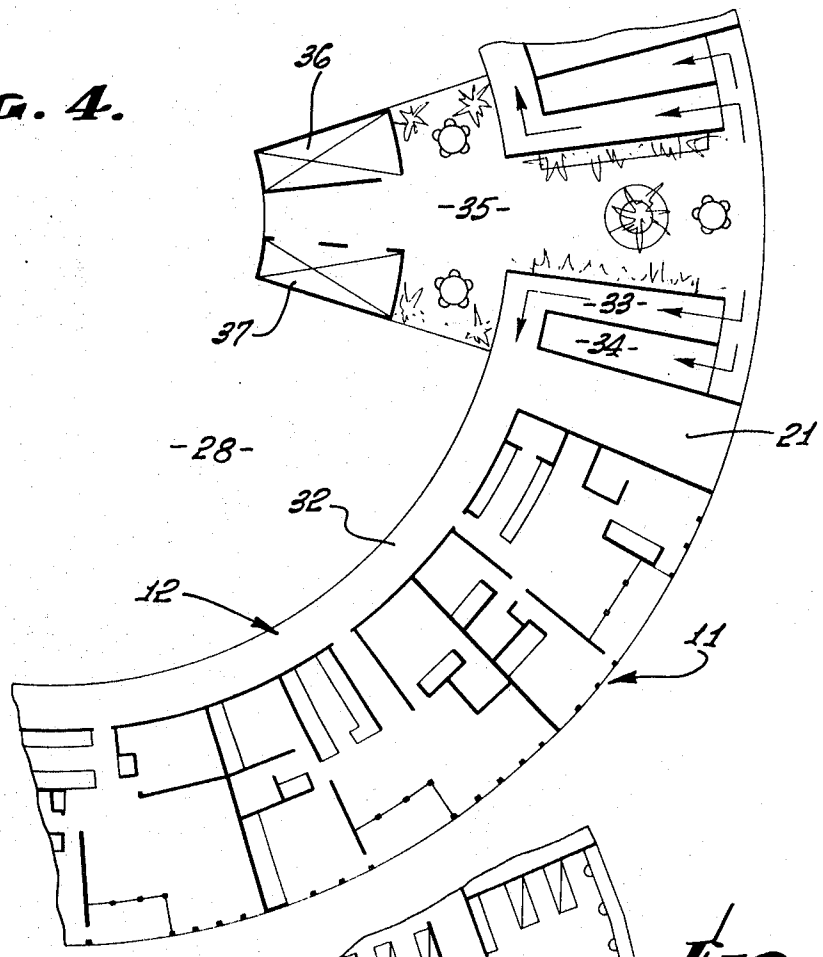
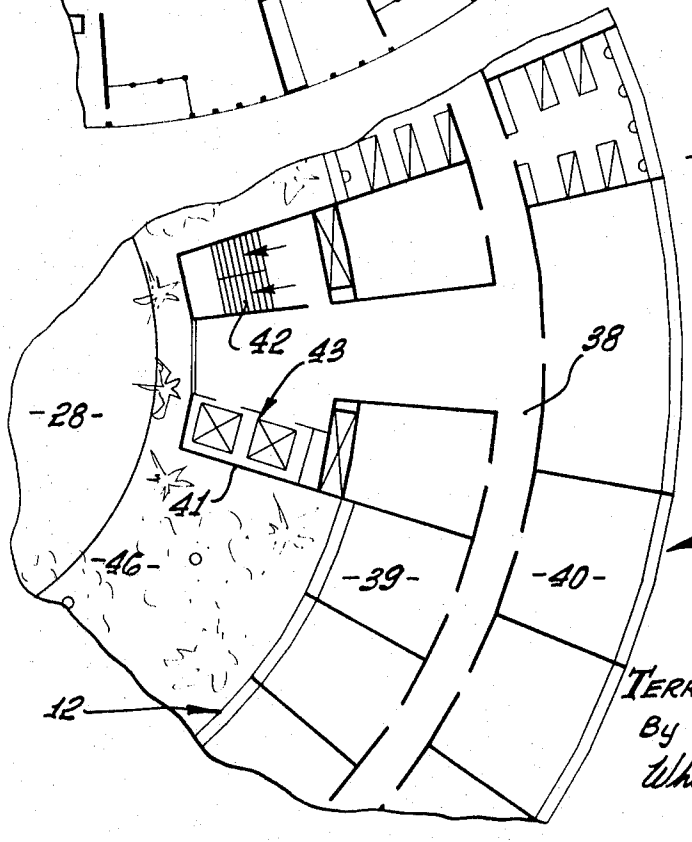


FIG. 5.



INVENTOR.
TERRANCE "J" WATERS
By
White & Haefliger
ATTORNEYS.

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HYPERBOLOID BUILDINGS

Terrance J. Waters, 33560 Mulholland Highway, Malibu, Calif. 90265

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Int. Cl. E04b 1/34

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ABSTRACT OF THE DISCLOSURE

A building comprises outer and inner frameworks having vertical axes which approximately coincide, the frameworks being spaced from one another and at least one is generally hyperboloidal; and modular means interconnects the frameworks at different elevations. No supporting columns are required, and the building is extremely stable and lends itself to extensive use of prefabricated structural elements.

BACKGROUND OF THE INVENTION

This invention relates generally to building design and more particularly concerns improvements in building supports, frameworks and beam design leading to substantial cost reduction and simplification in construction.

The high expense of conventional rectangular and circular cross-section buildings is in significant part due to the necessity for interior columns and walls required for building support and bracing. Also, present day construction methods are excessively time consuming and entail great expense due to conventional building design employing such interior columns and bracing. Accordingly, there is need for improved designs and methods of construction which will eliminate these disadvantages and take advantage of prefabrication techniques, in the area of building supports, frameworks and beam construction. Also, there is need for buildings that will lessen alienation, isolation and danger associated with apartment living.

SUMMARY OF THE INVENTION

It is a major object of the invention to provide a building construction employing the hyperboloid in a manner such as will significantly reduce the time and cost of building construction, and result in a stronger and more stable structure having many advantages, as will appear.

Basically, the invention is embodied in the combination comprising outer and inner generally annular frameworks having vertical axes which approximately coincide, the major extents of the frameworks being spaced from one another and at least one being generally hyperboloidal and means (as for example modules) interconnecting the frameworks at different elevations. As will be seen, both frameworks may advantageously be hyperboloidal, each with linearly elongated support members (typically concrete members) extending downwardly and laterally along hyperboloidal directrices, and in opposite directions about the framework axes; and framework ties may interconnect the members at loci proximate directrix intersections, the framework interconnecting means being attached to certain of the ties and providing generally annular building floors at different elevations.

As a result, the structure is simple yet extremely strong, all structural loads (whether live or dead loads) traveling in straight lines along the directrix oriented support members in compression, even though such lines are not vertical. Accordingly, the structure braces itself and needs no other bracing walls, shear walls or shear connections into vertical columns; also, there are no supporting columns required in the structure. Further, the annular floors are stable, loading being transferred around the structure for absorption by the mass of the structure and downward

travel along the directrix-oriented support members to eliminate any tendency for building rotation. It should also be noted that since the hyperbolically curved structure may be constructed using only straight support members as described, great savings are possible through prefabrication of all the component parts of the building.

Additional objects of the invention include the provision of a central vertical hollow within the building interior, the hollow for example being vertically open to provide natural draft upward air flow for low pressure inducement of cooling air laterally through apartments whose inner and outer windows are open; the provision of floor spacings which vary in height depending upon their locations within the building; the provision for radiant heating by heat transfer from ceiling piping, the latter being heated by liquid to which heat has been transferred by solar heating at the building top; the provision of ramps interconnecting the annular floors, and elevators located within shafts in the central hollow as referred to; and the provision of multiple buildings as described, interconnected by tunnels or bridges.

These and other objects and advantages of the invention, as well as the details of illustrative embodiments, will be more fully understood from the following description and drawings, in which:

DRAWING DESCRIPTION

FIG. 1 is an elevation showing the exterior and interior construction of a building incorporating the invention;

FIG. 2 is an enlarged fragmentary elevation of an exterior portion of the FIG. 1 building;

FIG. 3 is a section taken on line 3—3 of FIG. 2;

FIG. 4 is a plan view of a representative floor section in the FIG. 1 building;

FIG. 5 is a plan view like FIG. 4, but showing a modified floor section;

FIG. 6 is a plan view of a typical beam; and

FIG. 7 is a plan view of a building cluster.

DESCRIPTION OF PREFERRED EMBODIMENTS

In accordance with the invention, the building includes outer and inner upright generally annular supporting frameworks having vertical axes which are substantially coaxial, the major extent of the outer framework being spaced from the major extent of the inner framework, one of the frameworks being generally hyperboloidal, together with means interconnecting the frameworks at different elevations. In the example seen in FIGS. 1–4, the outer and inner supporting frameworks of the building **10** are generally designated at **11** and **12**, both being generally hyperboloidal and having a common central vertical axis **13**. In this regard, it will be noted that there need be no interior supporting columns; that althrough the frameworks **11** and **12** are each curved in two directions (vertically and horizontally) all supporting members extend in straight lines from the top to the bottom of the frameworks; and that all walls may be modular, non-supporting as respects building loads, demountable and movable. Accordingly, great simplicity and reductions in construction costs are achieved, as compared with conventional structures. Also, because of strength characteristics of hyperboloidal structures, the building can be economically constructed yet made many times stronger than required to withstand earthquakes or hurricane forces.

More specifically, the outer framework or truss **11** comprises linearly elongated support members certain (see members **14**) of which extend downwardly and laterally along hyperboloidal directrices in one direction about the framework axis, and others (see members **15**) of which extend downwardly and laterally along directrices in the

opposite direction about the framework axis. In addition, tie structure interconnects the members **14** and **15** at loci proximate directrix intersections, as for example is indicated by ties **16**, and the members and ties may consist of pre-cast concrete, metal or other usable material. The ties are grouped in sets at different elevations, the ties of each set at a selected elevation being circularly spaced. See for example the ties in representative sets at elevations **16***a*, **16***b* and **16***c* as indicated. The spacing of circularly successive ties in the majority of the sets is less than twelve feet. Members **14** and **15** may be connected to the ties in abutting relation as by straps **17** or other suitable connectors (as for example extensions **60** pinned at **61** to ties **16**).

The inner framework or truss **12** likewise comprises linearly elongated support members certain of which extend downwardly and laterally along hyperboloidal directrices in one direction about axis **13**, and others of which extend downwardly and laterally along directrices in the opposite direction about the framework axis. FIG. 3 shows inner framework members **14***a* and ties **16***a* corresponding to members **14** and ties **16** of the outer framework.

The inner and outer framework interconnecting means typically extends horizontally and supports generally annular floors at different elevations. Such means may take the form of modular beams **20***a*, **20***b*, **20***c*, etc. in FIG. 1, with floors at **21***a*, **21***b*, **21***c*, etc. Note in this regard that vertically successive floors have vertical separation which is greater for floors of overall greater diameter than for floors of lesser overall diameter. Thus, for example, the vertical separation between floors **20***n* and **20***o* is greater than that between floors **20***b* and **20***c*. This results from the fact that the horizontal beams are connected with and supported by the ties **16**, as better seen in FIGS. 2 and 3. For example, studs **22** such as metal pipes or cylinders may be carried by pre-cast concrete beams **20** to project from the beam end plates **23** and **24** for attachment to the ties **16** and members **14***a*. If desired, the separation between floors may be kept constant. The pre-cast floor segments incorporating beams have trapezoidal shape as seen in FIG. 6, and stud **22** of each beam segment at plate **23** attach to successive ties **16**. In this regard, the inner framework ties **16***a* may not be at precisely the same level as the outer framework ties **16**, as appears in FIG. 3. The beams may also include side plates **25** projecting downwardly to support ceiling structure **26** spaced at **27** below the main horizontal flooring **21**, to accommodate air and heating ducts, wiring, etc. See for example heating duct **62** to which hot water may be circulated from a heater **63** at the building top and which is heated by radiant solar energy. Plates **23** and **24** may be flat or slightly curved.

Turning to FIG. 4, the floors **21** are generally annular, inasmuch as the inner framework defines a central hollow **28** which may be vertically open as seen in FIG. 1. In addition, the frameworks **11** and **12** may define a lateral through passage **29** (louver controlled at **29***a*) communicating between the building exterior **30** and the lower interior of the central hollow **28**, for flowing air inwardly into the latter to rise with natural draft effect. The draft may be increased to keep snow or rain out of the central hollow and patio **46**.

Accordingly, inner and outer windows may be opened in apartments at the different floor levels with resultant good air flow through the apartments due to the tendency of the central draft to draw air laterally into the hollow **28**. Water may be sprayed at **45** into the central opening to cool the upward air flow.

FIG. 4 shows one arrangement of apartments on the annular floor **21**, and outwardly of a common annular hallway **32** adjacent the inner framework location **12**. Note the provision of ramps **33** and **34** leading to an immediate floor section **35** between vertically successive floors **21**. Ramp **34** leads from floor section **35** to the next lower annular floor **21**. Wedge-shaped floor section **35** provides a village park entry in which tables, plants and recreation items may be located, and it also helps eliminate the isolative effect of apartment living. A stair well is provided at **36**, and elevator shaft at **37**.

FIG. 5 illustrates a somewhat different floor arrangement in which the common annular hallway **38** is located between an inner row of rooms **39** and an outer row of rooms **40**. A vertical shaft **41** contains the staircase **42** and elevator shaft **43**.

Turning back to FIG. 1, the illustrated building also includes a base structure **50** supporting the frameworks **11** and **12**, and defining a series of lower floors **51–54** communicating with the elevator and stairway shaft **37**. Those floors may for example be used for utilities, parking, shops and lobbies, as desired. The top **55** of the base transfers loading from the frameworks **11** and **12** to the base side structure **56** and columns **57**. While such a base is useful and provides advantages, it is not essential to the support of the remainder of the building, as described. The term "generally annular" as applied to frameworks **11** and **12** and the flooring **21** includes elliptical as well as circular.

Finally, several buildings **64** similar to those described in FIG. 1 may be connected by tunnels **65** seen in FIG. 8, whereby road access to only one building of a cluster is needed, lending isolation of the cluster from road traffic. A parking or other area **70** may be provided by floor **71** suspended between the buildings by a cable **72** extending around each building at a selected upper floor level, and having stretches **72***a*–**72***f* supporting the floor. Bridges **73** connect area **70** with the buildings.

I claim:

1. In a building, the combination comprising

(a) outer and inner upright generally annular supporting frameworks having vertical axes which are substantially coaxial, the major extent of the outer framework being spaced from the major extent of the inner framework, each of the frameworks being generally hyperboloidal, the hyperbola of revolution defining each said hyperboloidal framework being concave in an outward direction away from said axes, each framework having linearly elongated support members extending downwardly and laterally along hyperboloidal directrices and in opposite directions about said axes; said support members comprising concrete and transmitting loading downwardly to be in compression; and

(b) means extending generally horizontally and interconnecting said frameworks at different elevations, and supporting building floors.

2. The combination of claim **1** wherein said members are substantially rigid and transmit downward loading to be in compression, and tie structure interconnecting said certain and other members.

3. The combination of claim **1** and further comprising ties interconnecting said members at loci proximate directrix intersections, said framework interconnecting means being connected to certain of said ties.

4. The combination of claim **3** wherein the ties are grouped in sets at different elevations, the ties of a set at a selected elevation being circularly spaced.

5. In a building, the combination comprising

(a) outer and inner upright generally annular supporting frameworks having vertical axes which are substantially coaxial, the major extent of the outer framework being spaced from the major extent of the inner framework, said frameworks being generally hyperboloidal,

(b) each framework having linearly elongated support members extending downwardly and laterally along hyperboloidal directrices, and in opposite directions about the framework axes, and ties interconnecting

said members at loci proximate directrix intersections, and

(c) means interconnecting said frameworks at different elevations and being connected to certain of said ties,

(d) said framework interconnecting means extending generally horizontally and supporting generally annular building floors at different elevations.

6. The combination of claim **5** wherein vertically successive floors have vertical separation which is greater for annular floors of greater overall diameters than for annular floors of lesser overall diameters.

7. The combination of claim **5** including multiple buildings as defined, the buildings being horizontally spaced, and including tunnels interconnecting the multiple buildings.

8. The combination of claim **5** including vertical partitions extending between vertically successive floors to form rooms.

9. The combination of claim **8** wherein the inner framework defines a central vertical hollow, and including an elevator shaft extending upwardly in said hollow for communication with said floors.

10. The combination of claim **8** including ramp walkways extending between vertically successive floors.

11. The combination of claim **8** wherein the inner framework defines a central hollow which is vertically open, the frameworks defining a lateral through passage communicating between the exterior of the building and lower interior of said central hollow for flowing air inwardly into said hollow to rise with natural draft effect therein.

12. In a building, the combination comprising

(a) an upright hyperboloidal framework having a central vertical axis,

(b) said framework having linearly elongated concrete support members extending downwardly and laterally along hyperboloidal directrices, and in opposite directions about said axis, said members being substantially rigid and transmitting loading downwardly to be in compression, and

(c) ties interconnecting said members at loci proximate directrix intersections, said members also supporting flooring at different elevations.

13. The combination of claim **12** wherein the ties are grouped in sets at different elevations, the ties of a set at a selected elevation being circularly spaced.

14. The combination of claim **13** wherein the spacing of circularly successive ties in the majority of said sets is less than twelve feet.

15. The combination of claim **1** wherein said means interconnecting the building frameworks includes horizontal upper flooring, and the building also including a base structure supporting said frameworks, said base structure defining horizontal lower floors at different elevations.

16. The combination of claim **1** including multiple spaced buildings as defined, and flooring suspended between the buildings by cable structure.

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PRICE C. FAW, JR., Primary Examiner

U.S. Cl. X.R.

52—30, 218, 236, 237, 245