Dec. 1, 1970 K. E. GURITZ 3,543,458

MONOLITHIC FLOOR STRUCTURE WITH AIR PASSAGES

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FIG. 1.

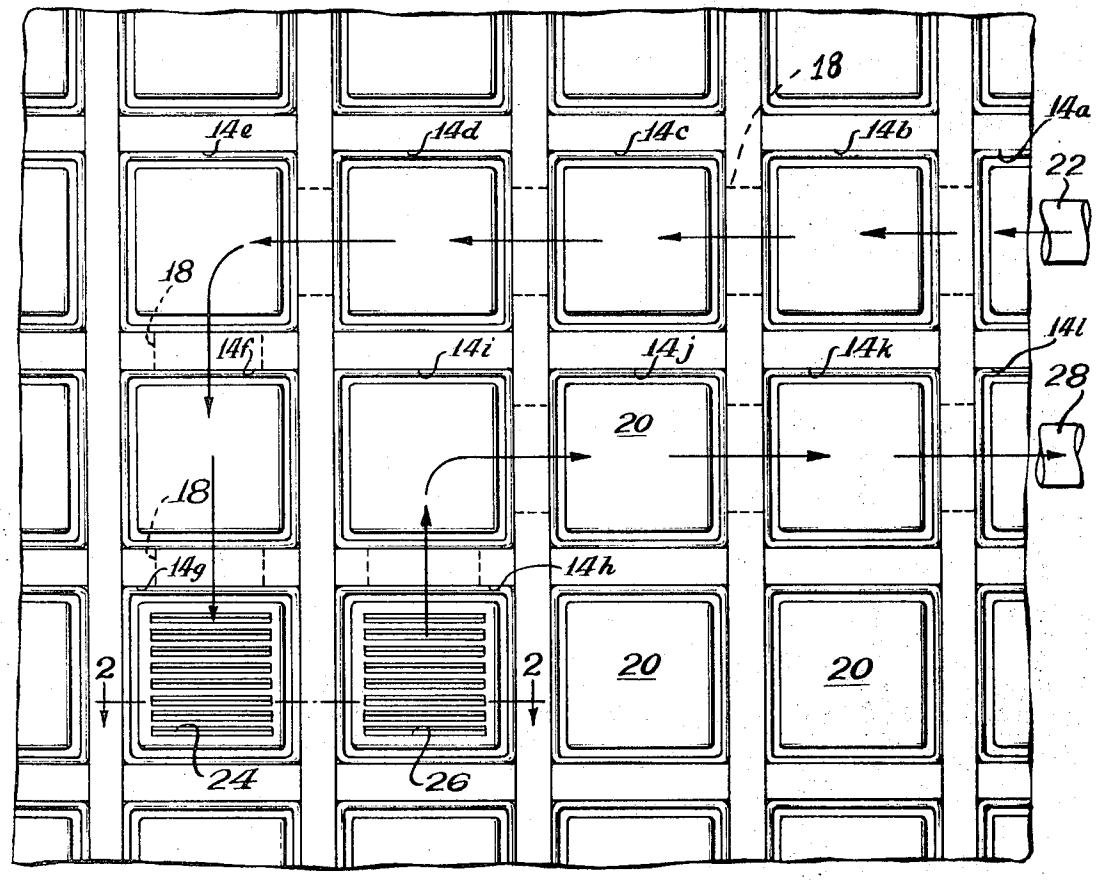
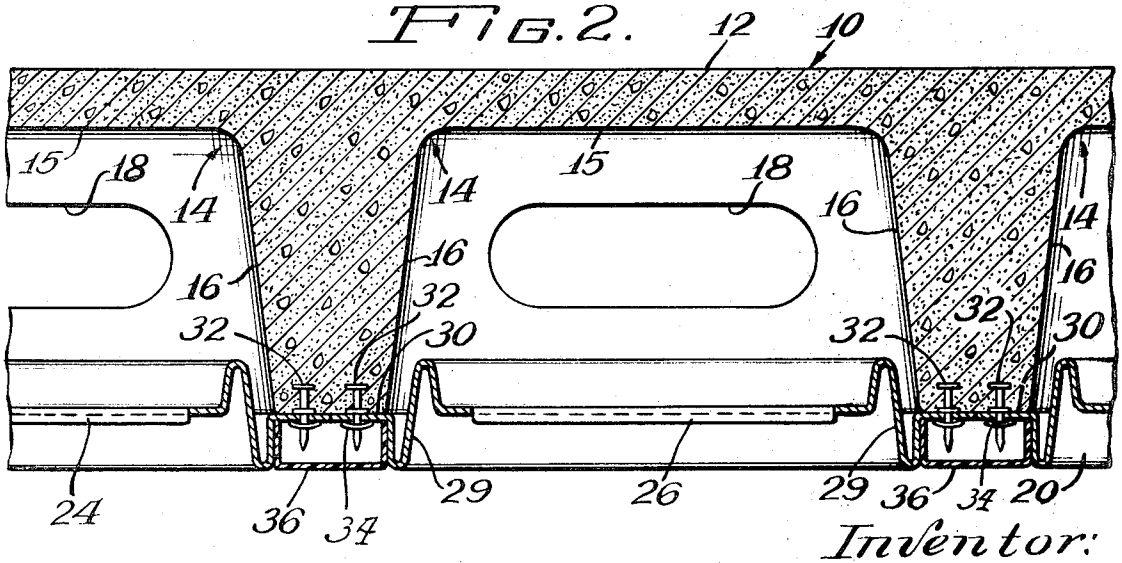


FIG. 2.



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FIG. 3.

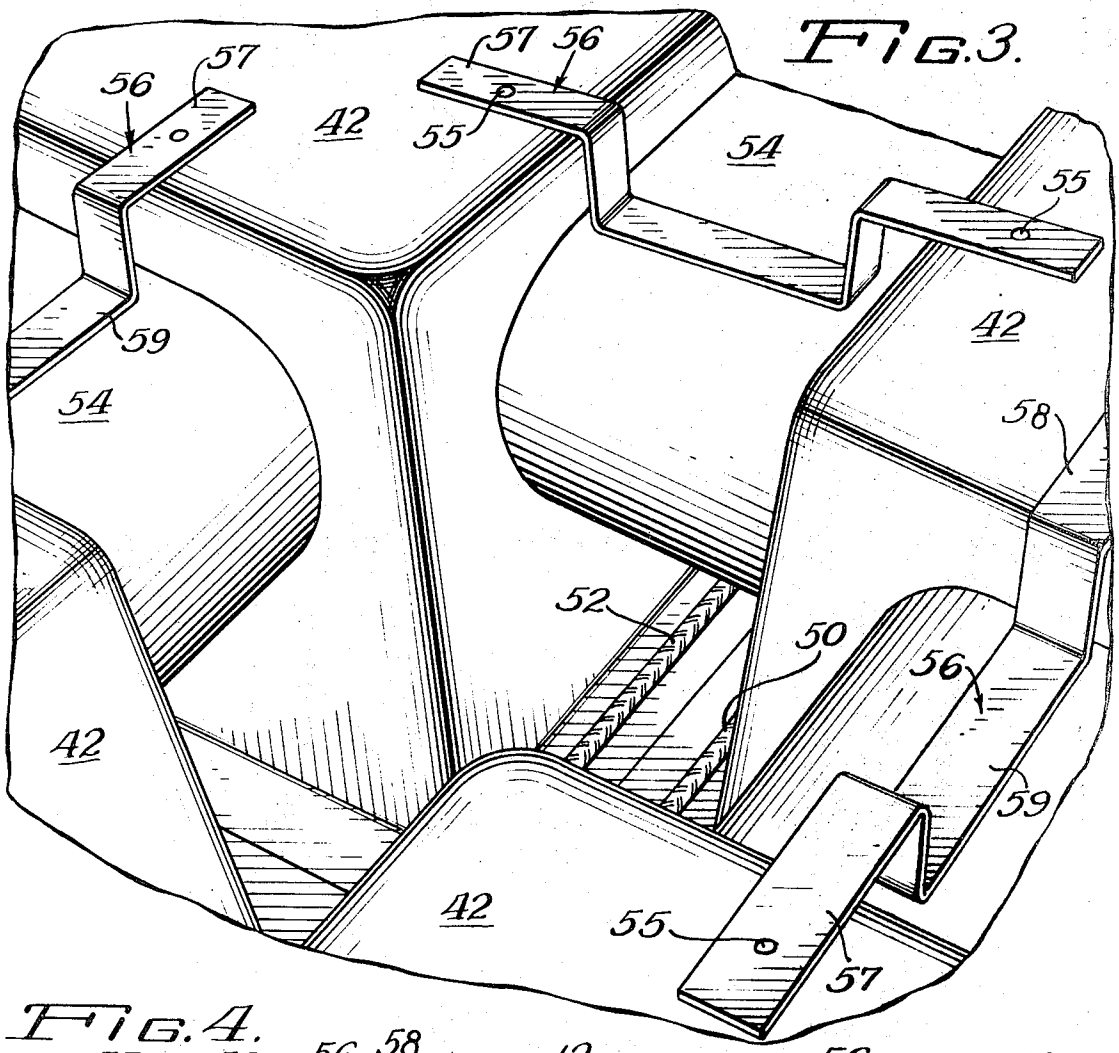
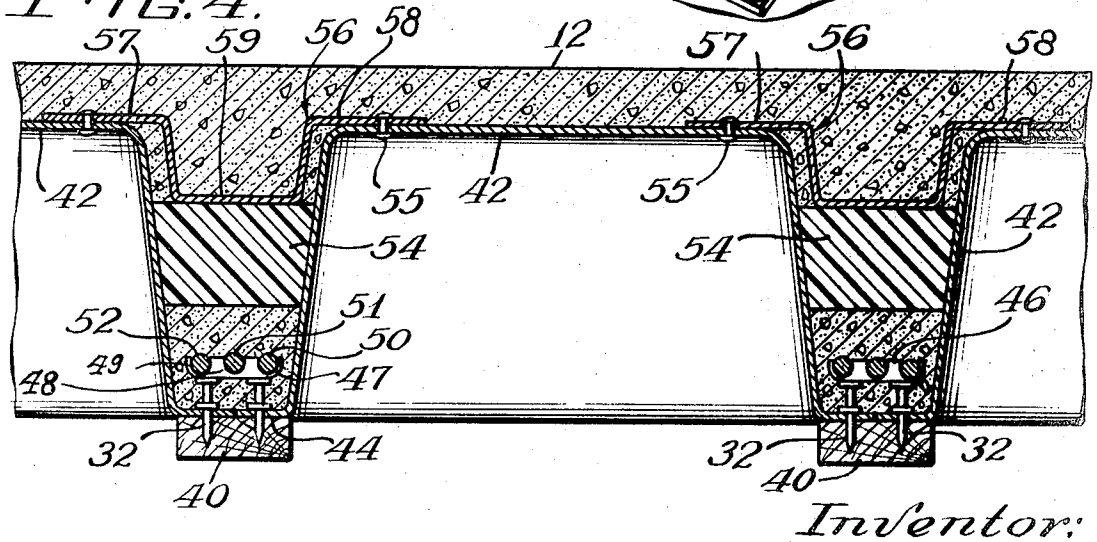


FIG. 4.



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MONOLITHIC FLOOR STRUCTURE WITH AIR PASSAGES

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FIG. 5.

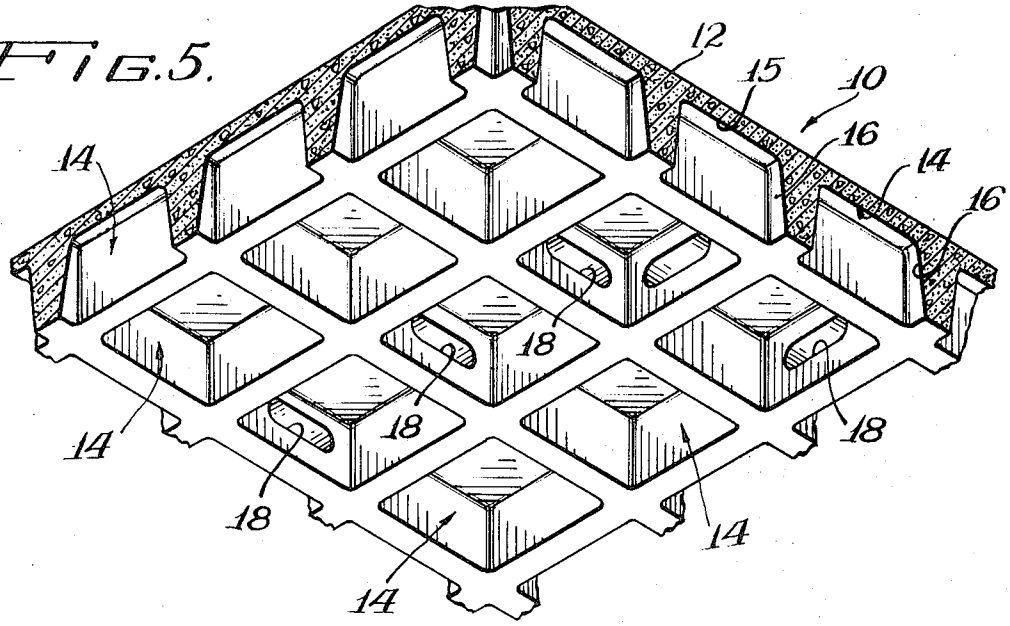


FIG. 6.

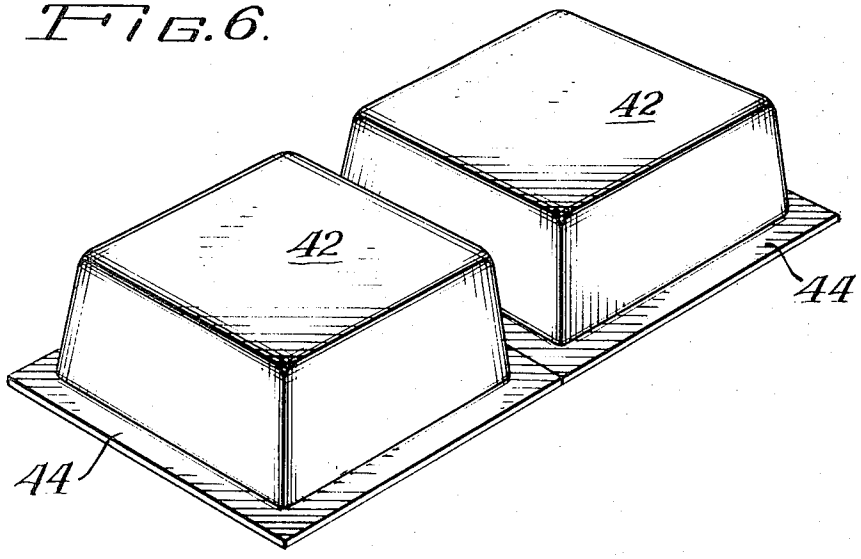
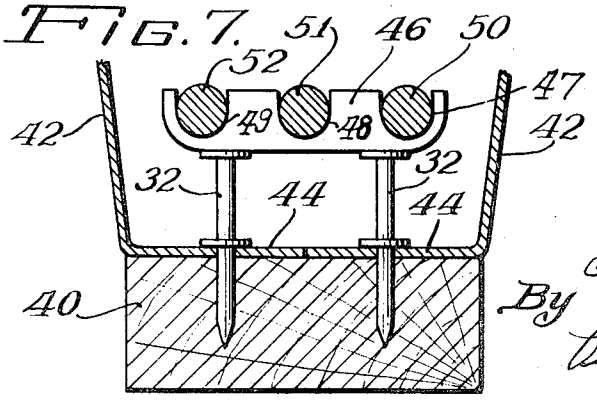


FIG. 7.



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MONOLITHIC FLOOR STRUCTURE WITH AIR PASSAGES

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Int. Cl. E04b *1/16*; E04f *17/04*
U.S. Cl. 52—127 12 Claims

ABSTRACT OF THE DISCLOSURE

A pan-type concrete floor construction wherein the joists thereof define a plurality of upward extending cavities. Openings of substantial area are placed at selected locations in the joists to provide passages for building services within the normal thickness of the floor. Where heating, ventilation and air conditioning are provided by forced air, the bottoms of selected cavities are provided with closures, diffusers and collectors as required. The method of forming a pan-type floor having such integral service passages is described.

BACKGROUND OF THE INVENTION

This invention relates to pan-type concrete floor construction, and more particularly, to an improved floor having passage means formed integrally in such floor in a simple expedient manner.

Pan-type concrete floor construction is utilized extensively in large buildings and particularly in multi-story buildings. Such floors comprise a slab of concrete having a relatively smooth top surface defining a floor and a bottom surface provided with a plurality of spaced and aligned cavities or recesses formed therein.

A pan-type floor is formed by pouring concrete over a plurality of inverted pans arranged in a pattern and supported from beneath. Horizontal reinforcing rods and connecting stirrups are commonly provided to reinforce the concrete in such construction. After the concrete has been poured and sets, the pans are removed. A principal advantage of this type of floor construction is its high strength to weight ratio.

Electrical ducts and conduits having a relatively small cross-section (on the order of two inches in diameter or maximum vertical dimension) are often placed above the pans, and concrete poured thereover so as to incorporate such ducts or conduits within the floor. Later, electrical cables, telephone lines and the like may be drawn through such ducts or conduits.

Such in the floor installations may provide only a portion of the entire conduit requirement. In such instances other conduits are suspended below the ceiling. Similarly, pipes and ducts for heating, ventilation, air conditioning and plumbing as well as light fixtures are similarly suspended below the ceiling. These unsightly building services may be hidden by a suspended ceiling. In this prior arrangement a substantial portion of the vertical distance between one floor and bottom of the next floor is reserved for such services. The use of a suspended ceiling to hide the air ducts is inefficient in that the thickness of the floor is unnecessarily increased, and thereby the floor to ceiling height is reduced. Increase of floor to ceiling height to accommodate the suspended ceiling structure increases building height, material cost, and overall construction costs.

An object of the present invention is to provide for building services within the normal thickness of pan-type floors.

A further object of this invention is to improve the structural characteristics of pan-type floor construction.

A still further object of this invention is a method for

constructing pan-type floors having provisions for building services within the thickness of the floor and having improved structural characteristics.

In accordance with one feature of this invention, passages of substantial cross section are provided between selected cavities of a pan-type floor.

In accordance with another feature of this invention, the selected cavities of a pan-type floor constructed in accordance with this invention are selectively provided with novel closing members and louvers for defining air passages for heating, ventilating and air conditioning.

In accordance with another feature of this invention, there is a substantial reduction in the weight and cost of the structural joists of a pan-type floor.

DESCRIPTION OF THE DRAWING

An illustrative embodiment of the present invention is shown in the attached drawing wherein:

FIG. 1 is a bottom view of a portion of a waffle-type floor embodying the present invention;

FIG. 2 is a transverse cross-sectional view illustrating a portion of a completed waffle-type concrete floor taken generally along line **2**—**2** of FIG. 1;

FIG. 3 is a perspective view illustrating the fabrication of the waffle-type floor and showing removable molds in place between pairs of adjacent pans;

FIG. 4 is a cross-section of the waffle-type floor during fabrication and illustrating the removable molds in place;

FIG. 5 is a perspective view of the bottom of a portion of a waffle-type floor illustrating the cavities and passages defined after removal of the pans and the removable molds;

FIG. 6 is a perspective view illustrating a pair of adjacent cup-shaped pans utilized to form cavities in the grid network of the floor;

FIG. 7 is an enlarged cross-sectional view illustrating a mounting support for supporting and properly positioning reniforcing rod during fabrication.

DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENT

Referring to FIGS. 1 and 2, there is shown a portion of a floor or ceiling construction embodying the present invention. The illustrative floor construction is of the waffle-type and is comprised of a slab of concrete **10** having a smooth top **12** and a bottom having a plurality of grid sections or cavities **14** defined therein. The illustrative waffle-type floor is one specific embodiment of a pan-type floor. The cavities **14** each have substantially flat to wall surfaces **1** and side wall surfaces **16** which converge upwardly. In horizontal cross-section, the cavities **14**, of the illustrative embodiment, square as shown in FIG. 1.

In selected side walls **16** openings **18** connect adjacent cavities **14**. The bottom of each cavity may be closed by a panel **20** so as to provide a closed passageway wholly within the confines of the concrete floor construction. For example, the inlet **22** which is adapted to be connected to a source of conditioned air connects to one end of a first passageway in the floor **10** which includes interconnected cavities **14***a*–**14***g*. The air flows through the passageway and is discharged through a supply grill **24** in a selected panel **20** into an area to be conditioned. Air from the area to be treated enters a second passageway in the floor **10** through a return grill **26** in another panel **20** and flows through cavities **14***h*–**14***l* for return through outlet **28** to the air treating system. Thus, supply and return air passages are provided within the floor construction, without the necessity for separate piping or ducting. Obviated is the necessity for a false ceiling or a dropped ceiling.

A concrete floor constructed in accordance with the present invention is lighter and contains less concrete than a comparable conventional construction.

The air passages so formed within the pan-type floor provide an efficient, low type impedance duct. This permits air to be moved at relatively low velocities and in both heating and cooling the temperature difference between the desired room temperature and the heating or cooling air may be maintained relatively low. Thus, an efficient and comfortable heating and cooling system results.

The panels **20** are provided with peripheral flanges having an S-shaped or Z-shaped portion **29** and an end flange portion **30**. The flange ends **30** are adapted to be secured to support nails **32** embedded in and extending from the floor construction by lock washers or like fasteners **34**. As will be explained more fully hereinafter, the support nails **32** are constructed and arranged so as to be retained in the floor construction during fabrication thereof.

A decorative channel member **36** made from metal or a suitable plastic is adapted to be inserted between adjacent panels **20** to finish the ceiling or bottom of the floor construction and present an aesthetically pleasing appearance from below. Alternatively, a series of longitudinally aligned decorative strips may be removed and a wall or divider may be engaged at its upper end in the recesses defined between adjacent aligned panels **20**. It is seen that the present invention readily lends itself to modern multi-story constructions where office walls are changed and moved about. The decorative strips or channel members **36** are suitably secured in place by an adhesive, by a force fit, or by spring the sides of the channel member or strip into place between the recessed flanges of the adjacent panels.

Referring to FIGS. 3 and 4, there is illustrated a method of fabricating a waffle-type floor in accordance with the present invention. A suitable wooden framework **40** is provided beneath the level of the anticipated floor or ceiling construction. It will be understood that in a multiple story dwelling the term "floor" and "ceiling" may be used interchangeably, since the floor construction of the present invention would define the ceiling of the story below as well as the floor of the story above. The construction of this invention would provide the ceiling and roof of a one-story building structure.

Supported upon the wooden supports **40** are a plurality of like shallow cup-shaped pans **42**, each of which has a peripheral flange **44** thereabout. The flanges **44** of adjacent pans are supported in abutting relationship by the wooden support members **40**. In this illustrative embodiment the pans **42** are arranged in rows longitudinally as well as transversely, so as to later form a plurality of longitudinally and transversely aligned cavities in a floor construction, thereby producing what is called a waffle-type floor construction. It is a feature of the present invention that the pans **42** be retained in place on the wooden supports **40** by means of the double-headed mounting nails **32**. Suitably affixed to selected adjacent mounting nails **32** and supported thereon is a support member **46** which is provided with a plurality of recesses **47**, **48** and **49** therein for suitably supporting reinforcing rods **50**, **51** and **52** in desired spaced relationship from one to another and form the adjacent pans **42**. The specific number of rods employed is variable and dependent upon design consideration. The specific form of support member shown merely illustrates one form of the invention.

To create the voids or openings **18** in the downwardly depending sidewalls forming the cavities in the waffle-type floor, removable molds **54** made from plastic or the like, for example, polyurethane foam, or the like material are disposed between adjacent pans **42** in closely fitting relationship. Such removable molds **54** are sufficiently firm so as to retain their general form and close fitting relationship with the pans **42**. However, they being

of plastic are deformable and destructible and therefore capable of easy removal. To prevent the floating or accidental movement of these molds **54** when concrete is poured into place, angle brackets **56** are provided. The anchor brackets **56** include end flanges **57** and **58**, which are adapted to be connected to adjacent pans by means of a rivet **55** or the like, and an intermediate generally U-shaped portion **59**, which is adapted to abut the top of a mold **54**, so as to retain the mold **54** in place during the pouring of the concrete. As aforenoted, the sides of the pans **42** are somewhat tapered and converge generally upwardly. The mold **54** is of a desired cross-sectional shape to define the desired passage between the section of the floor and it is apparent that the passage may have different shapes, provided it is of adequate size to permit the desired flow of air, the placement of other services or the desired joist weight reduction. If desired, conduit may be supported on the pans in a conventional manner, such conduit would become embedded in the floor and provide housing later for electric cable and for telephone lines.

After the concrete has been poured and has set, the wooden support framework **40** and the pans **42** are removed, thereby exposing the waffle-type concrete floor, as shown, for example, in FIG. 5. To open and thereby provide the passages **18** between the adjacent cavities, and thereby form a passageway or passageways integrally in the floor **10**, certain molds **54** are punched out or otherwise removed. It will be understood that all of the molds may be removed at a later date to provide additional service capacity.

The cavities **14** are defined by longitudinal and transverse interconnected joist members.

In FIG. 6, there is shown a pair of adjacent pan members **42** each having a peripheral flange **44** thereabout. The outer face of the flanges lies in a plane which is substantially parallel to the plane of the top of the pan. The pans **42** are generally square in transverse cross section as is evident from FIG. 6.

In FIG. 7, there is shown a detail of a mounting support for the reinforcing rods. The double-headed nails **32** not only retain the flanges **44** of the pans **42** in desired adjacent abutting relationship on the wooden frame **40**, but they also provide support for the support members **46** to properly orient the reinforcing bars **50**, **51**, **52** with respect to each other, to the adjacent pans and to the peripheral flanges of adjacent pans. The bars are spaced from the flanges of the pans **42** and from the adjacent sides of the pans. This permits proper location of the reinforcing bars **50**, **51** and **52** within a completed joist arrangement in a waffle-type floor construction.

By the present invention, in the illustrative embodiment there has been provided a concrete floor construction having a plurality of passages through the joists thereof. The passages are both transversely and longitudinally aligned and the bottom of the cavities may be closed, so as to define integrally within the floor air passages for the supply of conditioned air to areas to be treated and for the return of air from an area to be conditioned to the air conditioning system or to the exhaust. It will be understood that mechanical plumbing and electric wiring may also be installed within the passages. By the present construction, the dead load of the concrete has been minimized since the openings in the joists remove many pounds of unnecessary concrete from the floor construction. It has been found that the floor construction is improved by the removal of such concrete.

The creation of air passages in the concrete floor results in a concrete floor construction which has a relatively large thermal capacity. When there is a requirement for heating, warm air will be supplied through the passageway within the concrete floor construction and the walls thereof are warmed. The heat stored in the concrete creates a radiant effect. A similar effect results when cool air is supplied to the passageways defined in the floor.

The ceiling provided with the floor construction of the present invention has an aesthetically pleasing look, since the entire exposed concrete surface may be covered over by the panels **20**, grills **24** and **26**, light fixtures and by the decorative strips **36**.

As shown in FIG. 1, the panels **20** may be solid, or they may incorporate grills for supply and return air. It will be understood that lighting fixtures may be provided in selected cavities **14**. The lighting fixture may be substituted for a panel or alternately, the lighting fixture may be recessed in the cavity and a suitable panel **20** which will permit the light to reach the room may be provided in place of the decorative panel **20**. Further, the panels **20** may be made from acoustic materials for soundproofing or may be modified so as to accommodate sprinkler heads or radio speakers as desired. The overall result of the floor construction of the present invention is that the floor construction itself defines the air passageways therewithin, and all of the mechanical components including pipes for plumbing and electrical equipment may likewise be accommodated within the confines of the novel waffle-type floor.

While I have shown a presently preferred form of the invention, it will be understood that the invention is not limited thereto, since it may be otherwise embodied within the scope of the following claims.

What is claimed is:

1. A pan-type concrete floor construction comprising: a substantially horizontal concrete platform having a floor surface and an under surface; a monolithic grid comprising a plurality of sections formed of concrete joists continuously, integrally and downwardly depending from said platform, each said grid section comprising a cavity having a top comprising a portion of said under surface and downwardly extending sides comprising surfaces of webs of said joists, the sides of selected adjacent grid sections having horizontally elongated passages of substantial cross section extending therebetween, said passages having curved horizontal ends and being vertically located wholly within the upper and lower boundaries of said joists so that both the upper and lower surfaces of said passages are spaced apart from and lie vertically between the upper and lower surfaces of said joists; and removable means for closing the open bottoms of said selected grid sections for forming at least one continuous passage in the floor construction.

2. A floor construction as in claim **1**, wherein the passages are between a plurality of aligned grid sections to define a continuous longitudinal passage.

3. A floor construction as in claim **2**, wherein at least one of said selected grid sections is provided with a passage to an adjacent grid section in transverse alignment with said longitudinal passage to define an air passage transverse to said longitudinal passage.

4. A floor construction as in claim **2**, wherein at least two separate passages are defined, one of said passages connected to a source of conditioned air for supplying conditioned air to said passage, said conditioned air being discharged from said one passage through a supply grill into an area to be treated, said second passage having at least one grid section thereof fitted with a return air grill for receiving air to be returned to said source of conditioned air.

5. A floor construction as in claim **1**, further comprising studs protruding from the formed floor construction in a set pattern, and said means for closing said grid sections comprise panels adapted to be supported on said studs.

6. A floor constructing as in claim **5**, wherein the panels are retained on said studs by means of washer fasteners.

7. A floor construction as in claim **1**, wherein support members are carried on studs used to position forming pans during construction, said support members supporting reinforcing rods and positioning them with respect to one another and with respect to adjacent forming pans, said studs and said support members being retained in the floor construction after fabrication thereof.

8. A method of fabricating air passages in a pan-type concrete floor comprising the steps of orienting and supporting cup-shaped pans in a horizontal grid array, said pans each having a top surface, a bottom surface and a plurality of side surfaces, positioning removable molds of firm but deformable material such as plastic and having at least a pair of end surfaces, a top surface and a bottom surface between respective adjacent pans in aligned relationship to one another with the end surfaces of said molds being in close abutting relationship with the side surfaces of said respective adjacent pans, the top and bottom surfaces of said molds being vertically spaced apart from and positioned vertically intermediate the top and bottom surfaces of said pans, retaining said molds in place, pouring concrete over and around said molds and pans, removing said pans from the hardened concrete to form a substantially horizontal concrete platform comprising a floor surface and an under surface comprising aligned open-bottomed cavities, selectively removing said molds to form passage extending through the walls between selected adjacent cavities.

9. The method of claim **8** including the steps of forming a pair of separate passages in the concrete floor, one passage for supplying air from a source of conditioned air to an area to be treated and the other passage for returning air from said area to be treated to said source for reconditioning.

10. The method in accordance with claim **8** further comprising the step of closing the open bottoms of said selected adjacent cavities to define a continuous passage for air within the floor.

11. A monolithic floor structure comprising: a platform having a flat horizontal top surface, a first group of continuous horizontal concrete joists substantially parallel to each other continuously, integrally and downwardly depending from the bottom of said platform, a second group of continuous horizontal concrete joists substantially parallel to each other continuously, integrally and downwardly depending from the bottom of said platform, said joists of said first and said second groups intersecting each other to form a horizontal open-bottomed integral grid of said joists, webs of said joists forming the sides of the sections of said grid and the underside of said platform comprising the top of said sections of said grid, the sides of selected adjacent grid sections having horizontally elongated passages of substantial cross section therebetween, the portions of said joists lying below the bottom surfaces of said passages having embedded therein tension reinforcing bars and being subjected principally to tension forces.

12. A monolithic floor structure comprising: a platform having a flat horizontal top surface, a first group of continuous horizontal concrete joists substantially parallel to each other continuously, integrally and downwardly depending from the bottom of said platform, a second group of continuous horizontal concrete joists substandtially parallel to each other continuously, integrally and downwardly depending from the bottom of said platform, said joists of said first and said second groups intersecting each other to form a horizontal open-bottomed integral grid of said joists, webs of said joists forming the sides of the sections of said grid and the underside of said platform comprising the top of said sections of said grid, the sides of adjacent grid sections having horizontally elongated passages of substantial cross section extending therebetween, and a plurality of closing means of firm but deformable material having outside dimensions corresponding roughly to the dimensions of said passages

positioned in selected corresponding ones of said passages to form at least one continuous air passage within the thickness of said joists.

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ALFRED C. PERHAM, Primary Examiner

U.S. Cl. X.R.

52—173, 303, 332, 744; 98—31; 249—28; 264—31