May 6, 1969 K. C. NASLUND ET AL 3,442,058

CONCRETE FLOOR CONSTRUCTION WITH DUCT-FORMING VOIDS

Filed May 31, 1968

Sheet 1 of 3

FIG. 1

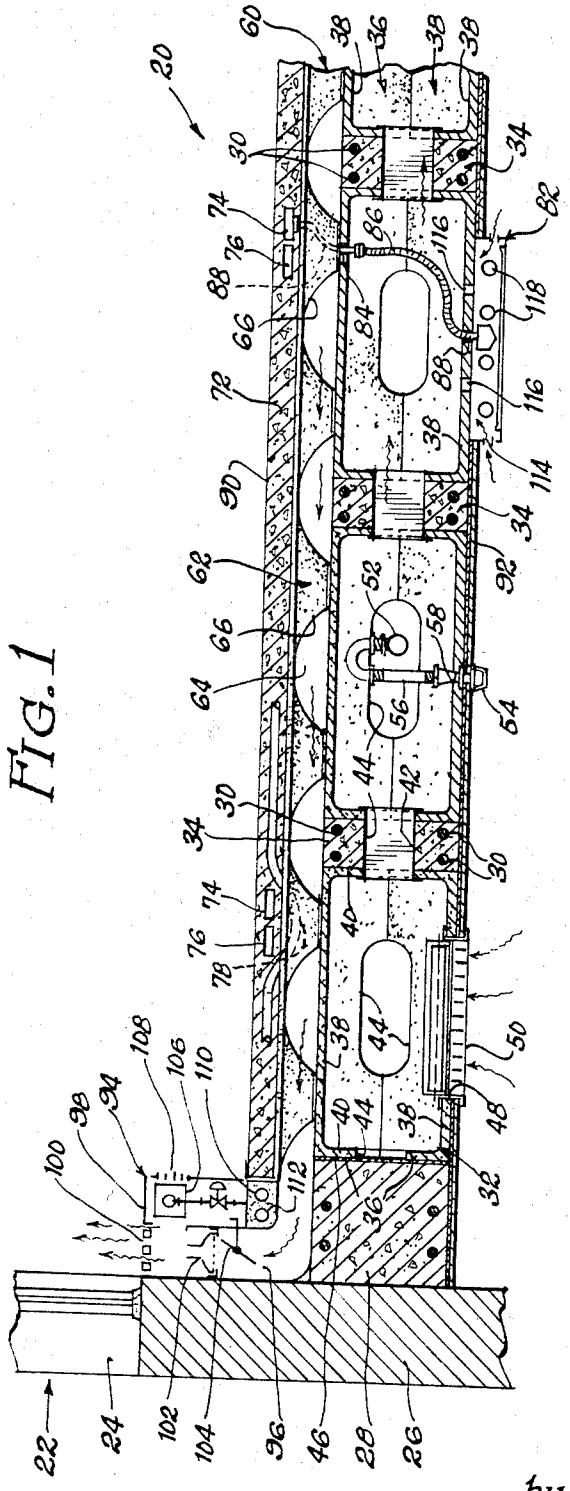
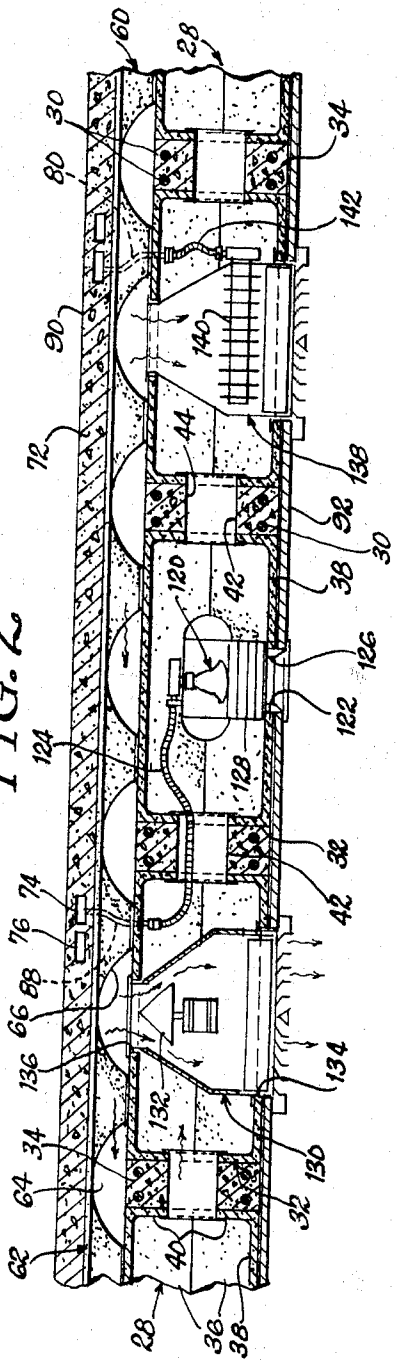


FIG. 2



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Filed May 31, 1968 Sheet 2 of 3

FIG. 3

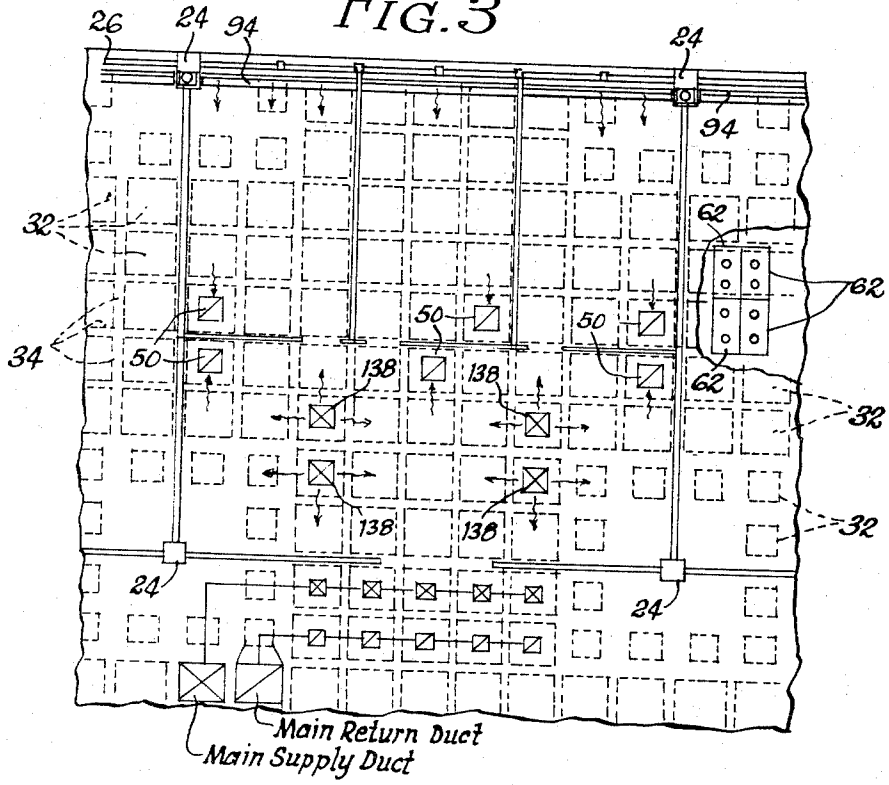


FIG. 4

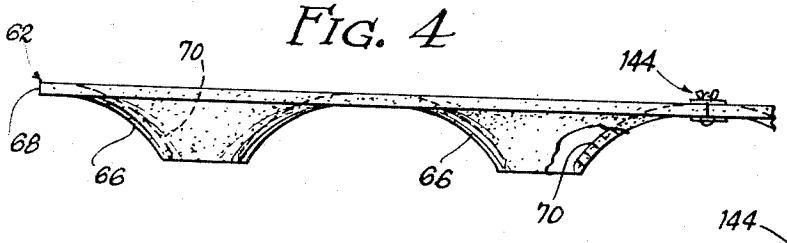


FIG. 5

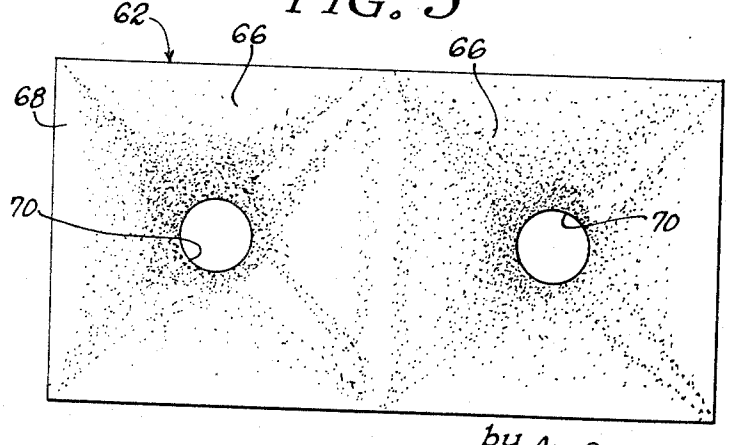
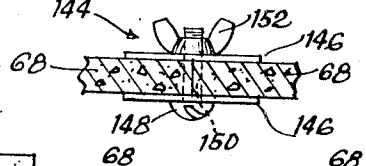


FIG. 6



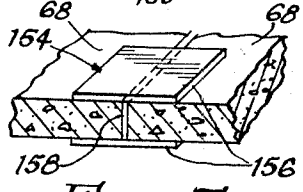


FIG. 7

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CONCRETE FLOOR CONSTRUCTION WITH DUCT-FORMING VOIDS

Filed May 31, 1968 Sheet 3 of 3

FIG. 9

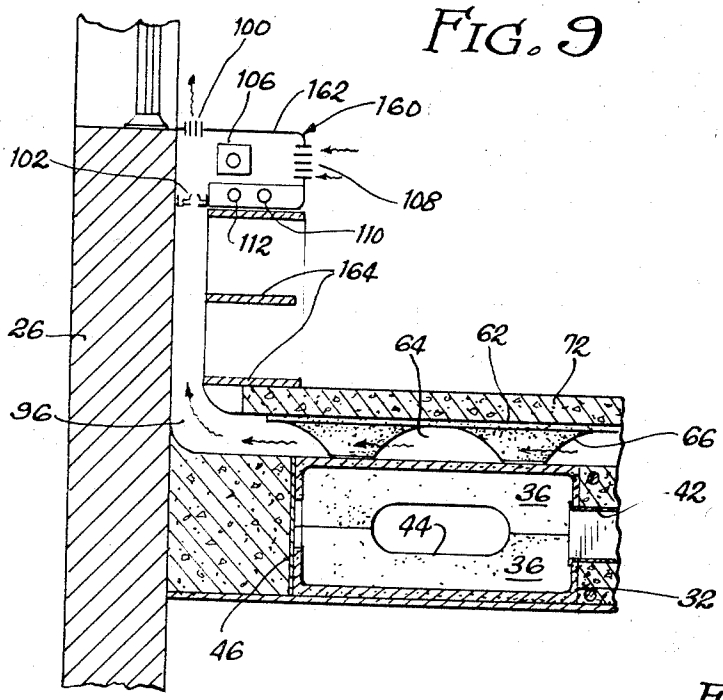


FIG. 8

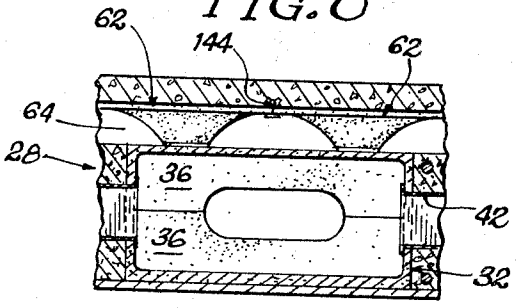
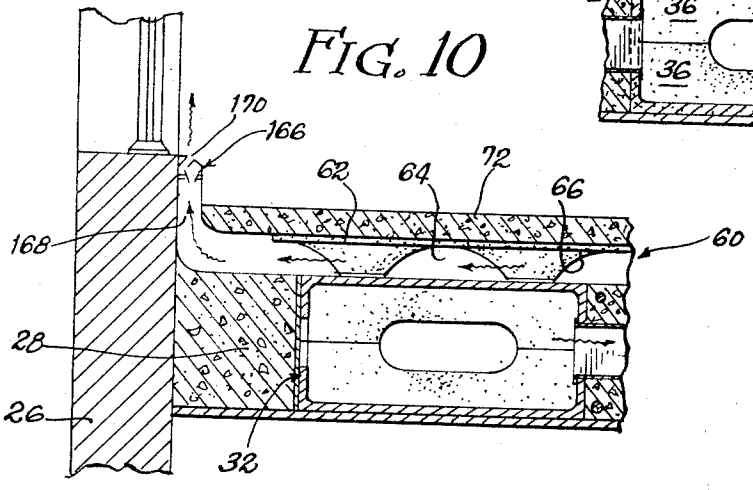


FIG. 10



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CONCRETE FLOOR CONSTRUCTION WITH DUCT-FORMING VOIDS

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Continuation-in-part of application Ser. No. 514,948, Dec. 20, 1965. This application May 31, 1968, Ser. No. 740,808

Int. Cl. E04b *5/48, 5/16;* E04c *2/04*

U.S. Cl. 52—221

32 Claims

ABSTRACT OF THE DISCLOSURE

A concrete floor construction comprising a reinforced concrete lower slab having hollow preformed cells embedded between a monolithic structure of crisscrossing concrete ribs, said cells being made of concrete, gypsum, vitrified clay or the like, said lower slab having ducts extending between said cells and embedded in said ribs for handling the flow of air, a plurality of preformed blocks or the like covering the upper side of said lower slab, each of said blocks having an upper horizontal rim portion with at least one inverted generally frusto-conical member projecting downwardly therefrom and having a flat horizontal bottom surface engaging the lower slab, each member being hollow and having a central opening therein extending downwardly to the lower slab, said blocks being made of concrete, gypsum, vitrified clay or the like, and an elevated concrete slab extending over and covering said preformed blocks, said elevated slab extending downwardly through said openings in said frusto-conical members and forming bonds with the lower slab, said preformed blocks forming air passages between and around said frusto-conical members.

This application is a continuation-in-part of our copending application Ser. No. 514,948, filed Dec. 20, 1965, and now abandoned.

This invention relates to the construction of reinforced concrete floors for buildings and other structures.

One object of the present invention is to provide a new and improved reinforced concrete floor construction which embodies ducts or passages for supplying or returning air in connection with the heating and cooling of the building or other structure.

A further and more specific object is to provide a concrete floor construction comprising a reinforced concrete lower slab. A plurality of preformed blocks are placed on the upper side of the lower slab, so as to cover the lower slab. Each block comprises at least one inverted, generally frusto-conical member engaging the lower slab. Each frusto-conical member is hollow and is formed with a central opening extending downwardly to the lower slab. Moreover, each frusto-conical member has a flat horizontal bottom surface which engages the lower slab. Each preformed block also has an upper horizontal rim portion of rectangular shape, such rim portion being aligned with the rim portions of the adjacent blocks. An elevated concrete slab is poured over the preformed blocks so as to cover the blocks. The elevated slab extends downwardly through the openings in the frusto-conical members so as to form bonds with the lower slab. The preformed blocks provide spaces between and around the frusto-conical members, and are effective to exclude the concrete of the elevated slab from such spaces, whereby the spaces provide passages for air or the like.

Another aspect of the present invention relates to the preformed building block as such, comprising a preformed member having a generally horizontal upper flange portion and a downwardly tapering hollow portion. The hollow portion is formed with a generally axial opening extending in a generally vertical direction. Moreover, the hollow portion has a flat horizontal bottom supporting surface, whereby the block may be supported on a concrete slab or the like.

The building block may have one or more of the downwardly tapering hollow portions projecting downwardly from the upper flange portion.

In another aspect, the present invention comprises a concrete floor construction, including a concrete slab having a plurality of hollow, generally rectangular, preformed cells embedded therein and spaced apart in the slab. A monolithic structure of crisscrossing ribs of concrete is poured between the cells. Each cell comprises upper and lower half-boxes with open ends facing each other and forming a chamber in the cell. Each half-box has a closed end wall, directed upwardly or downwardly, and a plurality of side walls projecting toward the open end of the half-box. At least some of the side walls of the half-boxes are formed with notches at the open ends of the half-boxes. Duct members are closely received in the notches so as to extend between the chambers in the adjacent cells, to handle a flow of air between the chambers. The duct members are embedded in the concrete ribs between the cells. This floor construction may be employed by itself, or as the lower slab in the previously described composite floor construction, in which the lower slab supports the preformed blocks and the elevated slab. In the composite floor construction, two sets of air ducts are provided in the upper and lower slabs. Thus one set of ducts may be employed for supplying air, while the other set of ducts is employed for returning the air to the central heating or air conditioning plant.

Further objects and advantages of the present invention will appear from the following description, taken with the accompanying drawings, in which:

FIG. 1 is a fragmentary elevational section showing a composite floor construction to be described as an illustrative embodiment of the present invention.

FIG. 2 is a fragmentary elevational section similar to FIG. 1 and showing additional features of the floor construction.

FIG. 3 is a fragmentary diagrammatic plan view of the floor construction of FIG. 1.

FIG. 4 is an elevational view, partly in section, of one of the upper preformed blocks for the floor construction.

FIG. 5 is a plan view of the preformed block shown in FIG. 4.

FIG. 6 is a fragmentary enlarged section showing details of a joint between two of the upper preformed blocks.

FIG. 7 is a fragmentary sectional perspective similar to FIG. 6 but showing a modified joint construction.

FIG. 8 is a fragmentary elevational section showing the joint construction of FIG. 6 as incorporated into the finished floor.

FIG. 9 is a fragmentary elevational section showing a modified air terminal unit for use with the floor construction.

FIG. 10 is a fragmentary elevational section showing a baseboard type of air outlet for use with the floor construction.

As already indicated, FIG. 1 illustrates a reinforced concrete floor construction **20** which incorporates complete structural, mechanical and electrical facilities. The floor **20** is incorporated into a building or other structure **22** having columns **24** and walls **26** for supporting the concrete floor.

It will be seen that the concrete floor **20** comprises a poured concrete slab **28** with reinforcing rods, cables

or other members **30** embedded therein. The reinforcing members **30** are normally made of steel, but other materials of high tensile strength may be employed.

A plurality of hollow preformed cells **32** are incorporated into the concrete slab **28** to reduce the weight of the slab, while also providing ducts or conduits for carrying air, as well as openings or spaces for electrical and other facilities. The illustrated cells **32** are square, as viewed from the top, but they may be rectangular or some other suitable shape. The cells **32** preferably extend through the slab **28** for the full depth thereof, but the depth of the slab may exceed the height of the cells, in which case the slab will completely cover the cells.

As shown in FIG. 3, the cells **32** are preferably arranged in a regular rectangular pattern, so that the poured concrete slab **28** will have intersecting ribs **34** extending between the cells. The ribs **34** are arranged in a pattern resembling a rectangular grid as viewed from the top. It will be seen that certain of the reinforcing rods or other members **30** are appropriately placed in the ribs **34** so that the rectangular grid formed by the ribs is capable of providing the main structural support for the floor. The grid-like ribs **34** act as beams to support the weight of the floor as well as the load which is placed on the floor, due to use of the building.

Preferably, each of the rectangular cells **32** comprises a pair of preformed blocks or shells **36** which are stacked, one upon the other, during the construction of the floor. Each of the illustrated blocks **36** is in the form of a rectangular tray or half-box, comprising a horizontal wall **38** and a set of four side walls **40**. The block is open on the side opposite from the horizontal wall **38**. The blocks **36** are preferably made of precast concrete, but may also be made of gypsum, vitrified clay, or other suitable materials.

The blocks **36** are assembled with the lower block in an upright position, to open upwardly, and with the upper block in an inverted position, to open downwardly into the lower block. Thus, the horizontal wall **38** of the lower block forms the bottom wall of the cell **32**. The horizontal wall **38** of the upper block forms the top wall of the cell. The side walls **40** of the superimposed blocks are aligned with one another to form the side walls of the cell **32**.

In the construction of the concrete slab **28**, temporary forms are built to support the slab. The pairs of blocks or half-boxes **36** are placed on the forms in the desired rectangular pattern. The reinforcing members **30** are placed above the forms. Then, concrete is poured into the forms to a depth corresponding to the total depth of the stacked blocks **36**. The concrete fills the spaces between the cells **32** so as to form the ribs **34**. After the concrete has hardened and cured sufficiently, the temporary forms may be removed. It will be evident that the filler blocks **36** serve as permanent forms which are incorporated into the poured concrete slab **28** to form the cells **32**.

In order that the hollow cells **32** may serve as air ducts, interconnecting conduits or ducts **42** are provided between the cells. The conduits **42** may be made of sheet metal or other suitable materials. In the illustrated construction, openings **44** are formed in the side walls **40** of the blocks **36** to receive the conduits **42**. The illustrated openings **44** are oval in shape but may be of any suitable shape. One half of each of the openings **44** is formed in each of the superimposed blocks **36**. The openings are preferably preformed in all four sides of the blocks **36**. Any of the openings which are not needed or desired may be closed by suitable panels **46** during the construction of the concrete slab **28**. The panels **46** may be made of sheet metal or other suitable material.

The conduits or pipes **42** are installed between the blocks **36** as the blocks are positioned on the temporary forms during the construction of the floor. Thus, all of the conduits **42** are in place before the concrete is poured

to complete the slab **28**. As shown in FIG. 1, some of the cells **32** may be formed with air openings **48** for admitting or discharging air. Each opening **48** is preferably formed in the lower horizontal wall **38** of the corresponding cell **32**. A grill or louver structure **50** may be mounted in or over the opening **48**. The opening **48** may be preformed in the corresponding block **36**, or may be cut through the horizontal wall of the block.

The hollow cells **32** may also be employed to carry other facilities such as pipes **52** for an automatic sprinkler system. As shown in FIG. 1, the pipes **52** extend through the conduits or ducts **42**. Sprinkler heads **54** may be connected to the pipes **52** by means of suitable branch pipes **56**. Openings **58** may be drilled or otherwise formed in the lower horizontal walls **38** of the cells **32** to accommodate the sprinkler heads **54**.

The lower slab **28** may be employed by itself, in some cases, but it is preferred to employ the slab **28** to support an elevated floor structure **60** which incorporates other mechanical and electrical facilities. As shown in FIG. 1, the elevated floor structure **60** employs preformed blocks **62** which provide hollow spaces or passages **64** within the elevated floor structure. The passages **64** are preferably employed as ducts or conduits to carry air in connection with the heating or cooling of the building. Thus, the concrete floor **20** provides two sets of air passages. One set is formed by the lower cells **32** and the interconnecting ducts **42**, while the other set is formed by the passages **64** in the elevated floor structure **60**. It is preferred to employ the upper passages **64** to supply air to the rooms of the building, while the lower passages in the cells **32** are employed for the return flow of air. However, this situation could be reversed. During the heating season, warm air is preferably supplied through the upper passages **64** so that the upper floor structure **60** will be heated to provide a radiant heat transfer component for the rooms of the building. The heated air may also be discharged into the rooms of the building. Cool air may be supplied similarly. The preformed blocks **62** are preferably made of precast concrete, but may be made of other suitable materials, such as gypsum, vitrified clay, or the like.

As shown to particular advantage in FIGS. 4 and 5, the illustrated preformed blocks **62** comprise members **66** which are generally frusto-conical in shape but are inverted so that the passages **64** will be formed between the adjacent members. The illustrated frusto-conical members **60** are curved or arching rather than being straight in slope. Each member **66** is hollow and thus is generally in the form of an upwardly flaring tube, resembling the bell of a trumpet or flower of a morning glory. The lower end of each member **60** is circular, but the upper end forms a square or rectangular rim **68**.

Each of the illustrated preformed blocks **62** is formed with two of the frusto-conical trumpet-shaped members **66**. However, this situation could be varied. Thus, for example, it would be convenient in some cases to form each frusto-conical member **66** as a separate block, or to combine four of the members **66** into a single block.

The upper floor structure **60** is constructed after the lower concrete slab **28** is completed. The preformed fillers or blocks **62** are placed on the slab **28** in the desired pattern. In the illustrated construction, four of the inverted frusto-conical members **66** are placed over each of the cells **32** in the slab **28**. Thus, two of the blocks **62** are placed over each cell **32**, as will be evident from FIG. 3. The size of the blocks **62** corresponds to the size of the cells **32** plus the width of the concrete ribs **34** between the cells.

The rectangular rims **68** of the upper form blocks **62** are made to provide continuous coverage of the slab **28**, except for the upwardly flaring openings **70** in the frusto-conical members **66**. Such openings **70** extend all the way through the blocks **62**. After the upper form blocks **62** are in place, concrete is poured over the blocks to form a continuous deck or floor surface **72**. The con-

crete fills the openings **70** within the frusto-conical members **66** and comes into contact with the upper side of the lower slab **28** within each of the openings. Thus, bonds are formed between the upper slab or deck **72** and the lower slab **28** within the openings **70** in the blocks **62**. In this way, the slabs **28** and **72** are securely joined to form a unitary structure.

Before the upper concrete slab **72** is poured, electrical conduits or raceways **74** and **76** may be mounted over the blocks **62**. The conduit **74** may be used for power wires, while the conduit **76** may be employed for telephone or other signal wires. As shown, the conduits **74** and **76** are preferably located over the frusto-conical members **66**. In this way, cross-overs between the conduits may be formed by providing offset or bent portions **78** which dip downwardly into the openings **70** within the frusto-conical members **66**.

Provision should be made for all mechanical and electrical facilities, insofar as possible, before the upper concrete slab **72** is poured. Thus, branch conduits **80** may be extended downwardly from the power conduit **76** through the openings **70** in the frusto-conical members **66** to afford electrical connections for lighting fixtures **82** or other electrical units to be mounted on the underside of the lower slab **28**. A suitable opening **84** may be drilled or otherwise formed through the upper horizontal wall **38** of the corresponding cell **32** to accommodate the branch conduit **80**. A flexible conduit **86** is preferably employed between the lower end of the branch conduit **80** and the lighting fixture **82**. An opening **88** may be drilled or otherwise formed in the lower horizontal wall **38** to accommodate the flexible conduit **86**.

It will be evident that the opening **70** in the frusto-conical members **66** of the upper form blocks **62** provide convenient access to the cells **32** of the lower slab **28**. Holes may easily be drilled through the upper walls **38** of the cells to accommodate electrical conduits and other facilities, as needed.

The upper slab **72** provides a smoothly finished, continuous floor surface **90**. If desired, acoustical plaster or other suitable finishing material **92** may be applied to the underside of the slab **28** to provide an attractive ceiling surface for the rooms below.

It is preferred to supply air to the passages **64** in the elevated floor structure **60** from a central source, such as a blower or fan. The air supplied to the passages **64** is normally heated during the heating season and cooled when air-conditioning is required. During the heating season, the heated air warms the upper slab **72** so that it provides a component of radiant heat transfer.

Various outlet or terminal devices may be employed for discharging the air from the passages **64** into the rooms of the building. One such terminal device **94** is illustrated in FIG. 1. The terminal device **94** is mounted above the upper slab **72** and adjacent one of the walls **26**. An opening **96** is formed in the edge portion of the upper slab **72** to provide for the flow of air from the passages **64** to the terminal device **94**. It will be seen that the terminal device **94** comprises a housing **98** having openings **100** therein for discharging the air into the room. The air passes upwardly from the opening **96** and through an induction nozzle **102** into the housing **98**, and then out of the housing through the openings **100**. A regulating or balancing damper **104** may be provided in the housing **98** below the nozzle **102**.

The terminal device **94** also includes a unit **106** for drawing air into the housing **98** from the room through openings **108**. Such air is discharged from the housing **98** through the openings **100**. The unit **106** is capable of heating or cooling the air drawn from the room. For this purpose, the unit **106** is connected to pipes **110** and **112** through which a heating or cooling fluid may be supplied to the unit **106**. Thus, for example, hot water may be supplied to the unit **106** during the heating season, while chilled water may be supplied during the cooling season.

As already indicated, air is returned from the rooms to the interior of the cells **32** through the return air grills or louvers **50**. The return air is preferably carried to the central fan or blown by the cells **32** and the interconnecting ducts **42**.

Air may also be returned to the cells **32** through openings **114** in the lighting fixtures **82**. The air passes upwardly into the overlying cells through openings **116** which are drilled or otherwise formed in the lower walls **38**. The air passing through the lighting fixtures **82** is heated to an appreciable extent by the heat of the lamps **118**. This heat passes into the cells **32** and thus is recovered by the central ventilating system.

Additional features of the floor construction are shown in FIG. 2. It will be understood that the various features are optional and may be employed as needed.

While the lighting fixture **82** of FIG. 1 is of the fluorescent type, FIG. 2 illustrates an incandescent type lighting fixture **120** which is recessed upwardly into one of the cells **32**. An opening **122** is formed in the lower wall **38** of the cell **32** to accommodate the lighting fixture **120**. A flexible electrical conduit **124** is preferably employed to supply power to the fixture **120**. Like the flexible conduit **86** of FIG. 1, the flexible conduit **124** is connected to one of the branch conduits **80** which comes down through the opening **70** in one of the frusto-conical members **64**. It will be seen that the flexible electrical conduit **124** extends through one of the interconnecting ducts **42** between the cells **32**. The ducts **42** make it easy to install electrical fixtures or appliances in any of the cells **32**, even after the entire floor has been completed. The fixture may simply be connected to the nearest branch conduit **80** through the ducts **42**.

The lighting fixture **20** may also function as a return air inlet. Thus, air may enter the fixture **120** through the lower opening **126** therein, and may pass out of the fixture into the cell **32** through louvered openings **128** in the sides of the fixture.

Various terminal devices may be employed to supply air from the passages **64** in the elevated floor **60** to the rooms below the lower floor slab **28**. FIG. 2 illustrates such a terminal unit **130**, which is in the form of a hollow tubular housing extending through the entire thickness of the lower slab **28** from one of the passages **64**. If desired, a variable volume damper **132** may be installed in the terminal device **130**, to provide for the regulation of the amount of air supplied to the room below.

A suitable opening **134** is cut or otherwise formed in the lower wall **38** of the cell **32** to accommodate the upper end of the terminal unit **130**. The opening **136** may be drilled or cut from below by working through the opening **134**. Thus, additional terminal units **130** may easily be installed after the entire floor has been completed.

FIG. 2 also illustrates another terminal unit **138** which is the same as the terminal unit **130**, except that a heating device **140** is installed in the terminal unit **138**, instead of the blower **132**. The heating unit **140** is illustrated as being an electric heater. A flexible electrical conduit **142** is connected between the heater **140** and one of the branch conduits **80**. The electric heater **140** may be thermostatically controlled to provide individual regulation of the temperature in the room below.

As illustrated in FIG. 3, the cells **32** may be made smaller in the vicinity of the column **24**. Moreover, the cells **32** may be spaced apart more widely in the neighborhood of the columns **24**. In this way, the amount of poured concrete is increased in the vicinity of the columns **24**, so as to increase the strength of the lower slab **28**. In this way, the slab is adequately strong to resist the greater shear stresses which exist around the column.

When the elevated floor structure **60** is being constructed, the preformed blocks **62** may be stabilized by employing devices therebetween for maintaining alignment between the adjacent blocks. FIG. 6 illustrates such an aligning device **144**, which comprises a pair of plates

or washers **146** adapted to form bridges between the rim portions **68** of the adjacent blocks **62**. The washers **146** engage the upper and lower sides of the rim portions **68**. A bolt **148** is preferably employed to clamp the washers **146** against the rim portions **68**. The bolt **148** extends through the washers **146** and through the joint between the adjacent rim portions **68**. Notches **150** may be formed in the rim portions **68** to accommodate the bolt **148**. A wing nut **152** is preferably provided on the bolt **148** so that it may readily be tightened against the washers **146**.

FIG. 7 illustrates another aligning device **154** which may be substituted for the device of FIG. 6. The aligning device **154** is in the form of a clip which is H-shaped in cross section. Thus, the device **154** has upper and lower flanges **156** with a central web **158** extending therebetween. The flanges or plates **156** engage the upper and lower sides of the adjacent rim portions **68**, while the web **158** passes between the adjacent rim portions. The clip **154** may also be described as being I-shaped in cross section.

FIG. 9 illustrates a terminal device **160** which is similar to the terminal device **94** of FIG. 1, except that the terminal device **160** is adapted particularly for use in school buildings. Thus, the terminal device **160** employs a housing **162** which extends to a greater height than the housing **98**, so that book shelves **164** may be built into the lower portion of the housing **162**. The other components of the terminal device **160** are the same as illustrated in FIG. 1 and are given the same reference characters.

FIG. 10 illustrates a baseboard-type of terminal device **166**, in the form of a low housing adapted to extend along one wall of the building in place of the baseboard. An opening **168** is formed in the upper slab **72** so that air may pass upwardly through the passages **64** into the terminal device **166**. The air passes out of the terminal device **166** through one or more openings **170** therein. Heating or cooling coils may be provided in the housing **166**, if desired.

It may be helpful to review the procedure which is employed in constructing the floor **20** of FIG. 1. Temporary forms are erected to support the cells **32**, which are placed upon the forms in a regular rectangular pattern. Each cell **32** comprises two of the preformed, pan-shaped blocks or half-boxes **36**, stacked edge to edge. The reinforcing rods or members **30** are also mounted over the temporary forms. The interconnecting ducts or conduits **42** are installed between the adjacent cells **32**. Any unused openings **44** in the cells are closed by the panels **46**. The sprinkler piping **52** and any similar facilities are installed in the ducts **42**.

After these preparations have been made, the concrete is poured into the forms to form the slab **28**, including the ribs **34** between the cells **32**. The ribs **34** form a rectangular grid which provides the main structural support for the floor. The concrete is illustrated as being poured to a depth corresponding to the height of the cells **32**, so that the poured concrete will be flush with the upper sides of the cells. However, the slab may be poured to a greater depth so as to cover the upper sides of the cells.

After the concrete in the slab **28** has hardened, the upper preformed blocks **62** are placed on the slab. Two of the blocks **62** are located over each cell **32**. Inasmuch as each block **62** comprises two of the frusto-conical members **66**, there are four of the frusto-conical members over each cell **32**. The blocks **62** provide continuous coverage for the slab **28**, except for the central openings in the frusto-conical members **66**.

The stabilizing devices **144** may be installed between the adjacent form blocks **62**, as shown in FIGS. 4, 6 and 8. Alternatively, the stabilizing or aligning devices **154** of FIG. 7 may be employed.

The electrical conduits or raceways **74** and **76** are mounted over the preformed blocks **62**. Crossovers may be provided between the conduits by providing the downwardly bent portions **78** which dip into the openings in the frusto-conical members **66**.

The branch electrical conduits **80** are extended downwardly from the conduits **74** through the openings **70** in the preformed blocks **62**. The necessary openings **84** are drilled or otherwise formed in the upper walls **38** of the cells.

After all the desired electrical and other facilities are in place, concrete is poured over the preformed blocks **62** to form the upper slab **72**. The concrete fills the openings **70** in the blocks **62** and forms bonds with the upper side of the lower slab **28**.

After the floor has been completed, openings may be cut or otherwise formed in the lower walls **38** of the cells **32** to accommodate the lighting fixtures **82** and **120**, the return air grills **50**, the terminal units **130** and **138**, and any other fixtures or facilities which may be desired.

The passages **64** formed by the frusto-conical members **66** of the upper blocks **62** are preferably employed to carry air to be supplied to the rooms of the building. The air supplied to the passages **64** is heated during the heating season. In this way, the floor is heated so that it provides radiant heating. The air is discharged into the rooms by the various types of terminal units **94** (FIG. 1), **130** and **138** (FIG. 2), **160** (FIG. 9), and **166** (FIG. 10). Inasmuch as the passages **64** extend throughout the entire elevated floor structure **60**, a terminal unit may be located at any desired point above the floor, at either an exterior or an interior location. When remodelling is necessary, an opening may easily be cut through the upper slab **72** into one of the passages **64**.

If it is desired to supply air to the room below, a terminal unit may be installed so as to extend through any of the cells **32**. Such terminal units are illustrated in FIG. 2.

The preformed blocks **62** of the elevated floor structure **60** are positioned so that four of the frusto-conical members **66** are located in a regular pattern over each of the cells **32** in the lower slab. Thus, one of the passages **64** in the elevated floor structure **60** is disposed directly over the center of each cell **32**. This arrangement is highly advantageous, because one of the terminal devices, of the type illustrated in FIG. 2, may be installed in any cell, with complete assurance that the upper end of the terminal device will have full communication with the passages **64** in the elevated floor structure.

Return air openings may be provided as needed in the lower walls of the cells. The lighting fixtures may also be constructed so as to serve as return air openings.

The passages **64** in the elevated floor structure **60** may be divided into zones or sections, if desired, by inserting panels between the preformed blocks **62** during the construction of the floor. In this way, the temperature or volume of the air supplied to the various zones may be controlled separately.

Similarly, the closure panels **46**, as shown in FIG. 1, may be employed to divide the lower slab **28** into zones or sections, so that the flow of air in the various zones may be controlled separately. The panels **46** are adapted to close the openings **44** in the side walls **40** of the cells, as desired.

The floor construction has the advantage of extremely low transmission of sound, due to the provision of the upper and lower superimposed slabs, each of which comprises preformed blocks plus a large mass of poured concrete. Moreover, the fire rating of the floor construction is high, with no need for additional fireproofing.

The concrete floor construction of the present invention is applicable to all types of building construction. However, it is particularly advantageous for office buildings, other commercial buildings, schools and apartment buildings.

The upper and lower floor slabs are preferably used together, to form a composite floor structure, but they may be used separately, or in connection with other floor slab constructions.

The concrete floor construction of the present invention is not subject to corrosion or deterioration due to high humidity, salt air, and other factors which normally

result in the rapid corrosion of ordinary steel ducts employed in conventional heating and ventilating systems. Thus, the concrete floor construction is particularly advantageous for use in the tropics, near seacoasts, and in other areas where corrosive atmospheric conditions are prevalent.

The supply and return air passages in the upper and lower slabs are large in effective cross section so that they afford ample carrying capacity for the flow of air. Thus, the power requirement for circulating the air is minimized. Accordingly, the cost of operating the circulating fans is low. Moreover, the air moves at low velocity so that a minimum of noise is produced by the ventilating system.

The floor construction of the present invention is particularly advantageous for the construction of buildings in cold weather, because the passages in the floor may be employed immediately as heating ducts to provide temporary heat in the building. There is no need to wait for the installation of separate heating ducts.

It will be evident that the floor construction of the present invention provides all of the necessary structural, mechanical and electrical facilities which will be needed in the building. Such facilities are provided at extremely low cost, and in a manner which greatly facilitates the construction of the floor.

We claim:

1. A concrete floor construction, comprising the combination of

a reinforced concrete lower slab,

a plurality of preformed blocks covering the upper side of said lower slab,

each of said blocks comprising at least one inverted generally frusto-conical member engaging the upper side of said slab,

each of said frusto-conical members being hollow and having a central opening therein extending downwardly to the upper side of said slab,

each of said frusto-conical members having a flat horizontal bottom surface engaging said slab for supporting the corresponding block,

each of said preformed blocks having an upper horizontal rim portion of rectangular shape,

said rim portion being aligned edge-to-edge with the rim portions of the adjacent preformed blocks,

and an elevated concrete slab extending over and covering said preformed blocks,

said elevated slab extending downwardly through said openings in said frusto-conical members and forming bonds with said lower slab,

said preformed blocks having spaces between and around said frusto-conical members and being effective to exclude the elevated concrete slab from said spaces whereby said spaces provide passages for air or the like.

2. A concrete floor construction according to claim **1**, in which each of said preformed blocks comprises only one of said frusto-conical members.

3. A concrete floor construction according to claim **1**, in which each of said preformed blocks comprises a pair of said inverted frusto-conical members.

4. A concrete floor construction according to claim **1**, in which electrical conduits are embedded in said upper elevated concrete slab above said preformed blocks, and in which at least two of said conduits cross each other,

one of such crossing conduits having a downwardly offset portion which dips downwardly into one of said openings in said inverted frusto-conical members at the cross-over point with the other crossing conduit.

5. A concrete floor construction according to claim **1**, comprising a terminal device disposed above said elevated concrete slab and having an outlet opening for discharging air or the like,

said elevated slab having a connecting opening extending upwardly therein from said passages in said elevated slab for connecting said passages to said terminal device.

6. A concrete floor construction according to claim **1**, including a plurality of aligning devices connected between the rim portions of the adjacent preformed blocks for aligning and stabilizing said blocks.

7. A concrete floor construction according to claim **1**, in which a plurality of aligning devices are connected between said rim portions of the adjacent preformed blocks for maintaining said rim portions in alignment,

each of said aligning devices comprising upper and lower washers engaging the upper and lower sides of said rim portions,

and a bolt extending through said washers and between said rim portions for clamping said washers against said rim portions.

8. A concrete floor construction according to claim **1**, in which said lower slab comprises a plurality of hollow preformed cells embedded therein,

said cells being spaced apart in said lower slab with concrete supporting ribs disposed between said cells,

each of said cells having an upper wall flush with the upper side of said lower slab,

said bottom surfaces of said inverted frusto-conical members being supported directly on said upper walls of said cells,

said bonds with said elevated slab being formed with said upper walls of said cells.

9. A concrete floor construction according to claim **8**, comprising a main electrical conduit embedded in said elevated slab above said preformed blocks,

a branch electrical conduit connected to said main conduit and extending downwardly through one of said openings in said inverted frusto-conical members and through said upper wall of one of said cells into the corresponding cell,

and an electrical device mounted on said cell and connected to said branch electrical conduit,

said upper wall of said cell being formed with an opening to accommodate said branch electrical conduit.

10. A concrete floor construction according to claim **8**, comprising a terminal conduit extending through said lower slab from one of said passages in said elevated slab,

said terminal conduit extending through one of said cells,

said upper wall of the corresponding cell being formed with an opening to accommodate said terminal conduit.

11. A concrete floor construction according to claim **10**, in which said cell has a lower wall formed with another opening to accommodate the lower portion of said terminal conduit.

12. A concrete floor construction according to claim **8**, in which a plurality of ducts are connected between the adjacent cells and are embedded in said lower slab for the passage of air or the like through said cells.

13. A concrete floor construction according to claim **12**, in which at least one of said cells is formed with a bottom wall having an opening extending therethrough for the passage of air or the like.

14. A concrete floor construction according to claim **8**, in which four of said inverted frusto-conical members of said preformed blocks are positioned over each of said cells in said lower slab.

15. A concrete floor construction according to claim **1**, in which said concrete lower slab comprises a plurality of hollow generally rectangular preformed cells embedded in said lower slab,

said cells being spaced apart in said lower slab,

said lower slab comprising a monolithic structure of crisscrossing ribs of concrete disposed between said cells,

each of said cells comprising upper and lower half-boxes with open ends facing each other and forming a chamber in said cells,
each of said half-boxes having a closed end wall and a plurality of side walls projecting therefrom toward the open end of said half-boxes,
at least some of said side walls of said half-boxes being formed with notches at the open ends of said half-boxes,
and duct members closely received in said notches and extending between said chambers in adjacent cells to handle a flow of air between said chambers,
said duct members being embedded in said concrete ribs between said cells.

16. A concrete floor construction according to claim **1**, in which said preformed blocks are made of precast concrete.

17. A concrete floor construction according to claim **1**, in which said preformed blocks are made of gypsum.

18. A building block, comprising
a preformed member having a generally horizontal upper flange portion and a downwardly tapering hollow portion projecting downwardly therefrom,
said hollow portion having a generally axial opening extending therethrough generally in a vertical direction,
said hollow portion having a lower end portion with a flat horizontal bottom supporting surface thereon.

19. A building block according to claim **18**, in which said hollow portion is generally of an inverted frusto-conical shape.

20. A building block according to claim **18**, in which said outwardly projecting generally horizontal flange portion is of substantially rectangular shape.

21. A building block according to claim **18**, in which said hollow portion is of an inverted frusto-conical shape,
and in which said outwardly projecting generally horizontal flange portion is of generally rectangular shape.

22. A building block according to claim **18**, made of precast concrete.

23. A building block according to claim **18**, made of gypsum.

24. A building block according to claim **18**, made of vitrified clay.

25. A building block, comprising
a preformed member having a generally horizontal upper flange portion with a pair of downwardly tapering portions projecting downwardly therefrom,
each of said downwardly tapering portions being hollow and having an axial opening extending therethrough generally in a vertical direction,
each of said downwardly tapering portions having a flat horizontal bottom supporting surface thereon.

26. A block according to claim **25**,

in which each of said downwardly tapering portions is of a generally inverted frusto-conical shape.

27. A block according to claim **25**, in which said flange portion is generally rectangular in shape.

28. A concrete floor construction,
comprising a concrete slab having a plurality of hollow generally rectangular preformed cells embedded therein,
said cells being spaced apart in said slab,
said slab comprising a monolithic structure of criss-crossing ribs of concrete disposed between said cells,
each of said cells comprising upper and lower half-boxes with open ends facing each other and forming a chamber in said cell,
each of said half-boxes having a closed end wall and a plurality of side walls projecting therefrom toward the open end of said half-box,
at least some of said side walls of said half-boxes being formed with notches at the open ends of said half-boxes,
and duct members closely received in said notches and extending between said chambers in the adjacent cells to handle a flow of air between said chambers,
said duct members being embedded in said concrete ribs between said cells.

29. A concrete floor construction according to claim **28**, in which said duct members are oval in cross section, and said notches are of corresponding semioval shape.

30. A concrete floor construction according to claim **28**, in which said cells are made of precast concrete.

31. A concrete floor construction according to claim **28**, in which said cells are made of gypsum.

32. A concrete floor construction according to claim **28**, in which said cells are made of vitrified clay.

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