

[54] VOID CREATING DEVICE TO BE EMBEDDED IN A CONCRETE STRUCTURE

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[51] Int. Cl.² E04B 5/48

[58] Field of Search 52/105, 99, 100, 220, 221, 52/309, 381, 383, 576, 577

[57] ABSTRACT

A device to be embedded in a concrete structure in order to define a labyrinth of passageways within the concrete structure is formed of frangible material and comprises an elongated hollow member preferably made of two interfitting sections, with the hollow member having at least two opposed projections disposed intermediate the length of the hollow member. When embedded in concrete, the ends of the elongated hollow member and the ends of the opposed projections extend to the surface of the concrete such that such projecting frangible elements may be punched out or removed in order to enable the passage of service lines through the interior of the concrete structure.

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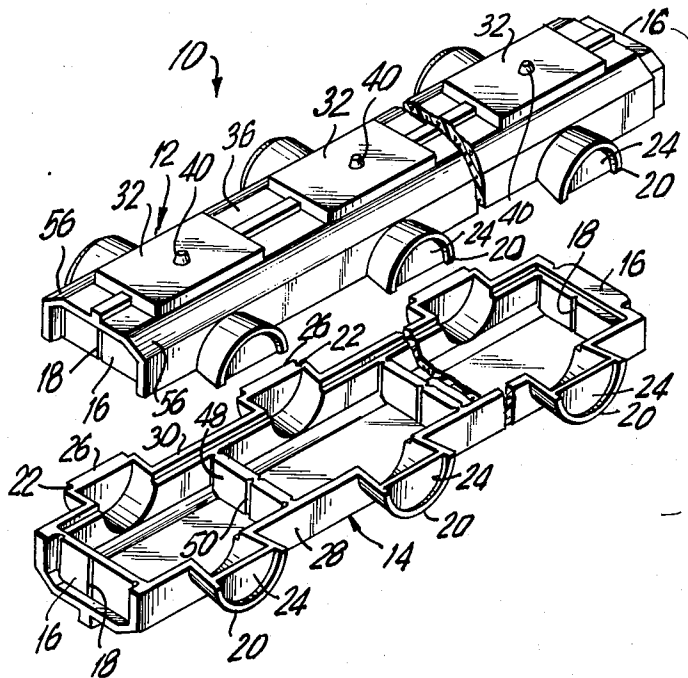
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25 Claims, 7 Drawing Figures



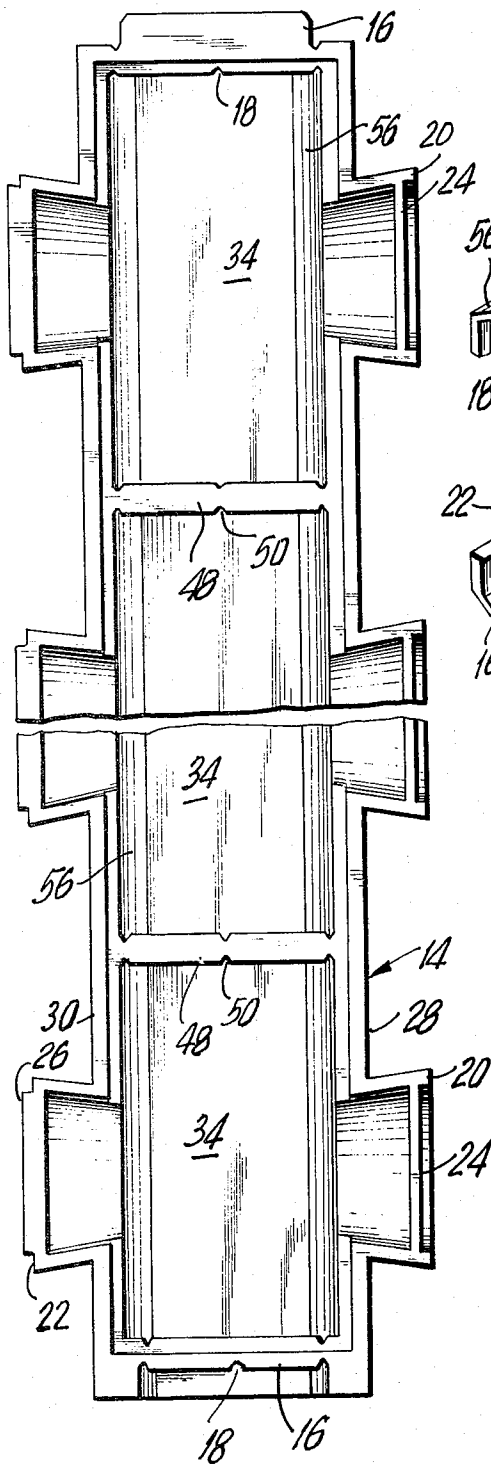


FIG. 2

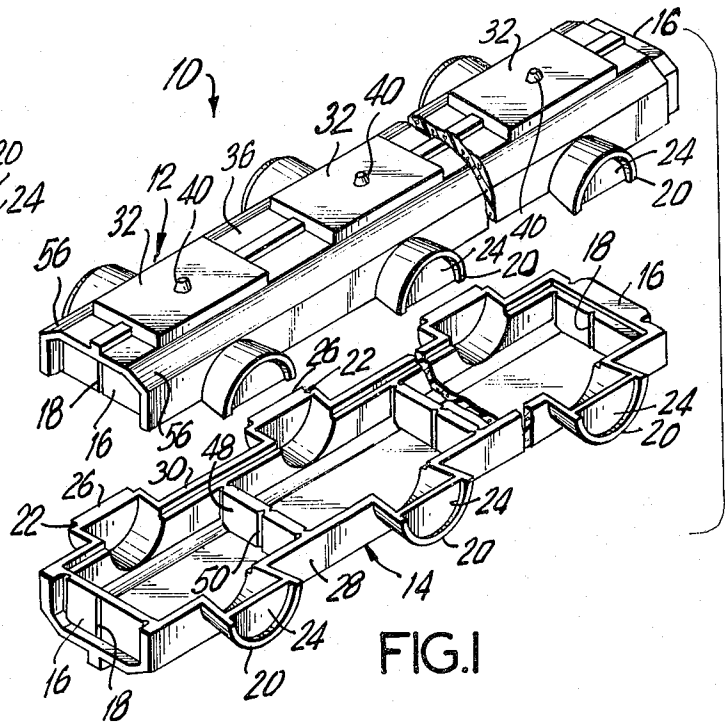


FIG. 1

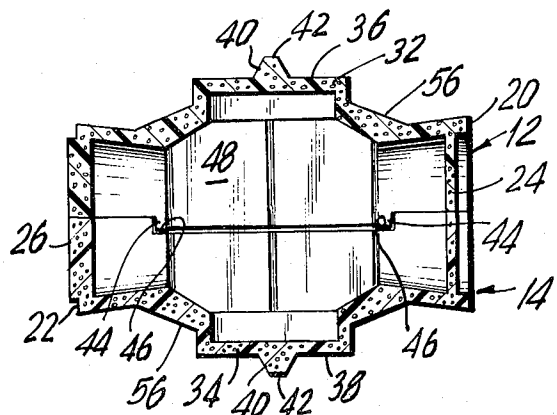


FIG. 3

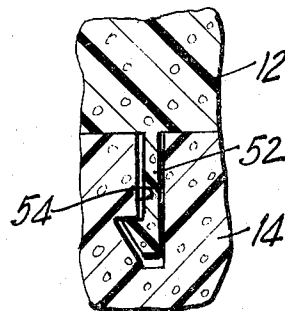


FIG. 4

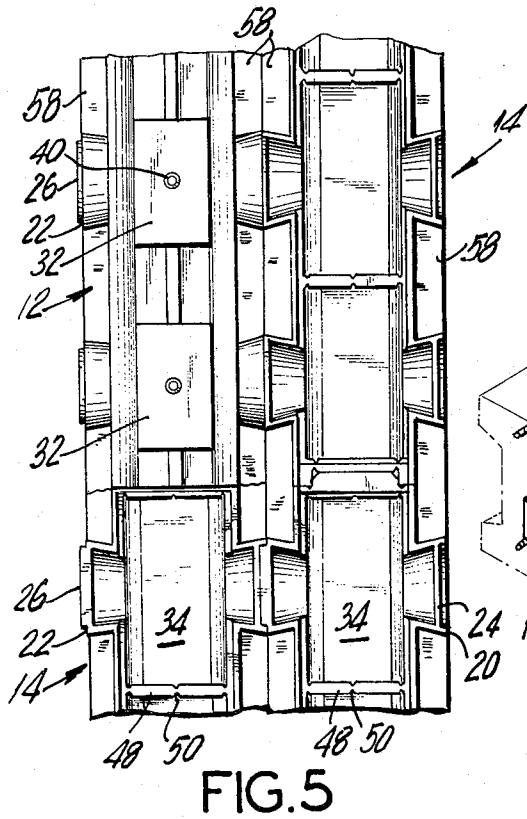


FIG. 5

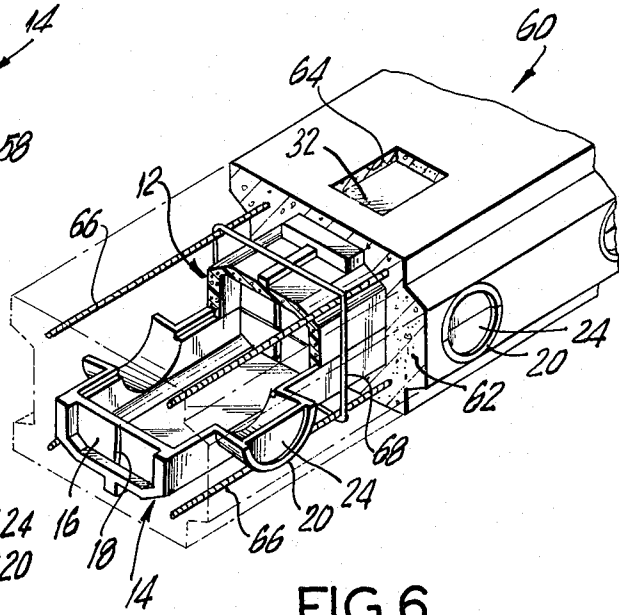


FIG. 6

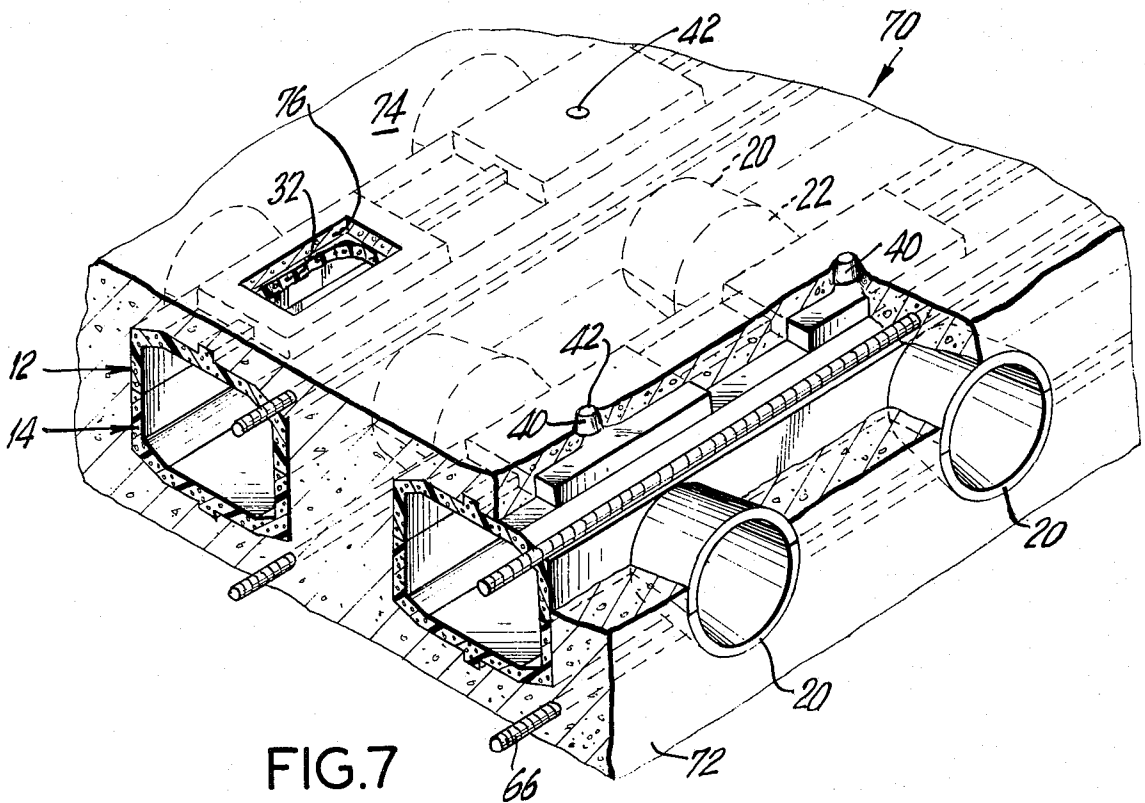


FIG. 7

VOID CREATING DEVICE TO BE EMBEDDED IN A CONCRETE STRUCTURE

CROSS-REFERENCE TO RELATED APPLICATIONS

The subject invention is related to the following corresponding applications of the applicant: (1) United States Application Ser. No. 399,087 filed Sept. 20, 1973 and entitled "CONCRETE STRUCTURE INCLUDING MODULAR CONCRETE BEAM AND METHOD OF MAKING SAME"; and (2) United States Application Ser. No. 486,605, filed July 11, 1974 and entitled "METHOD FOR MAKING CAST-IN-PLACE CONCRETE STRUCTURES."

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to a new and useful device to be employed in the construction of concrete structures. More particularly, the subject invention relates to a void creating device to be embedded in a concrete structure in order to define a labyrinth of passageways therein for enabling the passage of service lines and the like through the concrete structure, and in addition simultaneously providing the structure with improved insulative and sound deadening properties, without compromising the strength of the resulting structure.

Heretofore, voids in a concrete construction unit such as cored floor slabs, for example, have been known in the construction industry, and provide the benefits of improved weight-strength ratio by reducing unnecessary concrete in the construction unit, and simultaneously reducing the weight of the concrete unit. Other benefits which have been obtained to some degree is the limited insulation value of the simple core unit, as well as the ability to duct utility service lines through the single core units which extend in one direction and are of basic shapes such as round, square or rectangular.

The subject invention provides a new and useful void creating device which is to be embedded in a concrete structure and creates a completely new and revolutionary concept of voids in a concrete structure which will profoundly affect basic concrete structural design. The void creating device of the subject invention may be employed in the construction of pre-fabricated concrete beams which are later joined together to complete a concrete structure, or alternatively, may be employed in a cast-in-place concrete structure system which heretofore has been unsuccessfully attempted by means of the prior art single core members.

The primary accomplishments of the void creating device of the subject invention are:

1. The creation of a sophisticated labyrinth of passageways within the concrete structure, which passageways may be opened to the exterior of the concrete structure in any one of three mutually orthogonal axes;

2. Significant improvement in the weight-strength ratio of the concrete structure and a significant reduction of the mass-weight ratio, especially in light of the fact that up to 66 2/3% less concrete is required to complete a concrete structure when using the subject void creating device, as contrasted to conventional concrete construction. Furthermore, the design of the subject void creating device is controlled to eliminate all excess concrete but at the same time allow within

very critical tolerances, the correct amount of concrete for structural purposes. In addition the subject device may be configured to facilitate the proper and exact positioning of reinforcing bars within the concrete form during the pouring of the uncured concrete;

3. Extremely effective insulating properties of the resulting concrete structure which is inherently achieved by the embedding of the void creating device of the subject invention into the concrete structure;

4. As embedded in a concrete beam structure, the void creating device of the subject invention provides for connection and interconnection of individual concrete beam units so that the latter may function as a single unit in a completed building or wall structure;

5. The void creating device of the subject invention provides the capability for specific area reinforcing in the resulting concrete structure to meet the structural requirements of the structure, such as concentrated loads resistance to dynamic forces, specific area strength, etc.;

6. The void creating device is a single, all purpose, interchangeable construction module which may be readily employed by unskilled labor in the construction of concrete structures, and which, furthermore, does not require heavy construction equipment, thereby resulting in a great reduction of labor costs.

7. The unique configuration of the void creating device as embedded in a concrete structure provides three dimensional access to the interior of the concrete structure for enabling mechanical trades to duct service lines therethrough, and also to enable the connection of individual construction units together;

8. The void creating device as embedded in a modular concrete beam structure greatly reduces the weight of the resulting beam structure to create an extremely lightweight, interchangeable and completely self-integrating module which can be readily handled by manual labor;

9. The use of the void creating device of the subject invention reduces, up to 66 2/3%, the quantity of concrete required in a concrete structure, thereby decreasing the cost thereof, both in terms of material and labor; and

10. The use of interconnected void creating devices in a concrete structure provide an inherent three-directional, built-in network of ducts for heating and air conditioning.

In addition to the above, while embedded in the concrete structure, the void creating device of the subject invention inherently provides additional advantages to the resulting composite structure. More particularly, preferably the void creating device is made of an insulating material whereby additional insulative properties are imparted to the concrete structure, in addition to the insulative qualities provided by the labyrinth of passageways which define the dead air space within the concrete structure. Furthermore, since the insulation material of the void creating device per se and the dead air space are at the center of the concrete structure, this arrangement provides a unique self-integrated, single layer, self-insulated concrete structure that may be completely finished on both surfaces. This type of concrete structure has long been a desired objective of the construction industry, and is now provided by means of the void creating device of the subject invention. A second inherent advantage achieved by the employment of the subject invention as embedded in a concrete struc-

ture is the capability of achieving connections and interconnections, as well as reinforcing post and beam constructions. More particularly, in a concrete structure including a plurality of the subject devices, selected portions, or an entire void creating device, may be filed with concrete so as to provide a locally reinforced beam or post structure within the concrete structure in order to achieve required structural design capabilities. Another advantage inherently achieved by the subject void creating device is realized during the curing of the concrete structure. Since the void creating device is preferably made of a frangible, insulative, waterproof, inert, inorganic material, it tends to retain the heat given off by the concrete during curing thereby reducing the curing time of the concrete and increasing its strength.

These and other advantages and objectives are achieved by the void creating device of the subject invention which generally comprises an elongated hollow member made of a frangible, inert, waterproof, inorganic insulating material, and preferably made of two interfitting half-sections, with the elongated hollow member having at least two opposed projections disposed intermediate the length thereof. A single hollow member may be embedded in a single concrete beam, or a plurality of such elongated hollow members may be interconnected and placed within conventional concrete forms for the construction of a cast-in-place concrete structure. The opposite ends of each elongated hollow member are exposed, as well as some of the ends of the opposed projections, thereby enabling access, by removing or punching out of the frangible projections, to the labyrinth of passageways defined by the devices within the interior of the resulting concrete structure. Preferably, the void creating device is of generally rectangular cross section and includes two sets of opposed, spaced projections extending intermediate the length thereof, with the two sets of projections extending from the respective opposed sides of the rectangular cross section. By this arrangement, in conjunction with the ends of the hollow frangible member, three dimensional access is provided to the interior of the concrete structure.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded, perspective view of a void creating device of the subject invention;

FIG. 2 is a plan view of one of the two interfitting sections forming a portion of a void creating device of the subject invention;

FIG. 3 is a cross sectional view of the void creating device of the subject invention taken through an intermediate section where opposed projections are provided;

FIG. 4 is a detailed view of one embodiment of locking means for retaining two interfitting sections of the subject void creating device in a locked condition;

FIG. 5 is a plan view, partially in section, of an alternate embodiment of two interfitting void creating devices;

FIG. 6 is a perspective view, partially in section, of a void creating device as embedded in a single concrete beam structure; and

FIG. 7 is a perspective, partial sectional view, of a plurality of void creating devices as embedded in a cast-in-place concrete structure.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1, 2 and 3, the void creating device of the subject invention is designated by the numeral 10 and basically comprises an upper section 12 and a lower section 14, with the device 10 being of an integral, molded construction and made of a frangible material such as polystyrene foam. Alternatively, any other suitable plastic foam that is rigid and substantially non-compressible may also be employed for the manufacture of device 10, and other suitable plastic foams include epoxy foams, phenolic foams, polyurethane foams of the rigid or closed cell type, closed cell polyvinyl chloride foams, and cellulose acetate foams.

The configuration of the void creating device 10 is generally elongated, hollow member of generally rectangular cross section, which is closed at its opposed ends by means of baffles 16, 16. The end baffles 16, 16 are of tongue and groove configuration whereby two devices 10 may be interconnected and interfitted along their axial length when the devices are to be embedded in a concrete structure of greater length than each device 10. The end baffles 16, 16 may have lines 18 of reduced thickness in order to facilitate the removing or knocking out of the end baffles when it is desired to gain access to the interior of the resulting concrete structure for the passage of service lines or the like, as more fully described hereinafter.

Disposed intermediate the length of the device 10 is at least one pair of opposed projections 20, 22 that are hollow and include closure baffles 24 and 26, respectively, that may likewise be knocked out or removed in order to enable passage of service lines into the interior of the void creating device 10. As clearly illustrated in FIGS. 2 and 3, the opposed projections 20 and 22 are preferably of a truncated, conical configuration, with the greater diameter being at the extremity of each projection adjacent the respective closure baffle 24, 26, and as also more particularly illustrated in FIG. 3, the opposed projections 20 and 22 are configured in a tongue and groove configuration in order to enable the interconnection and interfitting of adjacent void creating devices, as more fully explained hereinafter with reference with FIG. 7.

As shown in FIG. 1, the void creating device may be provided with a plurality of the spaced opposed projections 20 and 22 extending from opposite sides 28 and 30 of the void creating device, and in addition a second set of opposed projections 32 and 34 may be provided on the other opposed sides 36 and 38 of the void creating device 10. Projections 32 and 34 may be of any suitable configuration, and are illustrated as being generally rectangular in configuration, as will be more fully described hereinafter, are usually positioned so as to face the opposed surface walls of the resulting concrete structure.

In order to maintain, during the construction of the resulting concrete structure, the void creating device at the desired location within the concrete form, the void creating device 10 may be provided with a plurality of spacer element 40 that are integrally formed with the opposed projections 32 and 34. As illustrated in FIG. 3, preferably each spacer element 40 is of a generally truncated conical configuration, having a relatively small flat end portion 42 which normally abuts against the concrete form for maintaining the device 10 in

proper position during the forming of the resulting concrete structure.

Extending along portions of the length of the upper section 12, and internally thereof are elongated flanges 44 which cooperate with similarly configured longitudinally extending cut-outs 46 (see FIG. 3) provided in the lower section 14 in order to maintain the upper section 12 and lower sections 14 in interfitting relationship. Similar flange and cut-out arrangements may also be provided along the end baffles 16, 16 for additional support.

Disposed internally of the void creating device 10 are internal baffles 48 which extend transverse to the longitudinal axis of the device 10, and which function to compartmentalize the interior of the void creating device 10. Each baffle 48 may also include reduced thickness lines 50 which define lines of weakness in order to facilitate the knocking out of the internal baffles 48 when it is desired to duct service lines or the like therethrough. As shown, the internal baffles 48 are defined by cooperating half-sections formed integral with upper section 12 and the lower section 14.

In order to maintain the upper and lower sections 12, 14 in a locked relationship, a suitable locking means, preferably of the mechanical type and formed integral with said sections 12 and 14, may be provided. As an example, reference is made to FIG. 4 wherein formed integral with the upper section 12 is a protrusion or hook shaped extension 52 which is adapted to be inserted and force fit into a cooperating hole 54 in the lower section 14 in order to lock the lower and upper sections together. Such locking mechanism may be provided at the four corners of the upper and lower sections, and possibly intermediate the length thereof where required. Alternatively the half-sections may be bonded together.

Referring again to FIG. 3 the corners of the cross section of the void creating device 10 are preferably beveled, as designated by numeral 56. The beveling of the corners facilitates the positioning of reinforcing bars extending parallel to the longitudinal axis of the void creating device and disposed at positions adjacent to the corners 56. This is more particularly shown in FIGS. 6 and 7.

FIG. 5 illustrates an alternate embodiment of the void creating device, and is partly in section in order to clearly indicate the interfitting of two void creating devices preparatory to being embedded in a concrete wall structure. As illustrated in FIG. 5, the opposed projections 20, 22 of the adjacent devices are interfitted by virtue of their tongue and groove configuration in order to establish an interlocking relationship between the adjacent void creating devices 10. In addition, as a modification of each device, each device is provided with elongated strips 58 which project laterally from the sides 28 and 30 intermediate the spaced projections 20 and 22. When two void creating devices are interfitting as shown in FIG. 5, the elongated strips 58, being an integral part of the respective void creating device 10, are in the abutting relationship thereby defining a complete insulation barrier which is to be embedded in a concrete wall. The elongated strips 58 are preferably flat, and may extend from both the upper and lower sections 12, 14, or alternatively, the strips 58 may be provided only on one of the sections of the void creating device. The thickness of strips will generally conform to the thickness of the walls of the void creating

device 10, and as previously mentioned, would be integrally molded with the device so as to form a single unitary structure. In the lower right hand corner of FIG. 5 there is illustrated the interconnection of two devices 10 by the interfitting of their tongue and groove end portions adjacent baffles 16, 16.

FIG. 6 illustrates the use of a void creating device 10 of the subject invention as embodied in a concrete beam in order to provide three dimensional access to the internal hollow structure of the beam. More particularly, as shown in FIG. 6, the concrete beam 60 comprises a composite structure of the internal void creating device 10 which is surrounded by and in intimate contact with a continuous circumferential concrete structure 62. That is, except for the end baffles 16, and the exposed baffles 24, 26 of the opposed spaced projections 20, 22. In addition, because of the fact that the opposed projections 32 and 34 extend beyond the opposed surfaces 36 and 38, the thickness of the concrete 62 in the region of said projections 32 and 34 is less than around other portions of the void creating device. Accordingly, access to the hollow interior of beam 60 may be readily accomplished through the top of the beam (as shown in FIG. 6) by cutting a hole 64 in the concrete structure 62 in the region of the projection 32 to thereby provide access through the upper portion of the beam to the interior of the void creating device 10. Since the opposed projections 20 and 22 extend to the outer surface of the concrete 62, access to the interior of the void creating device through the opposed projection 20 and 22 is simply a matter of removing or knocking out the baffles 24 and 26 within the projections 20 and 22, respectively. Likewise, access through the ends of the beams is readily accomplished since end baffles 16 of the void creating device 10 are exposed. By this arrangement, it is apparent that three dimensional access to the interior of the void creating device (and hence the beam 60) is readily achieved. Thus the labyrinth of passageways within each beam 60 is readily accessible for passage of service lines and the like of the resulting building structure in which the beam 60 is embodied. As illustrated in FIG. 6, preferably reinforcing bars 66 are disposed adjacent each of the beveled corners 56 of the void creating device, and in addition circumferential reinforcing bars 68 may be provided. As an example of the type of concrete structures which may be constructed utilizing the composite concrete beams of the type illustrated in FIG. 6, reference is made to applicant's copending application, U.S. Ser. No. 399,087 entitled "Concrete Structure Including Modular Concrete Beam And Method of Making Same" filed Sept. 20, 1973.

FIG. 7 illustrates the employment of the void creating device 10 of the subject invention in a cast-in-place concrete system. As illustrated, a plurality of the devices 10 are interconnected through the tongue and groove arrangements of the spaced opposed projections 20, 22, and are entirely embedded within the composite concrete structure 70, except for the end baffles of the devices (which are illustrated as having been removed) and the projections 20 extending along the end wall 72 of the concrete structure 70. A portion of the upper wall 74 of the concrete structure has been removed as designated at 76 in the vicinity of the projection 32 (a portion of which is also shown removed) extending from the upper surface 36 of the void creating device 10 in order to provide access through the

upper wall 74 of the concrete structure 70 of the interior of the void creating device 10. Accordingly three dimensional access to the interior of the resulting composite concrete structure 70 is available. More particularly, access along the longitudinal axis of the structure 70 is achieved through the end baffles 16 of the void creating device 10; lateral access is achieved through the projections 20; and vertical access is achieved through the opening 76 cut into the concrete structure and thence through the projection 32 to the interior of the void creating device 10. Because of the interfitting of abutting projections 20 and 22 of adjacent devices 10, a complete three dimensional labyrinth of passageways within the resulting concrete structure 70 is provided. Further details relative to the method of making a cast-in-place concrete structure utilizing void creating devices of the subject invention may be obtained from applicant's co-pending application entitled "Method For Making Cast-in-place Concrete Structures" filed concurrently with the subject application.

In summary, the void creating device of the subject invention provides the desirable objectives as fully set forth above, and in particular greatly improves the weight-strength ratio of the resulting concrete structure, while simultaneously reducing the weight of the concrete structure, and providing all of additional benefits fully discussed above. The substantial savings in time, weight and the economy of utilizing the void creating devices of the subject invention are advantages supplemental to the advantage of obtaining a superior concrete structure which is capable of accomodating service lines in any of three mutually orthogonal directions, a feature not heretofore accomplished by simple core arrangements in concrete structures. In addition, the void creating device 10 of the subject invention inherently provides the desirable characteristics of improved insulation characteristic of the resulting structure. The use of the void creating device of the subject invention creates a sophisticated, complex three dimensional void system within the concrete structure, and controls the shape of the void to accomplish the multitude of basic usage and functions as fully set forth above. As an example, the voids in a cast-in-place concrete structure will eliminate up to 66 % of the concrete required, all of which is unnecessary to the strength and function of the construction unit and will thereby profoundly affect the single most important factor of structural design, to wit, the strength-weight ratio of the concrete unit. The void creating device 10 of the subject invention may be utilized both in pre-cast concrete systems, as well as cast-in-place concrete system. The void creating device is economical, is molded of a suitable insulative, frangible material, in intricate and complex shape in order to achieve the extremely important functions of the resulting concrete structure. The device remains an integral part of the resulting concrete structure thereby rendering the structure self-insulating, as well as performing many other vital functions as set forth above.

In summary, the subject void creating device creates an integral, self-insulating construction unit which will for the first time create a single layer, single process construction unit that is completely self-integrated, is self-insulating and enables the resulting concrete structure to be finished on both sides. This construction unit has been the age old dream of the construction indus-

try, and is now provided by means of the subject invention.

What is claimed is:

1. A void creating device to be embedded in a concrete structure to define a labyrinth of passageways therein comprising an elongated hollow member made of a molded frangible material, said member having a first plurality of spaced, opposed projections disposed along the length thereof, and a second set of opposed, spaced projections extending along the length thereof, with said second set of projections extending generally orthogonal to the first set of spaced, opposed projections, and wherein the ends of said hollow member are closed by frangible baffles, and are of the tongue and groove configuration to enable interfitting of two such void creating devices along the longitudinal axes thereof.

2. A void creating device as in claim 1 wherein said hollow member is made of two interfitting elongated sections.

3. A void creating device as in claim 1 wherein said member is of integral construction.

4. A void creating device as in claim 1 wherein said member has a generally rectangular cross section with each set of spaced, opposed projections being disposed on opposite sides of said rectangular cross section.

5. A void creating device as in claim 1 further including spacer elements projecting from one set of said opposed projections.

6. A void creating device as in claim 5 wherein each of said spacer elements is of truncated cone shape.

7. A void creating device as in claim 1 wherein said hollow member is of generally rectangular cross section and includes tapered corners along the length thereof.

8. A void creating device as in claim 1 further including internal baffles extending orthogonal to the longitudinal axis of said device in order to compartmentalize the internal hollow portion thereof.

9. A void creating device as in claim 1 further including elongated strips projecting from opposite sides of the elongated hollow member and extending intermediate said first set of opposed projections.

10. A void creating device as in claim 1 wherein said hollow member is made of insulation material.

11. A void creating device as in claim 2 wherein said sections include a cooperating locking means for maintaining the sections in a locked position.

12. A void creating device as in claim 1 wherein one pair of said opposed projections are tapered.

13. A void creating device as in claim 1 wherein said member is made of polystyrene.

14. A void creating device as in claim 1 wherein each opposed projection is hollow, with the respective opposed projections being of a tongue and groove configuration for enabling interfitting and interconnection of two such devices along the sides thereof.

15. A void creating device as in claim 14 wherein there are provided internal baffles for compartmentalizing the interior of said device.

16. A void creating device as in claim 15 further including spacer elements projecting from one set of opposed projections.

17. A void creating device to be embedded in a concrete structure to define a labyrinth of passageways therein comprising an elongated hollow member made of a molded, frangible insulation material, said member made of two interfitting elongated sections, said mem-

ber having a first plurality of spaced, opposed projections disposed along the length thereof, and a second set of opposed, spaced projections extending along the length thereof, with said second set of projections extending generally orthogonal to the first set of spaced, opposed projections, and wherein the ends of said hollow member are closed by frangible baffles, and are of the tongue and groove configuration to enable interfitting of two such void creating device along the longitudinal axes thereof.

18. A void creating device as in claim 17 further including spacer elements projecting from one set of said opposed projections, each of said spacer elements being of truncated cone shape.

19. A void creating device as in claim 17 wherein said hollow member is of generally rectangular cross section, and includes tapered corners along the length thereof.

20. A void creating device as in claim 17 wherein said sections include a cooperating locking means for maintaining the sections in a locked position.

21. A void creating device as in claim 17 wherein said member is made of polystyrene.

22. A void creating device to be embedded in a concrete structure to define a labyrinth of passageways

therein comprising an elongated hollow member made of a molded frangible material, said member being made of two interfitting elongated sections, and having a first plurality of spaced, opposed projections disposed along the length thereof, and a second set of opposed, spaced projections extending along the length thereof, with said second set of projections extending generally orthogonal to the first set of spaced, opposed projections, and wherein the ends of said hollow member are closed by frangible baffles of the tongue and groove configuration to enable interfitting of two such void creating devices along the longitudinal axes thereof, and wherein said member is provided with internal baffles for compartmentalizing the interior of said device.

23. A void creating device as in claim 22 further including elongated strips projecting from opposite sides of the elongated hollow member and extending intermediate said first set of opposed projections.

24. A void creating device as in claim 22 wherein one set of said opposed projections are tapered.

25. A void creating device as in claim 24 wherein said set of tapered opposed projections are of the tongue and groove configuration.

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