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MacLean, III et al.

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[54] CAST-IN-PLACE STRUCTURAL TRUSS SLAB AND MANUFACTURED PAN

[72] Inventors: **Charles C. MacLean, III; Alfonso Villa,** both of San Juan, P.R.

[73] Assignee: **Hovey T. Freeman, Jr.,** Barrio Rio Guaynabo, P.R.

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[52] **U.S. Cl.** **52/337,** 52/576, 52/577, 52/602, 249/28

[51] **Int. Cl.** **E04b 1/16,** E04b 5/16, E04b 5/26

[58] **Field of Search** 52/337, 602, 576, 577, 323; 249/184, 186, 26–31, 176

[56] **References Cited**

UNITED STATES PATENTS

1,633,715	6/1927	Seelye	249/30
2,043,697	6/1936	Deichmann	52/602
2,534,580	12/1950	Edwards	52/602
2,592,634	4/1952	Wilson	52/576
2,775,019	12/1956	Bemis	249/176
2,892,238	6/1959	Budd	249/184
3,328,932	7/1967	Cheskin	52/576
3,495,367	2/1970	Kobayashi	52/576

FOREIGN PATENTS OR APPLICATIONS

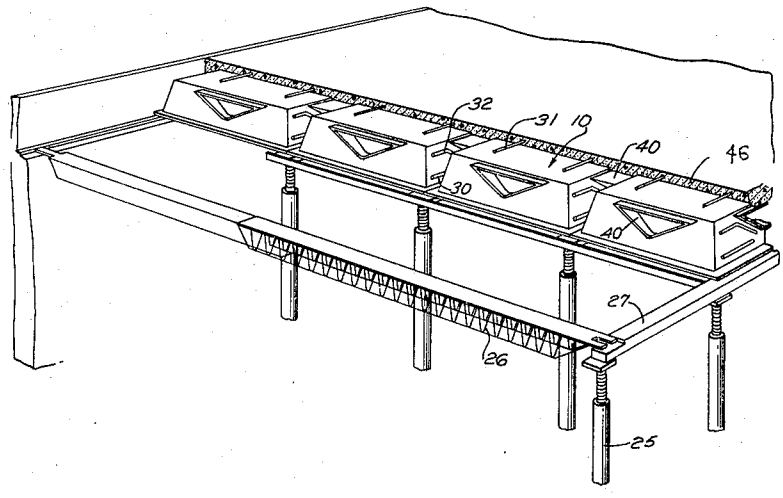
166,683	1/1956	Australia	52/337
551,370	1/1923	France	52/477

Primary Examiner—Frank L. Abbott
Assistant Examiner—James L. Ridgill, Jr.
Attorney—Barlow & Barlow

[57] **ABSTRACT**

A structural two-way truss slab of egg-crate form is provided with manufactured pans that have openings in the sidewalls thereof with interconnecting members between the openings. The arrangement is such that the pan can remain in place and thus provide a finished ceiling effect. The system further provides an ability to run air-conditioning, electrical, plumbing and other conduits through the slab itself after the slab has been poured. The slab is structurally equivalent to conventional two-way slabs but is of less gross weight.

5 Claims, 9 Drawing Figures



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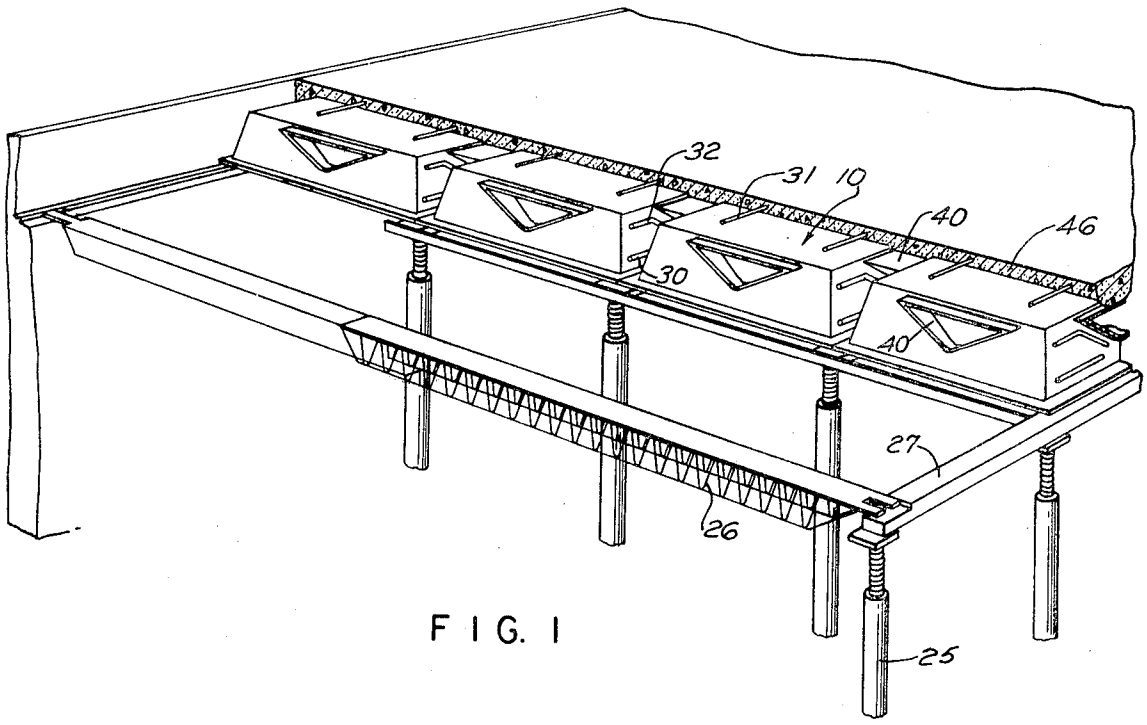


FIG. 1

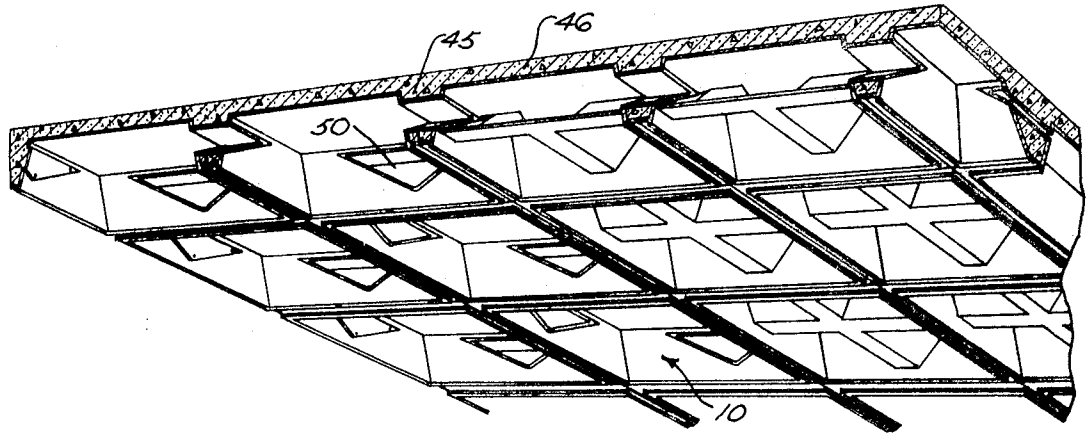


FIG. 2

INVENTORS
CHARLES C. MACLEAN III
ALFONSO VILLA
BY
Barlow & Barlow
ATTORNEYS

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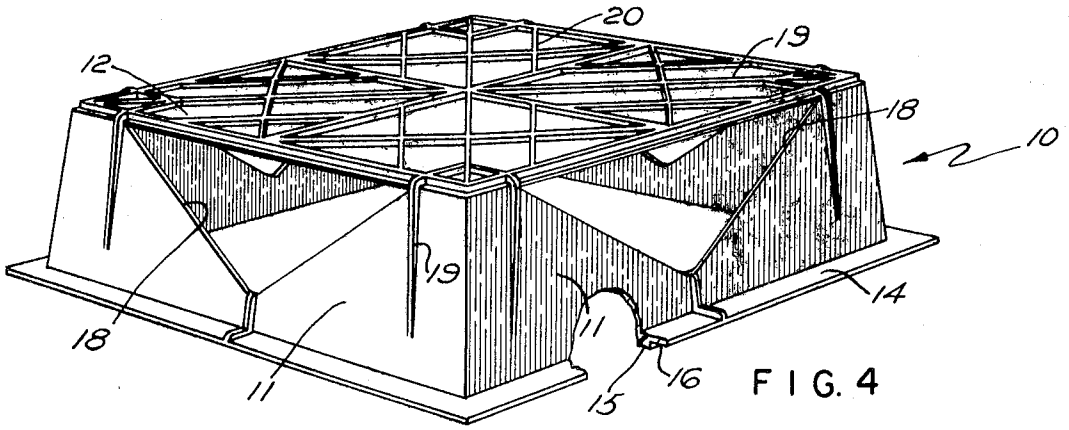


FIG. 4

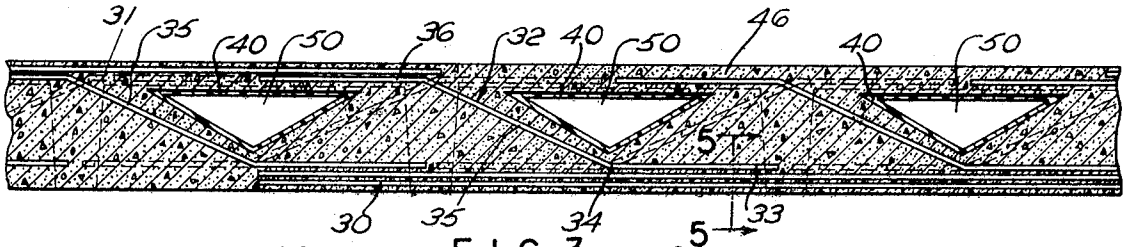


FIG. 3

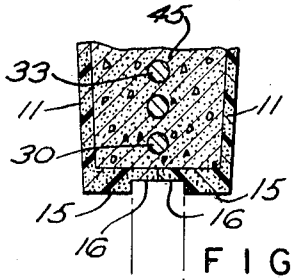


FIG. 5

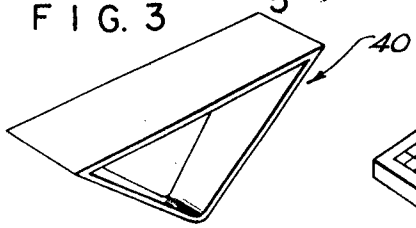


FIG. 6

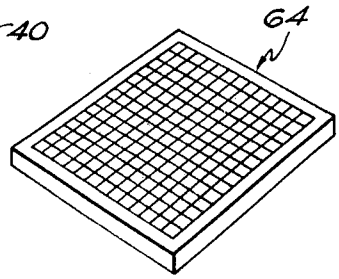


FIG. 9

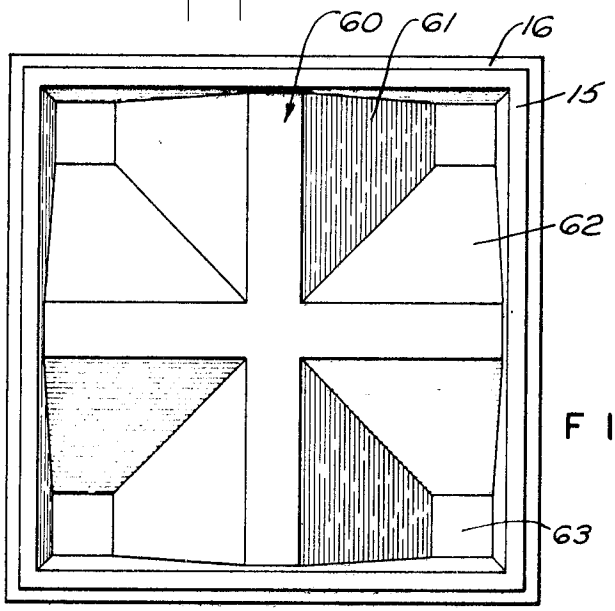


FIG. 7

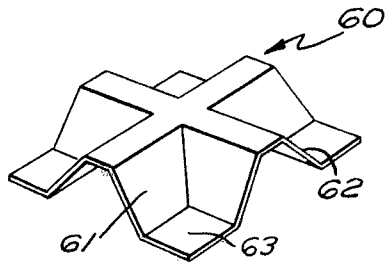


FIG. 8

INVENTORS
CHARLES C. MACLEAN III
ALFONSO VILLA
BY
Barlow & Barlow
ATTORNEYS

CAST-IN-PLACE STRUCTURAL TRUSS SLAB AND MANUFACTURED PAN

BACKGROUND OF THE INVENTION

At the present time the building industry is utilizing reinforced concrete slabs for floor construction in multistory buildings. To form the slabs, pan-type forms that are usually manufactured from steel or fiberglass and are generally square in plan have come into common use. A suitably supported plywood decking receives these pan-type forms in inverted relationship, and reinforcing rods, electrical conduit and plumbing provisions are made in the structure between adjacent pans before concrete is poured. After the slab is poured, the steel pans are removed revealing an egg-crate-type of construction underneath the slab which effectively is made up of a number of intersecting T-beams. Air-conditioning ducts are then hung beneath this egg-crate construction, and a ceiling is hung below the air-conditioning ducts in order to provide a finish appearance. This method of construction increases the overall height of the buildings since the floor-to-floor dimension must take into account the hung ceiling, and if changes are desired after the building is finished, such changes are limited by the original design insofar as plumbing and electrical services are concerned which are located for the most part within the cast slab. One approach to providing voids throughout a cast floor structure is shown in the Leemhuis Pat. No. 2,602,323, but this system lacks flexibility since the voids once created cannot be utilized after the structure is poured since access thereto is blocked. Another approach at utilizing voids was recently announced by the Portland Cement Association and is known as the "Triposite" building system. In this system precast concrete inverted double-T beams are supported by cast-in-place transverse beams in which voids are created in the floor for utility and ventilation distribution, but here again the system lacks complete flexibility as a flooring structure is placed on top of the beams and thus the floor limits access to the voids for effecting changes once the building is completed.

SUMMARY OF THE INVENTION

A structural two-way truss slab built around an integral manufactured pan is provided with a grid work of voids throughout the slab that permit, within the thickness dimension thereof, provision for continuous access to all mechanical and ventilating installations that are run through the void system and to provide in some cases, by suitable blocking of passageways, an integrated ventilation system in which the voids are used as passageways. The manufactured ceiling pan which is the heart of the system is preferably made from structural foam plastic which has properties of greater wall thickness per unit of weight so as to have a large stiffness to weight ratio. With this type of material being used as the ceiling pan, the surface appearance will remain consistent after the shores are removed, and flanges on the pans provide interlocking grooves in which wall systems may be locked. The provision of the voids within the beam system, which reduces the gross weight of the slab, does not reduce the strength of the beam as a particular reinforcing rod structure is used within the beams. The plastic also provides a good anchor for screws, nails, staples and other fastening devices in common use, and in this way the voids in the egg-crate type of construction may be utilized readily for hanging fluorescent fixtures and providing ventilation and grillwork inserts and mechanical covers to hide the mechanical work once the same is in place. The structural two-way truss slab system thus has the ability for ready access to any network of ducts, and as the building requirements change, it is much easier to make requisite changes in plumbing, electrical and other mechanical services as well as reducing the cost of the overall building by a factor of at least 15 percent.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view partly in section of a poured slab with the pan construction of the invention before removal of the slab supporting system;

FIG. 2 is a perspective view partly in section from the underside of the completed slab and with a portion showing the cover structure of FIG. 8 in place;

FIG. 3 is a partial sectional view taken through one of the beams illustrating the reinforcing rods and their possible placement to provide proper strength;

FIG. 4 is a perspective view of a ceiling pan used in the system with a portion broken away;

FIG. 5 is a sectional view taken on lines 5—5 of FIG. 3 showing the groove that is provided for interlocking with a vertical wall section;

FIG. 6 is a perspective view of an interconnecting hollow member provided between the pans;

FIG. 7 is a bottom plan view of one section underneath the pan with a mechanical equipment cover structure in place;

FIG 8 is a perspective view of a cover structure; and

FIG. 9 is a perspective view of a light diffuser that may be used within the pan.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 4, it will be seen there is illustrated a form of pan construction for use in the building system that may be utilized as a form in the pouring of concrete floors to produce a two-way truss structure. The pan generally designated **10** includes a top wall **12**, sidewalls **11** with lower flanges **14**. The bottom face of the flanges designated **15** is provided with a stepped construction to provide a groove **16** opening to the edge of the flange **14**. Each sidewall **11** is provided with an aperture or opening **18** of general triangular form with is apex downwardly providing a V, and since the structure is contemplated to be molded from structural foam plastic, a number of reinforcing ribs are provided to retain proper rigidity as, for example, ribs **19** on the sidewalls and a network of ribs such as **20** on the top wall **12**. To provide a good beam cross-sectional area, the sidewalls **11** are inclined slightly inwardly towards the top wall **12**.

Referring now to FIG. 1, it will be seen that there is illustrated a slab construction in intermediate stage of forming. In following preferred building practice, there is first place supporting jacks **25** arranged and held in a grid under the corners of each pan by stringers or other means, as for example a framework of removable beams **26, 27** which are placed to be under the intersecting edges of the pans **10**. Pans **10** are then positioned on the supporting grid so that the flanges **14** abut. After the pans have been properly placed, reinforcing rods are positioned between the pans. One form in which the reinforcing rods may be placed to properly form the truss slab construction is illustrated in FIG. 3. Here the reinforcing structure is made up of a number of horizontally oriented rods such as **30** in the bottom area of the slab and also rods **31** in the top area of the slab which extend longitudinally of the beam. Additionally, a number of diagonal rods such as **32** are provided to span the opening or aperture area **18** of the form, and as will be seen, these are made up of a straight section **33** which is bent as at **34** into a diagonal section that extends as at **35** at an angle to the general axis of the beam and thence a top or upper longitudinal section **36**. This arrangement may extend in right-angular directions along the right-angular extents of the beams. After the reinforcing rod structure has been properly clipped in place, interconnecting members **40** such as illustrated in perspective in FIG. **6** are placed between the pans which members are tapered to the inclination of the sidewalls **11**. The sections **40** conform in shape and size to the openings **18** so that they will tightly fit therein and are generally made up of molded sections having flat inner and outer faces with a hollow center.

With this amount of preparation having been accomplished, concrete is then poured onto the structure to form beams

designated **45** in between the pans and a floor slab **46** which overlies the pans. After the concrete has set the supporting structure **25**, the transverse members **26** and the beams **27** are removed, and the entire slab construction is self-supporting. It will be noted that the pans **10** have left in the floor construction to provide a finished ceiling appearance; as cast there will now be provided on at least a quarter relationship a number of openings or apertures which have been designated **50** in the finished structure. Effectively, the openings **50** with the void provided by the underside of the pan **10** forms a grid pattern of channels throughout the floor into which mechanical, electrical and air-conditioning may be directed. Each pan can be considered an individual cell which is the main constituent of a grid section in the floor. Since the piping and other fixtures may provide an unsightly appearance in the openings of the pan, it is contemplated to cover the mechanical material with a cover structure which has been generally designated **60** (FIG. **8**). Referring to FIGS. **7** and **8**, a typical cover construction for the mechanical services has been illustrated, and this is made up of two intersecting truncated triangular structures **61** and **62** that are slightly larger in cross-sectional form than the openings **18** provided by the pan **10** with corners **63**. Inasmuch as the pan **10** is preferably formed from structural foam plastic, it will readily accept fastening devices, and this part **60** may be easily fastened in place particularly thru corners **63** and easily removed. Alternately, it may be desired to utilize the open area of the pan to fasten fluorescent lighting fixtures or the like, and in this case the fluorescent fixtures may be fastened in place and a light diffuser such as **64** illustrated in FIG. **9** may be fastened in place substantially at the lower edge of the pan **10**. Further if the passageways are utilized for air-conditioning, the cover **60** may be modified to form a straight-thru, curved or T-connection duct section, and suitable air diffusers may likewise be fastened in place at outlet points.

It will be recalled that grooves **16** are formed in the bottom edge of the flanges **14** of each of the pans. When the pans are in abutting relationship, this groove **16** (see FIG. **5**) has been formed in a convenient manner so that vertical wall structures such as **65** may be received therein. If, for example, the pans **10** are made with a maximum dimension from one edge of one flange **14** to the opposite flange **14** of 5 feet, it will be apparent that the grooves **16** will appear on 5-foot centers. This will give extreme flexibility in the positioning of partitions for office building utilization, and practically any arrangement desired by a tenant can be had with a minimum of cost. It will be appreciated, however, that the dimensions may vary widely depending upon the spans involved, but a typical depth for the beam **45** may well be on the order of 2 feet with a 2- to 3-inch slab over at the top wall of the pan **10**. Typically the reinforcing bars **32** may be number **8** mild steel and the longitudinal bars such as **30** and **31** may vary between what may typically be No. **7** mild steel, the particular type being dictated by the span and floor loadings to be expected.

While not specifically illustrated, it will be apparent that to provide proper duct work for air-conditioning systems as mentioned above, it will become necessary to block off some of the openings formed by the grid work as cast, but this can be readily achieved if integral ducting is desired by the use of plates that may be screwed over the openings **18** of an individual pan, and further, of course, turns may be accomplished by the use of deflectors similarly fastened to the pan in a modified form of a cover such as **60** which lends itself admirably to this particular usage as the same is preferably molded out of structural foam plastic.

We claim:

1. A structural two-way beam truss slab comprising a slab of concrete having integrally formed therebeneath a plurality of supporting intersecting beams arranged in a grid, said grid made up of a plurality of grid sections each having individual cells formed by inverted plastic pans open at their bottom and whose top walls are firmly attached to the underside of the slab and whose sidewalls are firmly attached to the downwardly extending walls formed by said beams, the sidewalls of selected adjacent pans having aligned openings of substantial cross section, horizontally elongated interconnecting members of substantial cross section that conform in size and shape to the openings in the sidewalls of said pans, the opposite ends of said interconnecting members inserted in tightly fitting engagement in said openings in the sidewalls of said pans, and reinforcing members in said beams that produce a beam grid system of concrete formed with a network of apertures therethrough.

2. A structural two-way beam truss slab as recited in claim **1** wherein said pans have horizontally outwardly extending flanges at their bottoms with said adjacent pans having their flanges in abutting relationship, said flanges having an upwardly recessed sector at their outer periphery to form between the abutting flanges of said adjacent pans a channel which may receive a vertical wall structure.

3. A structural two-way beam truss slab as recited in claim **1** wherein said openings are V-shaped and the reinforcing members in the beams include a number of longitudinal reinforcing rods and a number of angularly bent rods whose angular portion thereon is substantially parallel to the inclination of the V-shaped opening in each beam.

4. A structural two-way beam truss slab as recited in claim **1** wherein said horizontally elongated connecting members are hollow.

5. A structural two-way beam truss slab as recited in claim **1** further comprising covers for said cells essentially formed by two intersecting hollow truncated triangular structures that are slightly larger in cross-sectional form than said openings in said pans with web corners connecting their top edges.

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