April 1, 1969 T. S. MERRILL ET AL 3,435,580

INSULATED, REINFORCED CONCRETE, PANEL-TYPE, BUILDING UNIT

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FIG. 1.

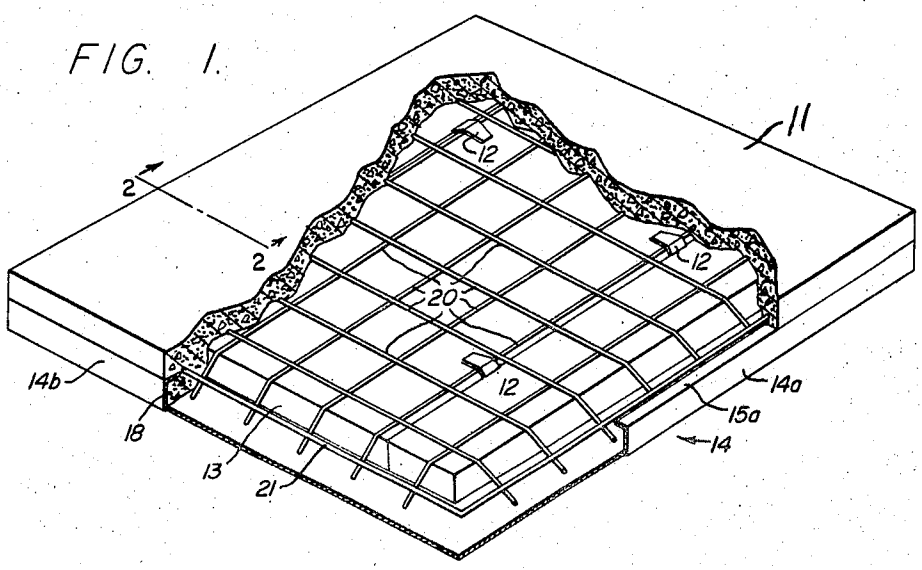

FIG. 2.

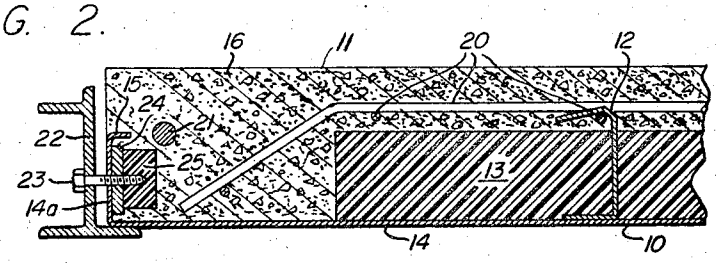

FIG. 4.

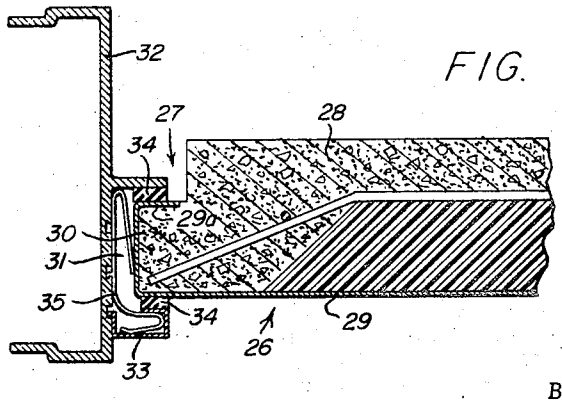

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FIG. 3.

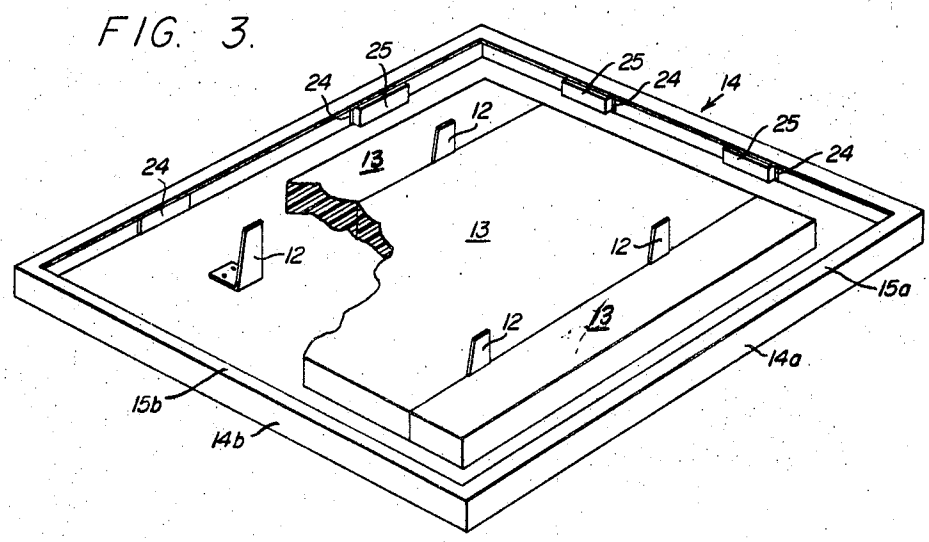


FIG. 5.

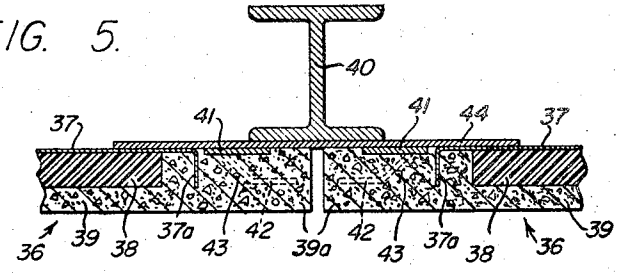
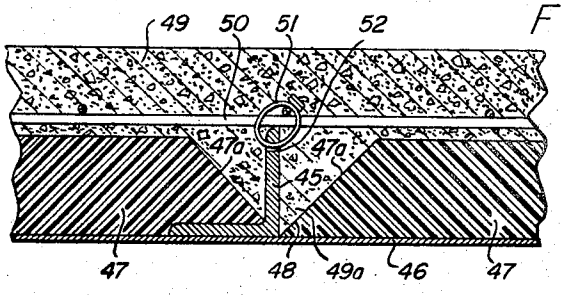


FIG. 6.



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INSULATED, REINFORCED CONCRETE, PANEL-TYPE BUILDING UNIT

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ABSTRACT OF THE DISCLOSURE

A curtain wall building unit of panel formation, having sheet material providing one broad face of the panel and a mesh-reinforced concrete slab providing the opposite face. Slab insulating material is positioned between the two facing components of the panel, and a plurality of relatively narrow strut pieces, mutually spaced both longitudinally and transversely of the panel, are fastened to the sheet material and extend through the insulating material into embedded engagement with the mesh reinforcing of the concrete slab.

This invention relates to thermally insulated, panel-type building units of reinforced concrete or the like, as used in the construction of curtain walls supported by load-bearing, structural columns in building construction.

The panel-type, curtain wall building units of the invention have mutually opposite, broad, panel faces that provide architecturally acceptable nd pleasing exterior and interior finish facings, respectively, for office buildings and other structures. One of these panel faces is provided by a metal sheet component that can be painted and otherwise decorated; the other is provided by a concrete material that is cast in place and preferably utilizes an aggregate or an additive to make it resemble building stone. Sandwiched between the two facing materials is thermal insulation, preferably a foamed plastic. The two facing materials are rigidly tied together by metal pieces that are secured to the inside face of the metal sheet, as by welding, and to the concrete by engagement with the reinforcement embedded therein. The edge faces of the units can be formed in various ways, depending upon the nature of the frame members of the building, with which they must connect, and upon the desired manner of securing the units thereto.

In the making of the invention, principal objects were to provide structural rigidity sufficient to effectively resist self-imposed stresses and strains and external stresses and strains, such as wind and seismic vibrations, as well as impact; to provide superior insulating properties, with minimum weight and bulk; and to provide a desired architectural finish at both broad panel faces.

These objects were accomplished by the aforedescribed rigid tying of a metal facing sheet to an opposed, reinforced, cementitious, slab facing, with thermal insulation therebetween.

Additional objects and features of the invention will become apparent from the following detailed description of the specific embodiments that are illustrated in the accompanying drawings and that represent the best mode presently contemplated of utilizing the generic inventive concepts particularly pointed out.

In the drawings:

FIG. 1 is a perspective view of one form of the curtain-wall unit of the invention, looking toward the cementitious slab face thereof and with part of the slab broken away to show internal structure;

FIG. 2, a fragmentary section taken on the line 2—2 of FIG. 1 and showing the unit attached to a framing

member of a building, the view being drawn to a larger scale;

FIG. 3, a perspective view showing the interior of the metal pan that provides the metal sheet facing for the unit of FIG. 1 with the thermal insulation material in place but broken away in part to reveal pan construction;

FIG. 4, a view similar to that of FIG. 2, but showing a somewhat different form of panel building unit to illustrate how panel edge faces can be varied to accommodate variations in building framing members:

FIG. 5, a corresponding view showing further variations in both panel building unit construction and its securement to a building framing member; and

FIG. 6, a fragmentary section corresponding to the righthand portion of FIG. 2, but illustrating a somewhat different form and arrangement of structural components especially suitable for large size units.

Referring to the drawings:

In the embodiments of FIGS. 1–3, the panel building unit is rectangular and comprises a metal sheet facing **10**, FIG. 2, and a concrete slab facing **11**, the two being rigidly tied together by a number of relatively narrow metal strut pieces **12**, with thermal insulating material **13** therebetween.

The metal sheet facing **10** is provided by the bottom of a broad and shallow, rectangular pan **14** of sheet metal, for example, twenty gauge mild steel, preferably specially treated at least on its exposed surface **10** for the retention of paint as is the proprietary product "Paintlock" produced by Republic Steel Company.

The sides **14***a* and **14***b* of the pan **14** serve as peripheral framing for the metal-faced portion of the unit, and, in this instance, are inturned to provide overhanging flanges **15***a* and **15***b*, respectively, for tie-in with the concrete slab portion **16** of the unit.

For rigidly tying together the broad bottom of the metal pan **14** and the concrete slab **16**, and, thus, the metal facing **10** with the slab facing **11**, the strut pieces **12**, here shown as formed of sheet metal, are secured, as by welding, to the inside face of such bottom, in mutually spaced relationship both longitudinally and transversely of the unit, as shown, so as to project upwardly for tying engagement with the reinforcing material for the slab.

A preferred way of insulating the unit is to position appropriately dimensioned batts of the insulating material **13**, such as a foamed plastic, i.e., expanded polystyrene, in metal pan **14**, so as to leave a peripheral channel **18** for the reception of the wet concrete mix, which is cast onto the insulation and confined laterally by a suitable temporary form structure (not shown) for defining exposed peripheral edge faces for the slab portion **16** of the unit. Although pre-formed batts of insulating material are preferred and are easily accommodated by the upstanding strut pieces **12**, it will be readily appreciated that the foamed plastic or some other type of thermal insulating material can be formed in place by casting or blowing into a suitable form structure placed temporarily or permanently in the pan.

The reinforcing material for the concrete slab **16** preferably comprises a heavy wire mesh **20**, FIG. 1. A 2" x 2" 14/14 gauge welded wire fabric has proven very satisfactory. With this weight reinforcing material and a twenty gauge steel pan, units of the invention have shown a load-carrying capacity of 75 lbs./sq. foot.

The reinforcing mesh **20** is preferably pre-formed to lie flat on or immediately above the tops of insulation bats **13**, with its peripheral margins bent downwardly to extend into the vicinity of peripheral channel **18**, and the sheet facing **10** as indicated in FIGS. 1 and 2, whereupon the strut pieces **12** are bent down over adjacent wires of such mesh in engagement therewith so as to tie

opposite face portions of the panel together. Additional reinforcing bars **21** may be provided in peripheral channel **18** or otherwise, as deemed advisable in particular instances.

Concrete slab **16** is cast into place over the insulating bats **13** and around reinforcing mesh **20** and bars **21**, filling peripheral channel **18** and providing the slab facing **11** for the unit. Upon setting and curing about the bent upper ends of strut pieces **12** and about the reinforcing mesh **20** engaged thereby, the concrete and such strut pieces establish rigid connection of the metal facing component of the unit with the slab facing component. The slab facing **11** can be of any ornamental character desired by appropriately choosing the aggregate or additives for the cementitious mix.

It should be noted that the metal skin, provided by pan **14**, and the concrete slab **16** combine to resist tension and/or compression, depending upon how the panel building unit is utilized in building construction.

In order to enable this form of the panel building unit of the invention to be easily secured to framing members of a building, for example, to the steel or aluminum mullion **22**, FIG. 2, by means of screws **23**, it is desirable that metal plates **24** be secured to the inside faces of the sides **14***a* and **14***b* of metal pan **14** at intervals along their lengths in any suitable manner, e.g., by cementing, and that these be backed by blocks **25** of foamed plastic or other soft filler material. In erecting the building, it is only necessary to drill and selectively tap receiving holes through the framing members, the sides of the pan, and the plates **24** for screws **23**, which can protrude without resistance into the backing blocks **25**.

In the embodiment of FIG. 4, the panel building unit **26** is of the same construction as the corresponding unit of the foregoing FIGS. 1–3, except for the edge margins, which are shouldered, as at **27**, by restricting the extent of the concrete slab portion **28** of the unit so it does not overlap the inturned flange **29***a* of the metal pan **29**. This leaves what is, in effect, rabbeted edge faces, with respective tongue portions **30** adapted to fit into receiving grooves **31** provided by mullion framing members **32** and respective, removably attached, auxiliary members **33**. Sealing tape **34** is applied to both the outer and inner peripheral margins of the tongue portions **30** to provide weather seals, and interposed leaf springs **35** hold the unit tightly in place.

In the embodiment of FIG. 5, the panel building units **36** are each constructed with a metal pan **37**, insulating material **38**, and a mesh-reinforced concrete slab **39** tied together by metal struts (not shown), as in the preceding embodiments, but the slab **39** completely surrounds the sides **37***a* of the pan to provide peripheral edge faces of exposed concrete, rather than metal. For a successful tie-in of the peripheral portions **39***a* of the concrete slab with the remainder of the slab, it is necessary to either perforate the sides **37***a* along their lengths by, for example, a series of holes of say ¾ inch diameter (not shown), or to otherwise form or provide such sides with tie-in projections that will disrupt the lines of parts existing otherwise at the faces of such sides **37***a*.

To provide for welding securement of the units **36** to structural steel columns **40** of the structural framework of a building, steel plates **41** are embedded in the peripheral portions **39***a* of the concrete slab **39** at and exposed to the inside, metal sheet face of the unit, because direct welding of the metal pan **37** to such a column **40** would buckle and deform the pan. These plates **41** may extend continuously around the peripheral margins of the unit or intermittently, as desired for particular instances. In either event, they are provided with stub reinforcing bars **42** projecting from welded securement to their back faces, as illustrated, and one or more reinforcing rods **43** may be laid in the concrete transversely thereof.

In attaching these units **36** to columns **40**, an intermediate steel plate **44** is spot welded to the exposed faces of plates **41** and to the column.

It should be noted that, in both embodiments of FIGS. 1–3 and FIG. 4, the sides of the metal pan can be eliminated and merely a flat metal sheet used for the pan, so long as a form is used for retaining and molding the wet concrete that is otherwise retained and molded by the sides of the pan. This leaves peripheral edge faces of exposed concrete, as in the embodiment of FIG. 5, rather than of metal.

The embodiment of FIG. 6 is a very advantageous construction for large panel building units conforming to the invention, for example, larger than 9 sq. ft., and can be also used for the smaller units when desired. In this embodiment, the metal strut pieces are in the form of short pieces of angle iron **45** welded to the inside faces of the metal pan **46**. The bats **47** of insulating material are preferably beveled, as at **47***a*, to provide V-shaped channels **48** along the respective lines of strut pieces, into which wet concrete will flow during the casting of the slab portion **49** of the unit, and, when set and cured, will provide steel-reinforced, slab-reinforcing, concrete ribs **49***a* for the unit.

Slab-reinforcing, steel mesh **50** is provided, as in the preceding embodiments, but, in this instance, is literally tied into the strut pieces **45** by means of tie wires **51** passing through receiving holes **52** provided in the upper ends of such strut pieces **45**. The peripheral edge details of this unit can be shown in any of the preceding embodiments.

It should be realized that there are many possible peripheral edge constructions that can be employed for each of the various embodiments of panel building units of the invention, depending upon the particular scheme of structural framing employed by any given builder, and that adapting these to the structural concepts here disclosed will be well within the skill of the art.

It should also be realized that, although it is highly advantageous to utilize sheet steel to provide the one panel face of the unit and steel struts welded to the inside face of such sheet, other sheet facing material can be used in place of the sheet steel, within the broadest purview of the invention, and other rigid material can be used for the struts and can be securely fastened in some other way to the sheet facing material. Also, although concrete made of Portland cement and a conventional aggregate is preferred for the concrete slab, other concretious materials utilizing various bonding agents can be employed, as can various natural and artificial stone and other materials as ornamental insets in the exposed face of the slab.

Whereas this invention is here described and illustrated with respect to certain forms thereof, it is to be understood that many variations are possible.

We claim:

1. A curtain wall building unit of composite panel type, comprising structural sheet material at one of the broad panel faces of the unit providing, exteriorly thereof, an interior finish panel face for the unit; a concrete slab at the opposite broad panel face of the unit providing, exteriorly thereof, an exterior finish panel face for the unit, the peripheral margins of said slab being in face-to-face engagement with peripheral marginal portions of said sheet material and intermediate portions of said slab being spaced apart from corresponding intermediate portions of said sheet material to provide a recess for the reception of insulating material; structural reinforcing mesh embedded in said slab, with its peripheral margins bent toward and into the vicinity of said sheet material and the periphery thereof surrounding said recess; a plurality of relatively narrow, rigid struts distributed in mutually spaced relationship along both the length and the breadth of said unit, each being securely fastened at one of its ends to said sheet and extending into tying engagement with said reinforcing mesh intermediate the said bent margins thereof; and thermal insulating material sandwiched between said

intermediate portions of said sheet material and said slab and surrounding said struts.

2. A panel building unit in accordance with claim 1, wherein the insulation material is channeled substantially to the inside face of the sheet facing material along lines joining pluralities of the struts, and portions of the slab extend into the channels and embed the said struts to provide reinforced concrete ribs as reinforcements for said slab.

3. A panel building unit in accordance with claim 1, wherein the struts are connected at their free extremities to the structural reinforcing of the slab by means of wire ties.

4. A panel building unit in accordance with claim 1, wherein the free extremities of the struts are tied to the structural reinforcement of the slab by being bent over said structural reinforcement.

5. A panel building unit in accordance with claim 1, wherein the sheet facing material has enclosing sides forming an externally closed pan into which peripheral marginal portions of the slab extend in face-to-face engagement with the sheet facing material.

6. A panel building unit in accordance with claim 5, wherein the sides of the pan terminate in inturned flanges overhanging the interior of the pan and encased in the concrete slab, leaving the lateral sides of the slab exposed therebeyond.

7. A panel building unit in accordance with claim 6, wherein the concrete slab terminates short of the inturned flanges, leaving peripherally projecting tongues encased by the sheet facing material.

8. A panel building unit in accordance with claim 5, wherein relatively small blocks of insulating material are secured to the inside faces of the sides of the pan at intervals along the lengths thereof for receiving screws in the securement of the unit to structural framework of a building.

9. A panel building unit in accordance with claim 1, wherein the sheet material terminates short of peripheral margins of the one panel face of the unit, such margins being provided by peripheral portions of the concrete slab; and wherein steel plates are embedded in said portions of the concrete slab, with one face of each exposed at said one panel face of the unit to provide areas for welding to supporting frame members of building construction.

10. A panel building unit in accordance with claim 9, wherein stub reinforcing members extend from securement to embedded faces of the steel plates into the peripheral portions of the concrete slab as part of the structural reinforcing thereof.

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U.S. Cl. X.R.

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