United States Patent [19]

Ramberg

[11] **3,744,194**

[45] **July 10, 1973**

[54] **REINFORCING ASSEMBLY AND METHOD OF FORMING REINFORCED CONCRETE BUILDING WALLS, ROOFS AND THE LIKE**

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[22] Filed: **July 6, 1971**

[21] Appl. No.: **159,643**

[52] **U.S. Cl.** **52/378,** 52/448, 52/581, 52/585, 52/665, 52/741

[51] **Int. Cl.** **E04b 1/16**

[58] **Field of Search** 52/378, 349, 414, 52/585, 626, 656, 601, 741, 665, 447, 448, 454

[56] **References Cited**

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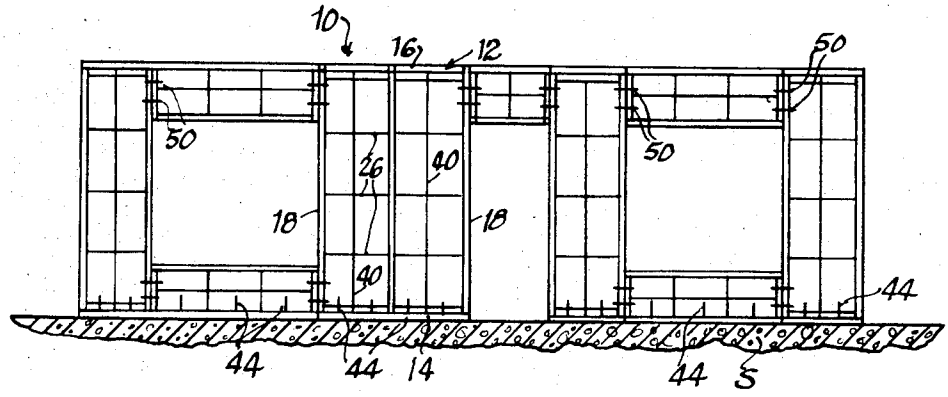
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Primary Examiner—Alfred C. Perham
Attorney—Max Dressler, Marshall W. Sutker et al.

[57] **ABSTRACT**

An improved system and method for forming concrete walls and roofs, such as for one and two story housing. A prefabricated frame assembly is formed of a plurality of peripheral frame members defining a rectangular peripheral frame section. Reinforcing rods are supported by an opposite pair of members and other reinforcing rods are secured to and cross the first reinforcing rods, thereby to form an open reinforcing network. The members provide surfaces to which panel board may be secured. A suitably configured plurality of the frame assemblies are positioned seriatim on a slab, are connected by short reinforcing rods to form a wall frame, a complete house frame and a roof. The array of frame assemblies, especially after panelling has been applied internally provides a skeleton reinforcing network to which concrete may then be applied to form a reinforced concrete structure.

20 Claims, 8 Drawing Figures

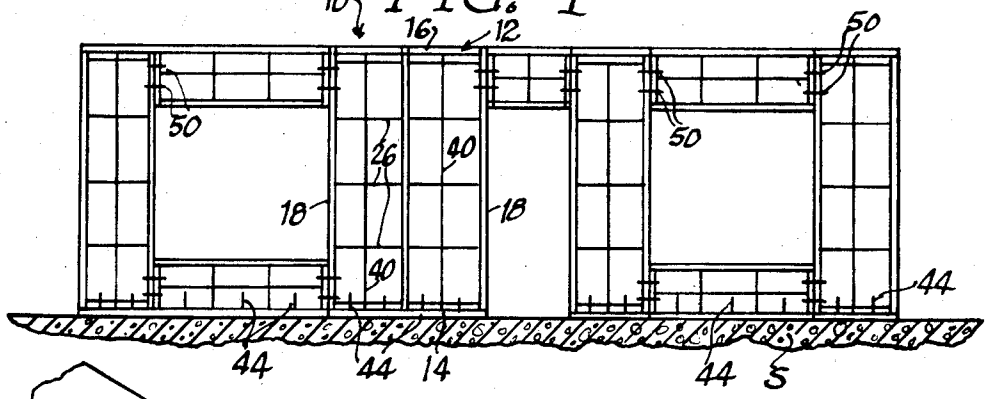


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SHEET 1 OF 2

FIG. 1



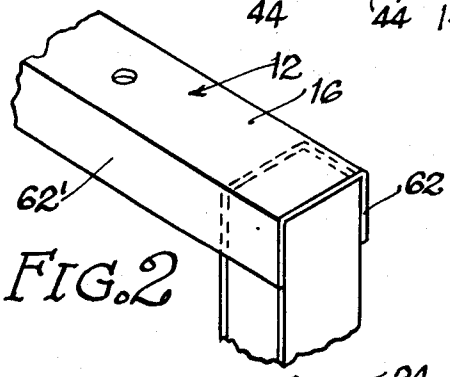
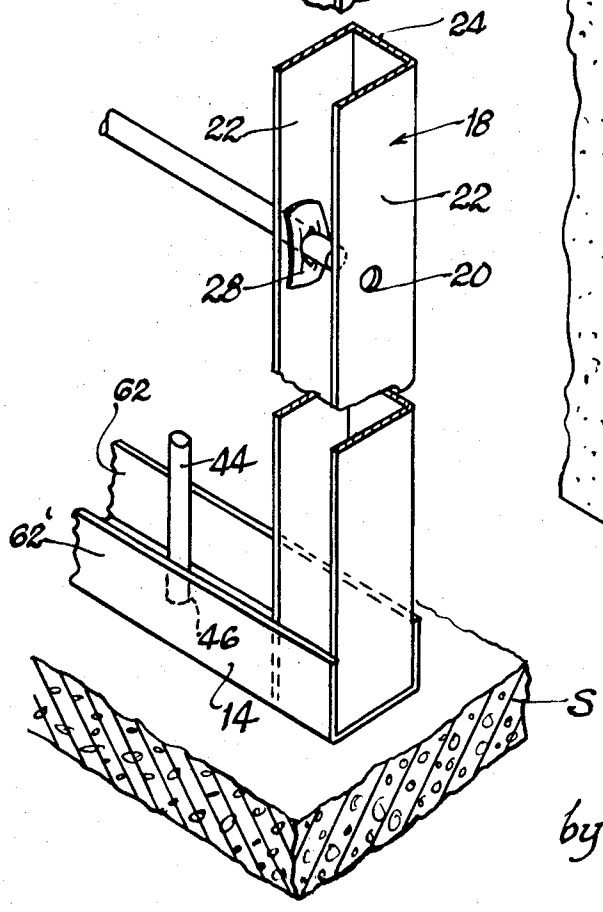


FIG. 2



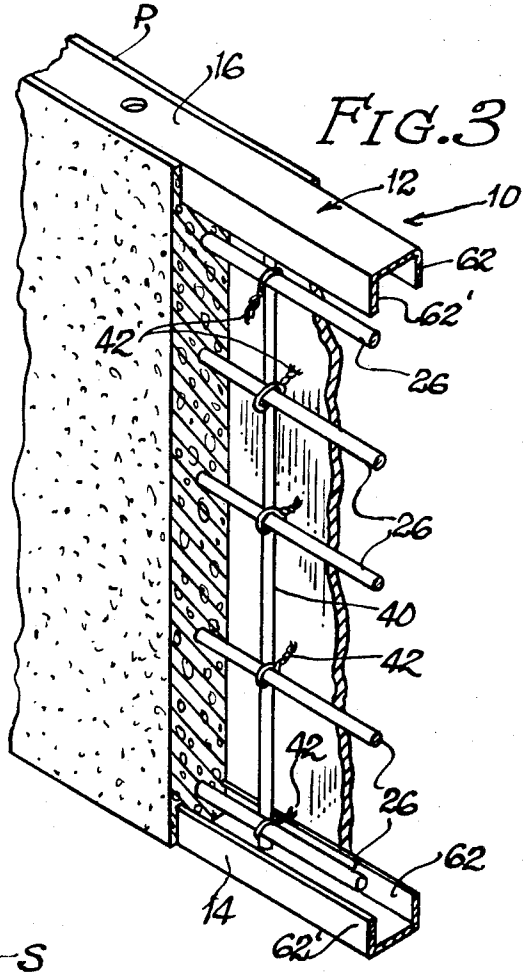


FIG. 3

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FIG. 4

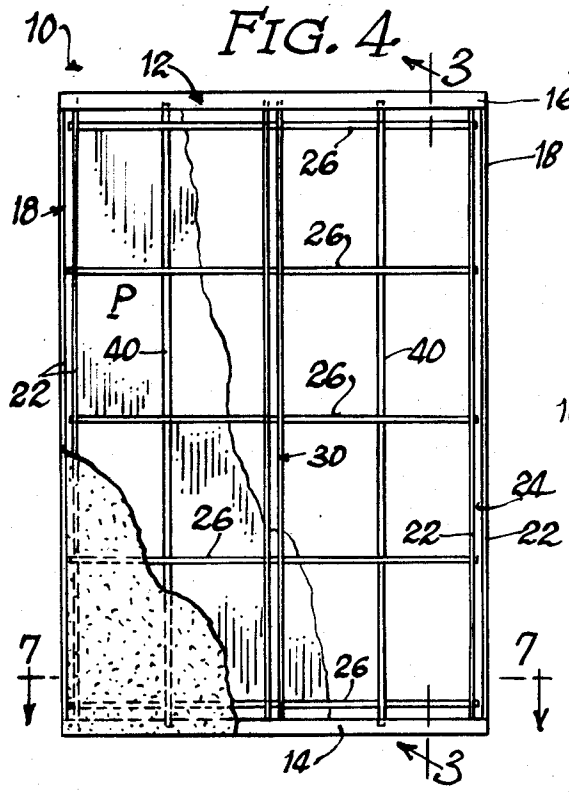


FIG. 5

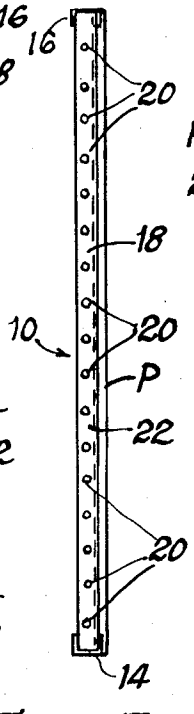


FIG. 6

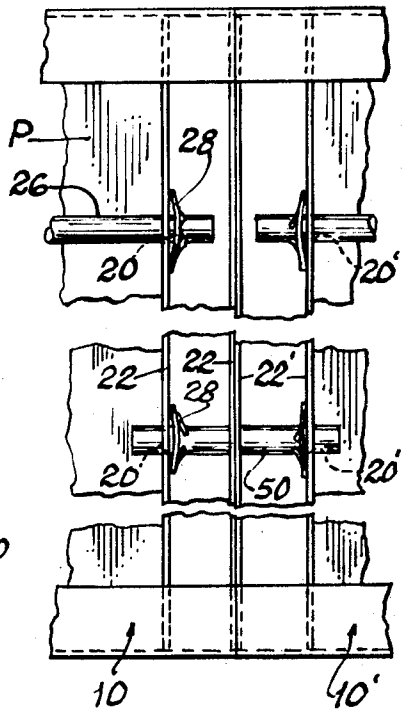


FIG. 7

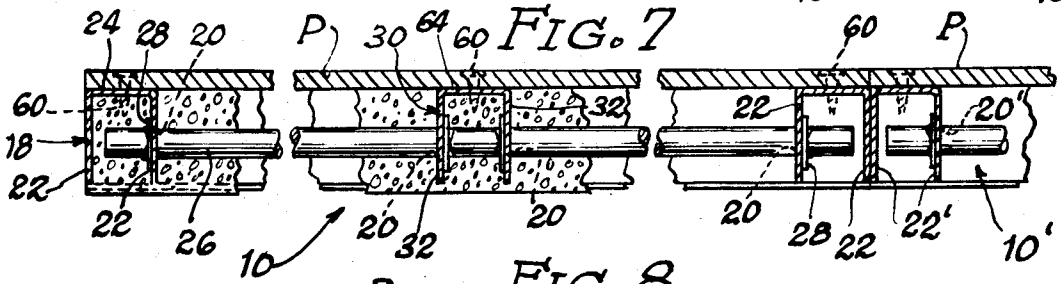
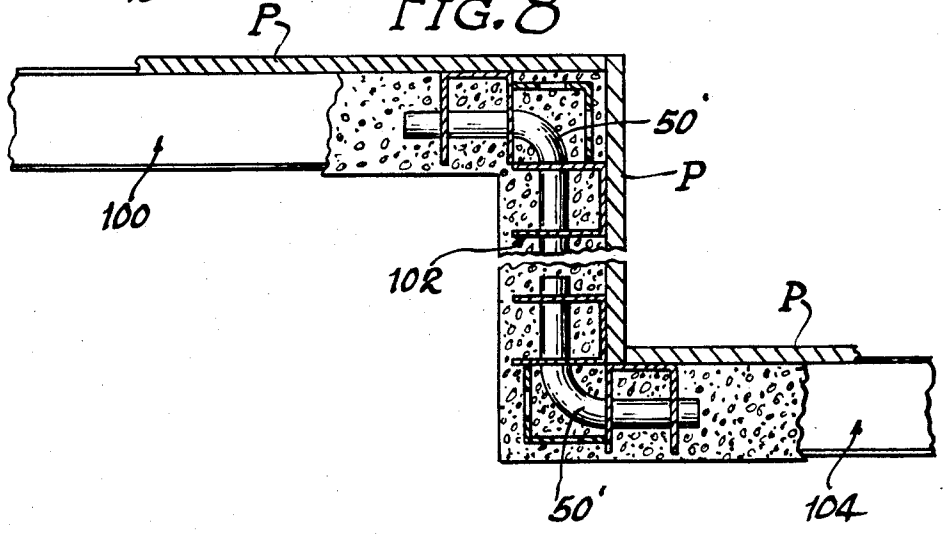


FIG. 8



REINFORCING ASSEMBLY AND METHOD OF FORMING REINFORCED CONCRETE BUILDING WALLS, ROOFS AND THE LIKE

A prefabricated frame assembly is formed of a plurality of peripheral frame members defining a rectangular peripheral frame section. Reinforcing rods are supported by an opposite pair of members and other reinforcing rods are secured to and cross the first reinforcing rods, thereby to form an open reinforcing network. The members provide surfaces to which panel board may be secured. A suitably configured plurality of the frame assemblies are positioned seriatim on a slab, are connected by short reinforcing rods to form a wall frame, a complete house frame and a roof. The array of frame assemblies, especially after panelling has been applied internally provides a skeleton reinforcing network to which concrete may then be applied to form a reinforced concrete structure.

This invention relates to a reinforced concrete structural member, to an improved skeleton array for reinforcing a concrete structure, and to an improved prefabricated reinforcing frame assembly which is easily erected on site, to which interior water-repellent paneling may be directly applied, and to which concrete, such as lightweight concrete, may be efficiently and quickly applied. This invention also relates to a method of erecting a skeleton reinforcing network to which concrete may be applied to form a reinforced wall, roof or the like.

One of the known modes of providing exterior structural walls for buildings, such as homes, is to erect and form reinforced concrete walls. Because the load bearing characteristics of concrete itself is not usually sufficient to serve as the wall, it is therefore necessary to embed reinforcing material in it. As such, reinforcing material, such as reinforcing rods or reinforcing wire mesh, must initially be mounted in some way, either temporarily to a support; or, for example, with the lower ends of long vertical reinforcing rods initially embedded in a slab for the building. In such cases, it is thereafter usually necessary to provide a temporary frame, as of wood, into which concrete is poured or sprayed to form a wall about the reinforcing rods, after which the temporary wood form is removed. If a temporary frame is omitted, and concrete is sprayed, as on a mesh form, very substantial quantities of the sprayed-on concrete are lost to waste.

In accordance with the invention, many of the disadvantages inherent in known methods of forming reinforced concrete walls and roofs, such as for a one or more story building, are minimized or avoided completely. This invention provides prefabricated frame assemblies which are easily erected and which are easily secured to each other to form a skeleton assembly for reinforced concrete walls and roofs. The skeleton assembly may desirably also include interior water repellent paneling which is easily secured to the frame assemblies, and which is intended to remain after application of the concrete to provide an interior wallboard surface for the walls. The prefabricated frame assemblies of this invention are easily and quickly erected on site into a unitary skeleton reinforcing assembly for entire walls and buildings, dramatically speeding the erection time of reinforced concrete structures.

Further objects, advantages, and features of this invention will become apparent from the following description and drawings, of which:

FIG. 1 illustrates a typical array of prefabricated frame assemblies of this invention, assembled to form a skeleton assembly to which concrete may be applied;

FIG. 2 is an enlarged fragmentary view of a frame assembly of FIG. 1;

FIG. 3 is an enlarged view, partially in section and partially broken away, taken substantially along the line 3—3 of FIG. 4;

FIG. 4 is a front elevation of a reinforced concrete structural member, partially broken away, embedding a frame assembly of this invention;

FIG. 5 is a side elevational view of a frame assembly of this invention;

FIG. 6 is an enlarged fragmentary view of a pair of adjacent frame assemblies secured together into a skeleton assembly prior to the application of concrete;

FIG. 7 is a cross-sectional view taken substantially along the line 7—7 of FIG. 4, showing additionally a next adjacent frame assembly; and

FIG. 8 is a view similar to FIG. 7 but illustrating adjacent frame assemblies juxtaposed and secured together to form inside and outside corners.

FIG. 1 illustrates a plurality of frame assemblies of this invention in a typical skelton assembly array which might serve as the front wall of a one-story home.

Referring first to typical frame assembly **10**, it is seen to comprise a plurality of generally coplanar elongate frame members secured together to form an outer rigid, rectangular peripheral frame section **12** for the frame assembly. The elongate frame members comprise a horizontal base member **14**, a horizontal header **16**, and a pair of opposed, spaced vertical members **18**. These frame members are secured together at their respective ends, as by tack welds, to form the rigid frame section **12**. Each of the frame members **14, 16,** and **18** is illustrated as a U-shaped channel, each channel having a central leg, and a pair of integral legs projecting from the edges of the central leg. To make certain that channels **14** and **16** are filled properly with concrete, as will be described, they may be L-shaped channels omitting one of the integral legs.

Each of the legs **22** of the pair of vertical frame members **18** defines a plurality of vertically spaced openings **20**. Openings **20** are proportioned to receive and accommodate the ends of reinforcing rods. As seen in the drawings, at least one elongate horizontal reinforcing rod **26**, and depending upon the height of the unit, more than one reinforcing rod **26**, spans the width of the frame assembly **10**. The ends of the reinforcing rods **26** are preferably disposed, at opposite ends, between the pairs of integral legs **22**, as is illustrated in FIG. 2–7. Desirably, the reinforcing rods **26** are secured at the openings **20** as by nuts **28**.

Vertical members **18** may provide openings **20**, which are as much as three-fourths inch in diameter, thereby to accommodate, as desired, reinforcing rods **26** having diameters ranging from approximately one-fourth inch to three-fourths inch, depending upon the strength required from the reinforcing frame assembly to be embedded in the particular concrete structure. It has also been found desirable to form the channel frame members **14, 16, 18** from 20-gauge black iron into channels of about 2 inches × 2-5/8 inches, although, of course, other dimensions and materials may also be used.

A typical frame assembly **10** may be about 9 feet high by about 4 feet wide. When a frame assembly is of that

size, it is desirable to provide an additional vertical frame member, such as frame member **30**. Frame member **30** may also be a U-shaped channel and may be positioned within the horizontal base and header members **14** and **16**, generally in the manner that vertical member **18** is shown as being mounted in FIG. **2**. The integral legs **32** of vertical frame members **30** also define openings corresponding to openings **20**, so that reinforcing rods **26** may pass completely therethrough. The openings **20** in members **18** and **30** are coaxial.

To erect the frame assembly **10**, frame members **14**, **16**, **18**, and **30** are positioned as illustrated, and are then secured to each other, as by tack welding. Thereafter, reinforcing rods **26** are slid through the openings **20** in the legs **22** of one vertical member **18**, through the central vertical member openings and through the openings **20** in the legs of the opposed frame member **18**. Desirably, the reinforcing rods **26** are slightly shorter than the width of the frame assembly **10**, so that the ends of the reinforcing rods **26** lie between legs **22** at each side of the frame section **12**.

After the reinforcing rods **26** are secured in position, as by the spring nuts **28**, at least one second elongate reinforcing rod, such as vertical reinforcing rods **40**, is positioned perpendicularly to rods **26**, as illustrated in FIGS. **3** and **4**. Preferably they are secured to the horizontal reinforcing rods **26**, as by tying them together with tie wires **42** or the like. As such, the reinforcing rods **40** cross and are secured to the reinforcing rods **26** and, together with the frame section members and the reinforcing rods **26**, define an opening reinforcing network. Desirably, each frame assembly incorporates at least three reinforcing rods. It will be seen that the ends of the second reinforcing rods **40** also lie within the outer periphery defined by peripheral frame section **12**.

Frame assemblies, such as frame assembly **10**, may be prefabricated, as in a factory, and may then be transported to the construction site for erection.

As illustrated in FIG. **1**, a typical use of prefabricated frame assemblies, such as assembly **10**, would be to erect them on a pre-formed concrete slab S. A frame assembly, such as assembly **10**, is positioned and mounted on a slab S in a pre-determined location. The location may be predetermined, as by a series of short reinforcing rods **44** each having an end embedded in the slab and projecting upwardly, rods **44** being spaced and located to enter locating apertures **46** in the central leg of horizontal base member **14**. If such rods are used, they will serve, subsequently, to tie the entire reinforced concrete structure to the slab.

Of course, to form a reinforced concrete structural member of this invention, such as a wall or a roof, a plurality of frame assemblies is suitably secured, as to the slab S and to each other, to form a skeleton assembly, such as of the type illustrated in FIG. **1**. To that end, as illustrated in FIG. **1**, a plurality of additional frame assemblies is shown as being positioned to be secured to each other and adjacent ones to frame assembly **10**. Each of the other frame assemblies is appropriately formed, generally in accordance with the foregoing, each having one or more first and second reinforcing rods, the ends of which rods are disposed within an outer frame section defined by peripheral frame members. The skeleton assembly array illustrated in FIG. **1** provides openings for, for example, a door and windows.

Those additional frame assemblies which lie against slab S may be secured to slab S in the manner in which frame assembly **10** is secured to the slab. Adjacent frame assemblies are tied and secured together by short reinforcing rods, such as rods **50** (see FIG. **6**). Rods **50** are adapted to pass through and lie in openings **20**, **20'** of adjacent frame assemblies **10**, **10'**, thereby to locate the frame assemblies with respect to each other, and, when concrete is subsequently applied, to tie the adjacent frame assemblies and the entire reinforcing network together. Desirably, at least two such reinforcing rods **50** span each pair of adjacent pairs of legs **22**, **22'**, as is illustrated schematically in FIG. **1** and as is shown in FIG. **6**. Reinforcing rods **50** may be tied to legs **22**, **22'**, as by additional nuts **28**, or the like. Those additional frame assemblies **10'** which are not adjacent the slab S, such as those above the window areas and door illustrated in FIG. **1**., are secured to adjacent frame assemblies, as by a suitable plurality of short reinforcing rods **50**, and in the manner described.

Once a skeleton array such as the front wall array illustrated in FIG. **1**, has been erected, it may be combined with appropriately configured skeleton arrays for side walls, back walls, roofs, and the like, secured to each other and to the slab as appropriate. Indeed the corners formed at intersecting walls tend to stabilize an entire peripheral exterior wall assembly to eliminate the need for supports to maintain the vertical skeleton arrays in a vertical position. Roof frame assemblies can be directly secured to the upper edges of vertical frame assemblies to form a complete wall and roof network for a home to which concrete may be applied at one time.

To complete a suitable skeleton array, the interior of the erected frame assemblies are covered with a water repellent paneling, such as waterproof or water repellent plasterboard. This may then serve as a final interior wall surface for the reinforced concrete structural member.

To that end, panel board P is secured by suitable fasteners **60** to support surfaces which the legs of the frame members **14**, **16**, **18**, and, if present, frame member **30** provide. Suitable fasteners **60** pass through the paneling and into the frame member legs, as illustrated in FIG. **7**. In the embodiment of FIG. **2**, panel P would be secured to the interior surface of central legs **24** of vertical frame members **18**, and to projecting integral legs **62**, of horizontal frame members **14** and **16**. When the expanse of the frame member **10** is wide enough to require additional support, as in frame assembly **10**, one of the legs of vertical frame member **30** also provides a support surface **64** against which the panel P is disposed for securance thereto by further fasteners **60**. All of the support surfaces to which the paneling P is secured is preferably substantially coplanar, as is the case with the frame assembly **10**, as is seen best in FIG. **2**.

After the paneling P has been suitably mounted to the frame assemblies, the skeleton assembly is ready for the application of concrete, such as sprayable lightweight concrete. The panel boards P not only serve to provide either a finished interior wall (or one which may be subsequently finished with plaster), but also serve as a backing for the skeleton frame array, omitting the necessity for temporary forms, or the like. When concrete C is sprayed from the exterior surface, it forms against the paneling and about each of the

frame assemblies, the reinforcing rods, as well as the frame members. To facilitate filling the frame assemblies with concrete, it may be desirable to utilize horizontal frame members, omitting a leg **62'**, i.e., to utilize one or more right angle, horizontal frame members.

Because each of the frame assemblies is tied together by short reinforcing rods **50,** the entire structure is formed into a strongly reinforced unitary structure. That provides very strong wall sections, or roof sections, or entire building shells quickly and efficiently, and with a minimum of waste of concrete. Typical reinforced concrete sections incorporating reinforcing frame assemblies of this invention are illustrated in the drawings. For example, FIG. **7** illustrates a pair of coplanar adjacent frame assemblies **10, 10'**.

Referring now to FIG. **8,** a series of frame assemblies **100, 102,** and **104,** similar in construction to frame assembly **10,** are illustrated. Rather than being coplanar, as were frame assemblies **10, 10'** in FIG. **7,** frame assemblies **100, 102, 104** are disposed at angles of 90° to each other and illustrate the manner in which inside and outside corners may be formed. In such cases, when the individual frames are erected on site, and are to be tied together so that a unitary concrete structure is formed when the concrete is applied, right angle, short reinforcing rods **50'** are positioned in openings corresponding to openings **20** in the frame members of the frame assemblies. Thereafter, paneling P is applied in the manner previously described, and concrete is applied in the same manner it was applied to the embodiment illustrated in FIG. **7.**

Although rectangular frame assemblies have been illustrated, it will be apparent that frame assemblies having other external peripheral configurations may be used. For example, triangular frame assemblies may be formed, wherein first reinforcing rods are positioned in two opposite frame members, and second reinforcing rods are secured to the first reinforcing rods and cross the first reinforcing rods. Further, the frame assemblies may be flat coplanar assemblies, or may assume other shapes, such as a parti-spherical shape.

It will be apparent to those skilled in the art, from the foregoing description and drawings, that other frame assemblies, skeleton arrays, and structural members than those specifically illustrated and described may be made within the spirit and scope of this invention. Accordingly, this invention is not to be considered as being limited by the foregoing specification and drawings, except insofar as is required by the appended claims.

What is claimed is:

1. A prefabricated frame assembly for reinforcing concrete structural members, said frame assembly comprising a plurality of elongate frame members lying in a generally flat coplanar array secured together adjacent their respective ends to define a relatively rigid peripheral frame section for said frame assembly, each of said frame members being a U-shaped channel, each of an opposed pair of said frame members defining a plurality of spaced openings along its length, at least two substantially straight first elongate reinforcing rods being disposed in an opening in each of said pair of frame members, at least one end of each of said first reinforcing rods lying within the periphery of said peripheral frame section, each of said first reinforcing rods being secured to said frame members, and at least one substantially straight second elongate reinforcing rod secured to and crossing said first reinforcing rods to define therewith, and with said frame section, an open reinforcing network, the ends of each of said second reinforcing rods lying within the periphery of said peripheral frame section, each of said elongate channels having a central leg providing a first support surface to which a panel board may be secured and a pair of integral second legs projecting from the edges of said central leg, each of the support surfaces being generally coplanar, and wherein said spaced openings are provided in each of said integral second legs of each of the opposed pair of frame members.

2. A prefabricated frame assembly in accordance with claim **1,** wherein said frame members define a rigid rectangular peripheral frame section.

3. A prefabricated frame assembly in accordance with claim **1,** wherein an additional elongate frame member parallel to said opposed pair of frame members is disposed therebetween and defines a plurality of spaced openings along its length in which central portions of said first reinforcing rods are disposed.

4. A prefabricated frame assembly in accordance with claim **1,** wherein a pair of horizontal frame members are L-shaped channels and a pair of vertical frame members are U-shaped channels.

5. An erected skeleton assembly for forming a reinforced concrete structural member, said skeleton assembly comprising

1. a pair of adjacent frame assemblies, each frame assembly comprising a plurality of elongate frame members secured together in a generally coplanar array to define a peripheral frame section for said frame assembly, each of an opposed pair of said frame members defining a plurality of spaced openings along its length, at least one first elongate reinforcing rod, each of said rods being disposed in an opening in each of said pair of frame members, at least one end of each of said first reinforcing rods lying within the periphery of said peripheral frame section, each of said first reinforcing rods being secured to said frame members, and at least one second elongate reinforcing rod secured to and crossing said first reinforcing rods to define therewith and with said frame section an open reinforcing network, the ends of each of said second rods lying within the periphery of said peripheral frame section, and

2. A plurality of short reinforcing rods in openings in adjacent ones of said pairs of frame members of adjacent frame assemblies, whereby when concrete is applied to said adjacent pair of frame assemblies, the frame assemblies are tied together by said third short reinforcing rods.

6. A skeleton assembly in accordance with claim **5,** wherein said frame members of each frame assembly define a rigid rectangular peripheral frame section, thereby to provide a pair of rectangular frame assemblies, and wherein there are at least three reinforcing rods in each frame assembly.

7. A skeleton assembly in accordance with claim **5,** wherein each of a plurality of said elongate frame members of each frame assembly includes a first support surface to which a panel board may be secured, each of said support surfaces being substantially coplanar.

8. A skeleton assembly in accordance with claim **7,** wherein each of said plurality of elongate frame members comprises a said first leg providing a first support

surface and a second integral leg, the second legs of the opposed pair of frame members in each frame assembly defining said openings.

9. A skeleton assembly in accordance with claim **8**, wherein each of said plurality of elongate frame members is a U-shaped channel having a central leg and a pair of integral legs projecting from the edges of said central leg, and wherein said spaced openings are provided in each of said integral legs of each of the opposed pair of frame members.

10. A skeleton assembly in accordance with claim **7**, wherein panel boards are secured to the first support surfaces of each frame assembly.

11. An erected skeleton assembly in accordance with claim **5** in which at least one of said frame assemblies includes an additional elongate frame member parallel to said opposed pair of frame members disposed therebetween, said additional frame member defining a plurality of spaced openings along its length in which central portions of said first reinforcing rods are disposed.

12. A reinforced concrete structural member, such as an external wall or roof or the like, said member comprising

1. a pair of adjacent frame assemblies, each frame assembly comprising a plurality of elongate frame members secured together in a generally coplanar array to define a peripheral frame section for said frame assembly, each of an opposed pair of said frame members defining a plurality of spaced openings along its length, at least one first elongate reinforcing rod, each of said rods being disposed in an opening in each of said pair of frame members, at least one end of each of said first reinforcing rods lying within the periphery of said peripheral frame section, each of said first reinforcing rods being secured to said frame members, at least one second elongate reinforcing rod secured to and crossing said first reinforcing rods to define therewith, and with said frame section, an open reinforcing network, the ends of each of said second rods lying within the periphery of said peripheral frame section, and support surfaces defined by a plurality of said frame members,

2. a plurality of short reinforcing rods in openings in adjacent ones of said pairs of frame members of adjacent frame assemblies,

3. panel boards secured to said support surfaces to provide an internal surface for said structural member, and

4. concrete formed against said panel boards and embedding said frame assemblies and short reinforcing rods.

13. The reinforced concrete structural member of claim **12**, wherein the frame members of each of said frame assemblies defines a rectangular peripheral frame section, and there are at least three elongate reinforcing rods in each frame assembly.

14. A reinforced concrete structural member in accordance with claim **13**, wherein each of said plurality of frame members is a U-shaped channel having a central leg and a pair of integral legs projecting from the edges of said central leg, and wherein said spaced openings are provided in each of said integral legs of each of the opposed pair of frame members, said support surfaces being provided by surfaces of said legs.

15. A method of erecting a skeleton reinforcing network to which concrete may be applied to form a reinforced concrete wall, comprising the steps of providing a plurality of rectangular frame assemblies, each frame assembly comprising a plurality of elongate frame members secured together to define a frame section, an opposed pair of said frame members defining a plurality of spaced openings along their length, at least one first elongate reinforcing rod supported at its ends in openings in said opposed pair of frame members, at least one second reinforcing rod secured to and crossing said first reinforcing rods to define therewith, and with said frame section an open reinforcing network, mounting a first of said frame assemblies on a slab, positioning a second of said frame assemblies adjacent said first frame assembly, and positioning short reinforcing rods in openings in adjacent frame assembly frame members to secure and tie said adjacent frame members and frame assemblies to each other.

16. A method in accordance with claim **15**, comprising the further step of securing water repellent panel board material to said frame members to form a skeleton array.

17. A method in accordance with claim **15**, in which one of the frame members of one of said frame assemblies defines openings and said frame assembly is positioned on the slab with short reinforcing rods projecting upwardly from the slab through one or more of said openings thereby to tie said frame assembly to the slab.

18. A method of erecting a skeleton reinforcing network to which concrete may be applied to form a reinforced concrete member, comprising the steps of providing a plurality of frame assemblies, each frame assembly comprising a plurality of elongate frame members secured together to define a frame section, an opposed pair of said frame members defining a plurality of spaced openings along their length, at least one first elongate reinforcing rod supported at its ends in openings in said opposed pair of frame members, at least one second reinforcing rod secured to and crossing said first reinforcing rods to define therewith, and with said frame section an open reinforcing network, positioning a pair of said frame assemblies adjacent each other, and positioning short reinforcing rods in openings in adjacent frame assemb'y frame members to secure and tie said adjacent frame members and frame assemblies to each other.

19. A method in accordance with claim **18**, wherein the frame members of said frame assemblies lie in a generally coplanar array.

20. A method in accordance with claim **19**, wherein said frame assemblies are generally rectangular in shape.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,744,194 Dated July 10, 1973

Inventor(s) LAWRENCE R. RAMBERG

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, lines 4-18, delete the paragraph "A prefabricated frame ... concrete structure."

Column 8, line 51, change "assemb'y" to --assembly--.

Signed and sealed this 20th day of August 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
☆ U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.