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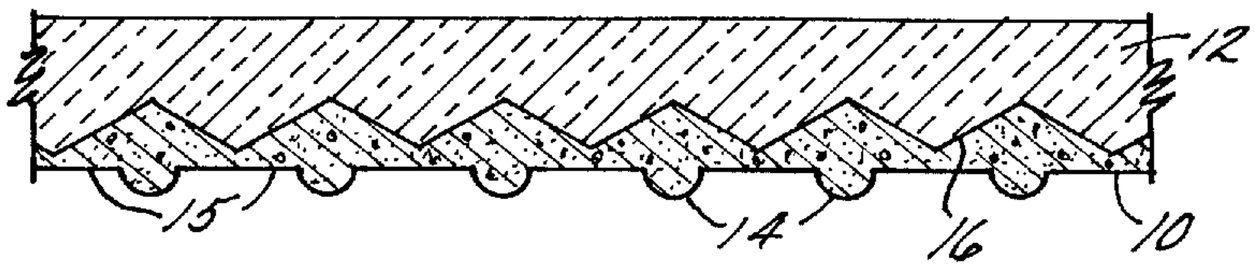
(54) **TOIT DE BETON LEGER ARME DE RENFORT TISSE**

(54) **SCRIM REINFORCED LIGHTWEIGHT CONCRETE ROOF SYSTEM**



(57) A roofing system incorporating lightweight concrete. The system includes a deck and an insulation board. Lightweight concrete is placed between the deck and the insulation board. The deck includes upper and lower flutes and the insulation board has a plurality of channels formed therein. The lower flutes and channels form ribs in the concrete layer that strengthen the roofing system. The concrete layer may be attached to the deck by a series of protrusions in the deck that extend into the concrete. Alternatively, the concrete layer may float above the deck to prevent cracking. A release agent may be used to prevent the concrete layer from adhering to the deck.

SCRIM REINFORCED LIGHTWEIGHT CONCRETE ROOF SYSTEM

ABSTRACT

A roofing system incorporating lightweight concrete. The system includes a deck and an insulation board. Lightweight concrete is placed between the deck and the insulation board. The deck includes upper and lower flutes and the insulation board has a plurality of channels formed therein. The lower flutes and channels form ribs in the concrete layer that strengthen the roofing system. The concrete layer may be attached to the deck by a series of protrusions in the deck that extend into the concrete. Alternatively, the concrete layer may float above the deck to prevent cracking. A release agent may be used to prevent the concrete layer from adhering to the deck.

SCRIM REINFORCED LIGHTWEIGHT CONCRETE ROOF SYSTEM

Background of the Invention

Field of the Invention

The invention relates generally to roof systems and in particular to a roof system having a roof deck and a lightweight concrete poured over the roof deck.

Prior Art

FIGURE 1 is a cross-sectional view of a conventional roofing system. This roofing system is described in U.S. Patent 4,888,930, which is incorporated herein by reference. In FIGURE 1, a roof deck 103 is attached to purloins 102 through fasteners 104. An insulation board 108 is attached to the deck 103 through fasteners 109, 110. A membrane 107 is placed over the top of the insulation board 108 to seal the roof. As shown in FIGURE 2, the deck 103 may be sealed by applying a caulk 112 at the deck joints. By sealing the deck 103, wind uplift forces WF are applied to the deck 103, and not the insulation board 108. The deck 103 can be rigidly fastened to the purlins 102 and thus withstand the uplift wind forces.

It is also known in the art to incorporate concrete into a roofing system in order to add stability to the roof. The concrete is placed between the insulation board and the roof deck. Holes are formed in the insulation board and when pressure is

applied to the top of the insulation board, the concrete is forced up through the holes. Thus, the concrete provides a stable roof system. When uplift wind force is applied to the deck, the deck flexes causing the concrete to become detached from the deck and crack. This results in roof failure. There is a perceived need in the art for a concrete roof system that is resistant to uplift wind forces.

Summary of the Invention:

The above-discussed and other drawbacks and deficiencies of the prior art are overcome or alleviated by the concrete roof system of the invention. In the present invention, the concrete is either affixed to the roof deck or allowed to float above the roof deck when uplift force is present. Both alternatives reduce cracking of the lightweight concrete. The lightweight concrete may be affixed to the roof deck by providing undercuts in the deck material that hold the concrete to the deck and prevent flexing and cracking. Alternatively, the concrete can float above deck when the deck flexes. The concrete moves away from the deck when uplift forces are present and returns to contact the deck when the uplift force has subsided.

Brief Description of the Drawings

Referring now to the drawings wherein like elements are numbered alike in the several FIGURES:

FIGURE 1 is a cross-sectional view of a conventional roofing system.

FIGURE 2 is an enlarged view of a portion of the conventional roof system of FIGURE 1;

FIGURES 3A-3C are cross-sectional views of the roof deck and the insulation board;

FIGURE 4 is a cross-sectional view of the roof deck and insulation board;

FIGURE 5A is a cross-sectional view of the roof system including lightweight concrete;

FIGURE 5B is a cross-sectional view of an alternative top surface of the roof system including lightweight concrete;

FIGURE 6 is a cross-sectional view of a roof system having a sealed roof deck;

FIGURE 7 is a cross-sectional view of an alternative roof deck;

FIGURE 8 perspective cut-away view of a roof system including cables placed in the roof deck;

FIGURE 9 cross-sectional view of the cable surrounded by concrete; and

FIGURE 10 is a cross-sectional view of an alternative roof system .

Detailed Description of the Invention

FIGURES 3A-3C are cross-sectional views of a roof deck 10 and an insulation board 12. The roof deck 10 may be made by overlapping corrugated panels made from metal or a concrete tectum composite. Alternatively, the roof deck 10 may be poured in place monolithic. The insulation board 12 may be a polystyrene material. As shown in FIGURE 3A, the roof deck 10 is corrugated and includes a plurality of high flutes 15 and low flutes 14. The low flutes 14 in FIGURE 3A are C-shaped. Formed in the insulation board 12, above each low flute 14, is a channel 16. The channel 16 in FIGURE 3A has a triangular cross section. The lightweight concrete is placed between the insulation board 12 and the deck 10 to strengthen the roof assembly. By including channels 16 in the insulation board 12, the cured concrete includes a plurality of ribs defined by the channels 16 and the lower flutes 14 that strengthen the concrete form. The strength of the concrete will additionally strengthen the deck 10 against bowing movement and wind uplift pressures. Accordingly, it is less likely that the concrete will become detached from the deck 10 and subsequently crack. FIGURE 3B shows an alternative channel 18 which has curved cross section. FIGURE 3C shows another alternative channel 22 having a trapezoidal cross section and a lower flute 20 formed in the deck 10 having a trapezoidal cross section.

FIGURE 4 is a cross-sectional view of the insulation board 12 positioned above the deck 10. A nail and disk 24 is placed in the deck 10 so that the bottom of the insulation board 12 is positioned approximately ½" above the upper flute 15 of the

deck 10. The lightweight concrete is then pumped into the space between the insulation board 12 and the deck 10. A block 26 may also be placed between the deck 10 and the insulation board 12 to prevent the movement of the concrete beyond a desired area.

FIGURE 5 is a cross-sectional view of the roofing system including the lightweight concrete. Holes 28 are formed in the insulation board 12. Once concrete 30 is placed in the area between the deck 10 and the insulation board 12, pressure is applied to the top of insulation board 12. This causes the concrete 30 to be forced up through holes 28 to the top surface of the insulation board 12. Additional concrete may be poured over the top of the insulation board 12 to form a top concrete layer 32. The top concrete layer 32 may include a reinforcement structure 34 in the form of an elastic or polymeric mesh. Preferably, the mesh (scrim) is comprised of polyester or fiberglass and preferably includes a coating to inhibit deterioration from the highly alkaline compounds inherent in concrete. Mesh material that may be employed in the invention is Bond coat polyester or JPStevens fiberglass open mesh sheets both of which are commercially available from a variety of sources common and known to the industry. The elastic or polymeric mesh is fastened to the side edges of the insulation board 12 and is embedded (floated) in the top concrete layer 32. An additional benefit of the polymeric material is that it is light in weight. Therefore, the mesh "floats" near or at the top surface of the concrete. This has several advantages: the mesh holds water in the concrete to provide for a better cure of the concrete, provides a more aesthetically pleasing finish due to mitigating effects on bumps or lumps, and, importantly, the location of the mesh near the top surface of the concrete endows the concrete with greater resistance to fracture. Benefits as set forth can also be obtained if scrim is laid over partially cured concrete and an additional layer of concrete is poured thereover. As shown in FIGURE 5B, additional ribs 33 may be formed in the top concrete layer 32 to provide additional rigidity. The ribs 33 may be either parallel or perpendicular to the ribs formed by channel 22 in the insulation board 12. The channels 22 formed in the insulation board 12 create ribs in the concrete 30 and enhance the strength of the deck 10 thereby reducing the likelihood

that the deck 10 will flex causing the concrete 30 to become detached from the deck 10 and crack.

The combination of the deck 10 and the lightweight concrete assembly comprising the insulation board, bottom concrete layer 30 and top concrete layer 32 is fastened with mechanical fasteners between roof girder or joists with so that the roof would naturally bow between girders. A roof membrane, similar to membrane 107 in FIGURE 1, is then laid loose or adhesively attached to the mechanical fasteners connecting the roof system to the girders or joists.

The deck 10 may be air sealed in a variety of ways. The deck 10 may be made from individual panels as shown in FIGURE 1. These panels overlap at their ends and a caulk 112 is placed between the overlapping ends to seal the deck. Alternatively, as shown in FIGURE 6, an air impermeable film 36 may be placed over the deck 10 to create an air sealed deck.

As mentioned previously, the concrete may be attached to the deck to create an even stronger structure and to prevent the concrete from becoming detached from the deck. FIGURE 7 shows a deck structure that prevents concrete from becoming detached from the deck. The deck 40 is similar to deck 10 described above except that the upper flute 41 includes a protrusion 42 extending into the area defined by the lower flute to create a recess 44 in the lower flute. When the concrete is poured over the deck 40, the recess 44 is filled with liquid concrete. When the concrete hardens, the protrusion 42 prevents the concrete from becoming detached from the deck 40. It is understood that other formations in the deck 10 may be used to affix the concrete layer 30 to the deck 10. This creates a solid deck and reduces the likelihood that the deck will flex or that the concrete will become detached from the deck and cause the concrete to crack.

As mentioned above, the concrete may alternatively float above the deck. As the deck bends or flexes, the concrete can pull away from the deck and prevent stress on the concrete. FIGURE 8 is a perspective cutaway view of a system for allowing the concrete to float relative to the deck. In FIGURE 8, a lower flute 20 includes a cable 48. The cable 48 is attached to the roof system by fastener 50 that attaches the

cable 48 to the purloins 102. As shown in FIGURE 9, when the concrete 30 is poured over the deck 10, the concrete 30 flows around cable 48 and cable 48 becomes embedded in the hardened concrete 30. The ribs formed opposite the lower flute are not shown for ease of illustration. In the embodiment shown in FIGURES 8 and 9, the deck is not air sealed, so uplift wind forces are applied to the deck 10 and the concrete layer 30. The concrete 30 may pull away from the deck 10 when the deck flexes thereby preventing the concrete 30 from cracking. The cable 48 prevents the concrete 30 from moving too far from the deck 10. When the uplift wind force has subsided, the concrete 30 comes back into contact with the deck 10. A release agent 52, such as an oil or a thin membrane having a low coefficient of friction, may be placed over the deck 10 to prevent the concrete 30 from adhering to the deck 10 and allowing the concrete 30 to freely float above the deck 10.

If the deck 10 is sealed, then the uplift wind force is applied to the deck 10 and does not directly contact the concrete 30. As shown in FIGURE 10, the cable 48 is not needed to keep the concrete 30 proximate to the deck 10. The uplift wind force will be applied to the deck 10. If the deck 10 flexes or bends, the concrete 30 will rise above the deck 10 preventing stress and cracking of the concrete 30.

While preferred embodiments have been shown and described, various modifications and substitutions may be made thereto without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the present invention has been described by way of illustration and not limitation.

What is claimed is:

CLAIM 1. A roofing system comprising:

a deck; and

a concrete layer having a plurality of ribs formed therein.

CLAIM 2. The roofing system of claim 1, further comprising an insulation board positioned above said concrete layer.

CLAIM 3. The roofing system of claim 2, wherein:

said deck comprises a plurality upper flutes and lower flutes;

said insulation board comprises a plurality of channels; and

said ribs are defined by said lower flutes and said channels.

CLAIM 4. The roofing system of claim 2, wherein:

said insulation board has a top surface, said top surface being covered with a top concrete layer.

CLAIM 5. The roofing system of claim 4, wherein said top concrete layer comprises a reinforcement structure embedded in said top concrete layer.

CLAIM 6. The roofing system of claim 5, wherein said reinforcement structure is a reinforcing mesh.

CLAIM 7. The roofing system of claim 5, wherein said reinforcement structure is a polymeric mesh.

CLAIM 8. The roofing system of claim 5, wherein said reinforcement structure is an elastic mesh material.

CLAIM 9. The roofing system of claim 4 further comprising a membrane positioned above said top concrete layer.

CLAIM 10. The roofing system of claim 1, wherein said deck is formed from a plurality of overlapping metal panels.

CLAIM 11. The roofing system of claim 1, wherein said deck is formed from a plurality of overlapping concrete tectum panels.

CLAIM 12. The roofing system of claim 1, wherein said deck is a poured monolithic deck.

CLAIM 13. A roofing deck for securing a layer of concrete to said deck, said deck comprising:

a protrusion for holding the concrete layer to said deck.

CLAIM 14. The roofing deck of claim 13 wherein said deck comprises a plurality of upper flutes and lower flutes, said protrusion extending from said upper flute into a space defined by said lower flute to form a recess for receiving concrete and attaching the concrete layer to said deck.

CLAIM 15. A roofing system comprising:

a deck; and

a concrete layer positioned above said deck and movable relative to said deck.

CLAIM 16. The roofing system of claim 15 wherein said deck is air permeable, said roofing system further comprising at least one cable for retaining said concrete proximate to said deck.

CLAIM 17. The roofing system of claim 16 wherein said deck comprises a plurality of upper flutes and lower flutes, said cable being positioned in said lower flute.

CLAIM 18. The roofing system of claim 16 wherein said deck is positioned above purlins, said roofing system further comprising a fastener for connecting said cable to at least one purlin.

CLAIM 19. The roofing system of claim 17 wherein said deck is positioned above purlins, said roofing system further comprising a fastener for connecting said cable to at least one purlin.

CLAIM 20. The roofing system of claim 15 wherein said deck is sealed.

CLAIM 21. The roofing system of claim 15 further comprising a release agent between said concrete layer and said deck, said release agent preventing said concrete layer from adhering to said deck.

CLAIM 22. The roofing system of claim 21 wherein said release agent is an oil.

CLAIM 23. The roofing system of claim 21 wherein said release agent is a sheet of material having a low coefficient of friction.

CLAIM 24. A roof construction comprising:

a roof deck;

a concrete layer poured over said roof deck;

a mesh material floated in said concrete layer near a top surface thereof.

CLAIM 25. A roof deck comprising:

a corrugated metal material having inwardly protruding tabs therein.

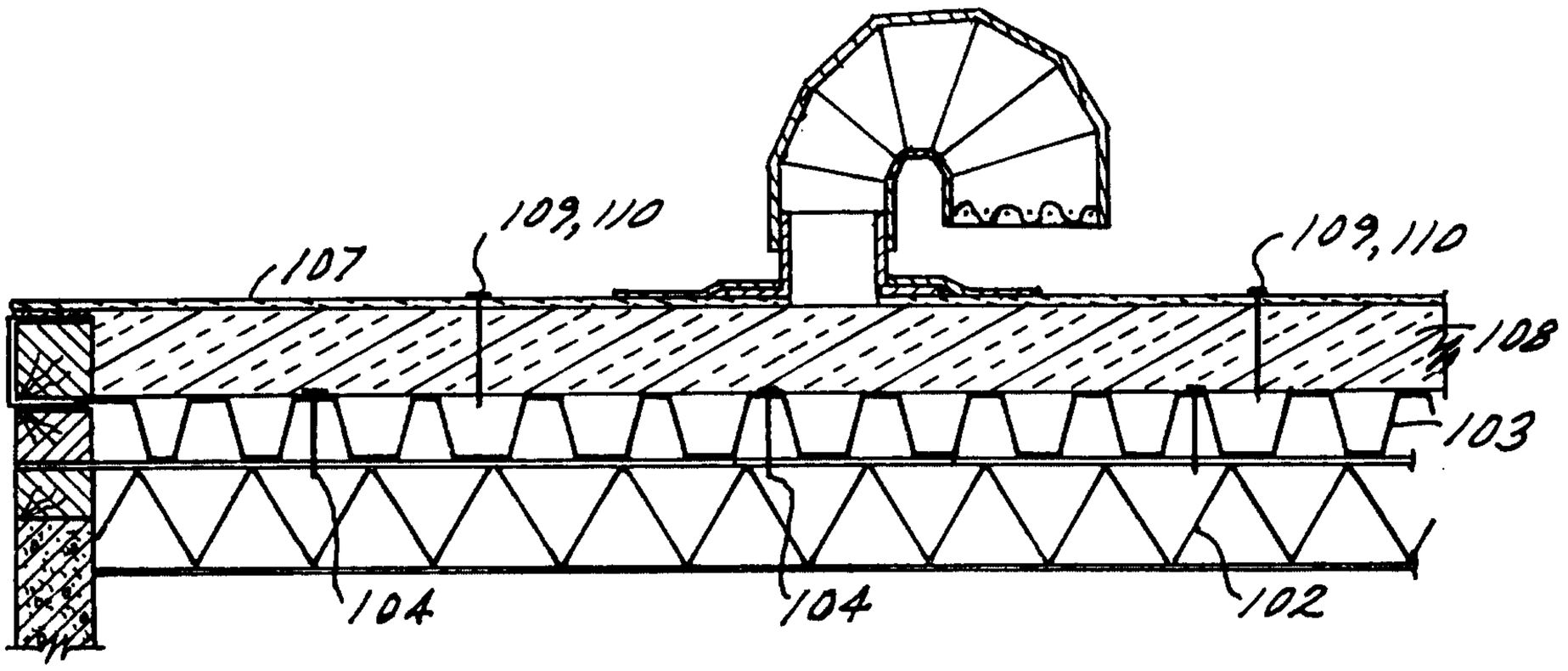


FIG. 1
(PRIOR ART)

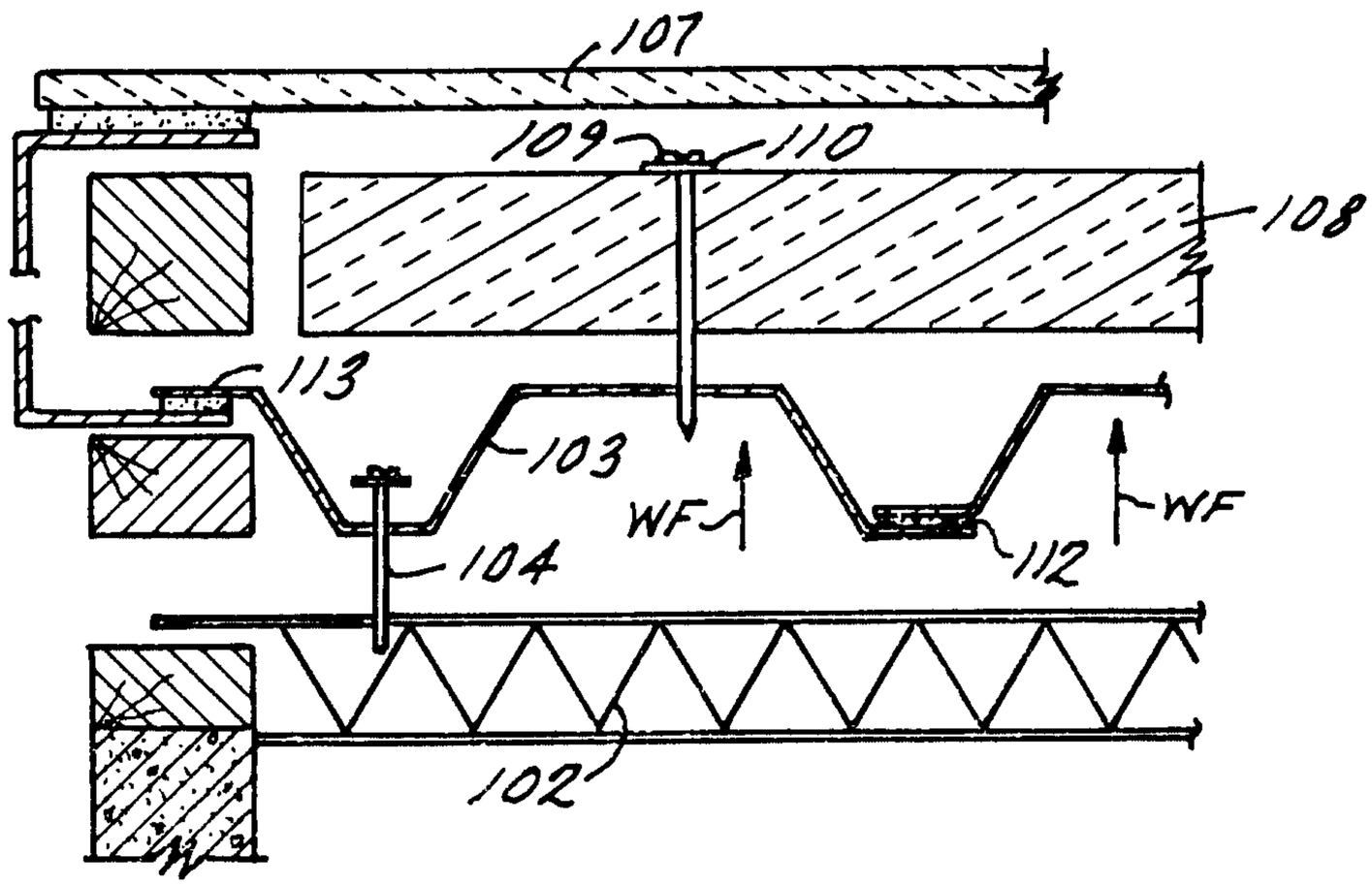


FIG. 2
(PRIOR ART)

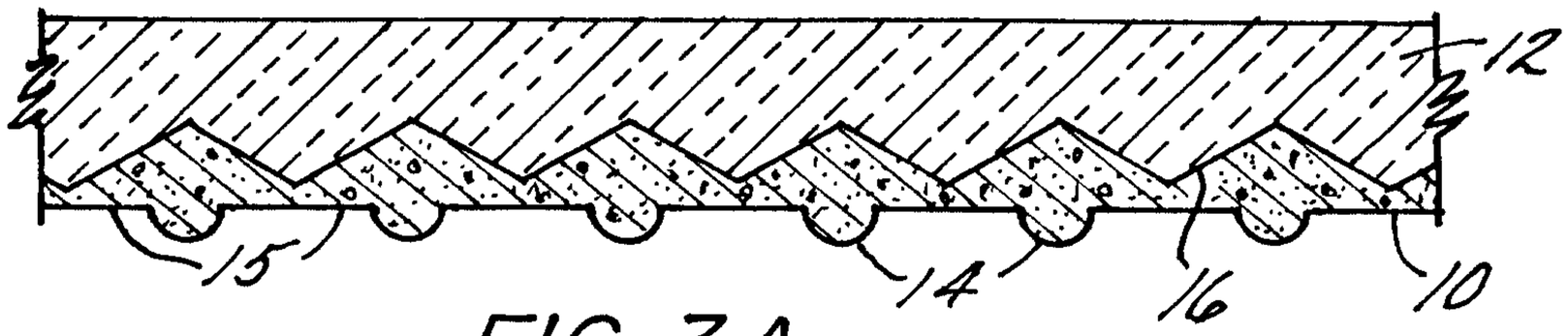


FIG. 3A

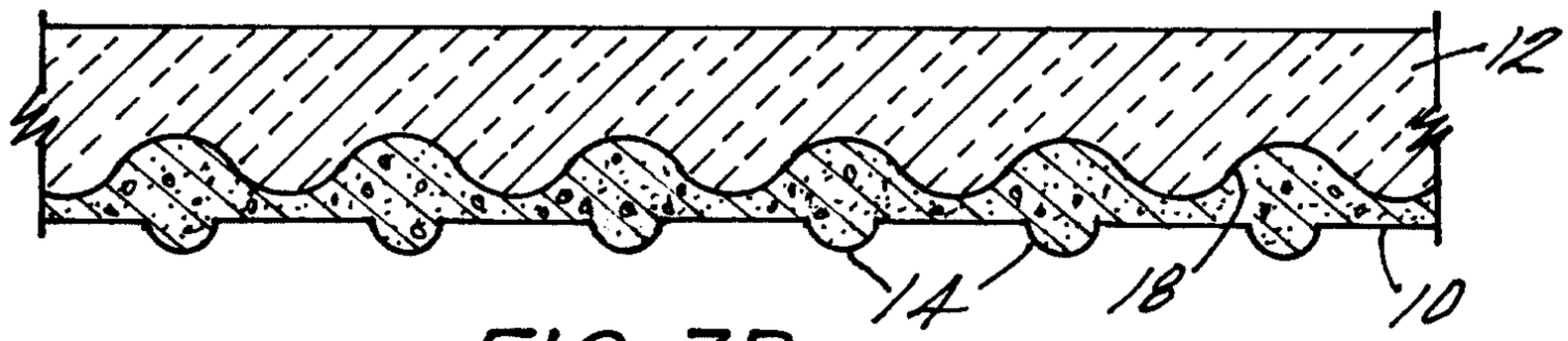


FIG. 3B

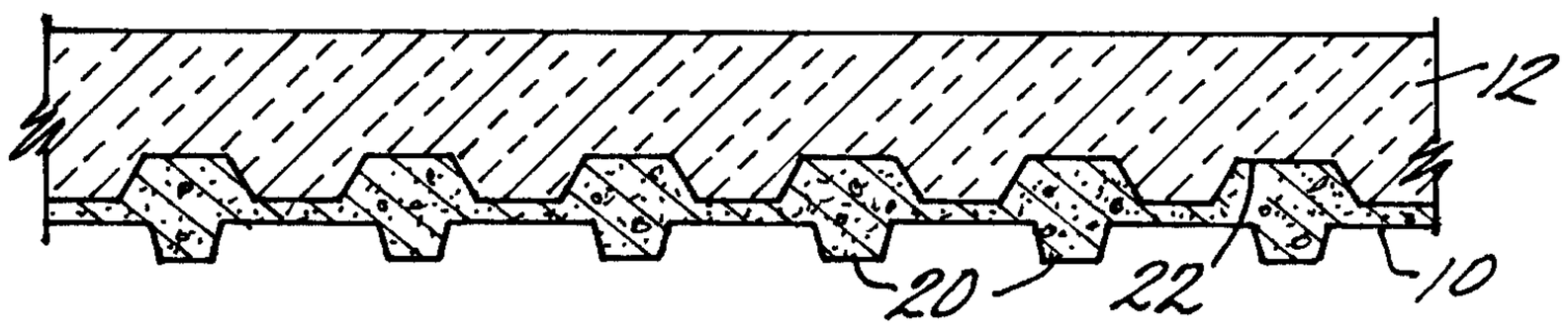


FIG. 3C

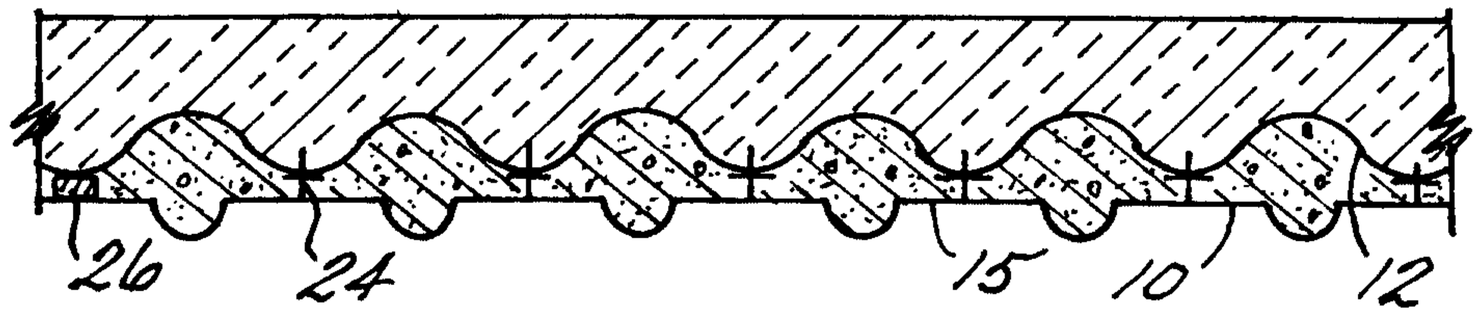


FIG. 4

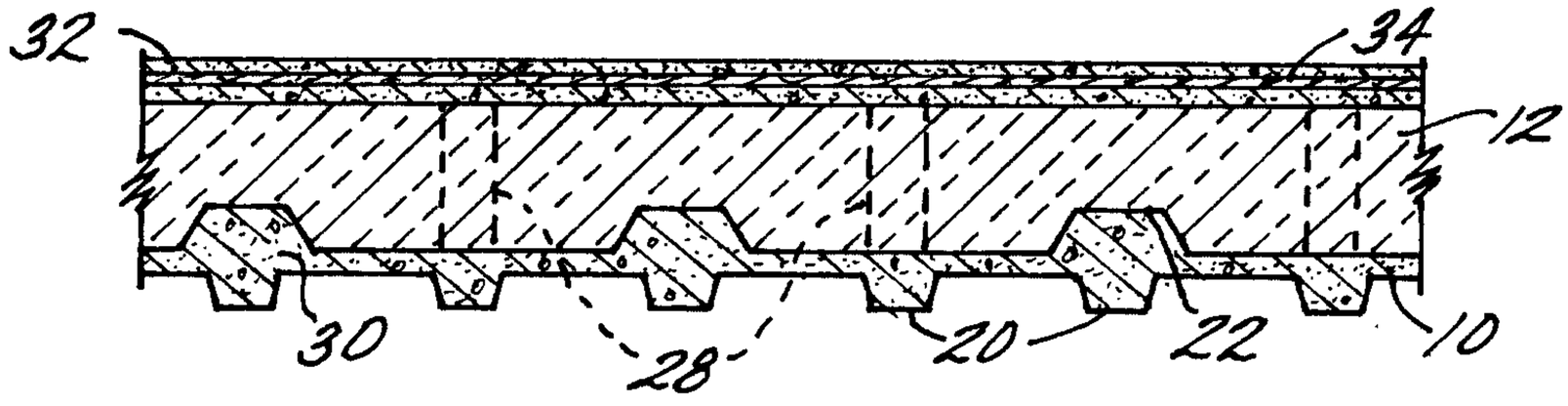


FIG. 5A

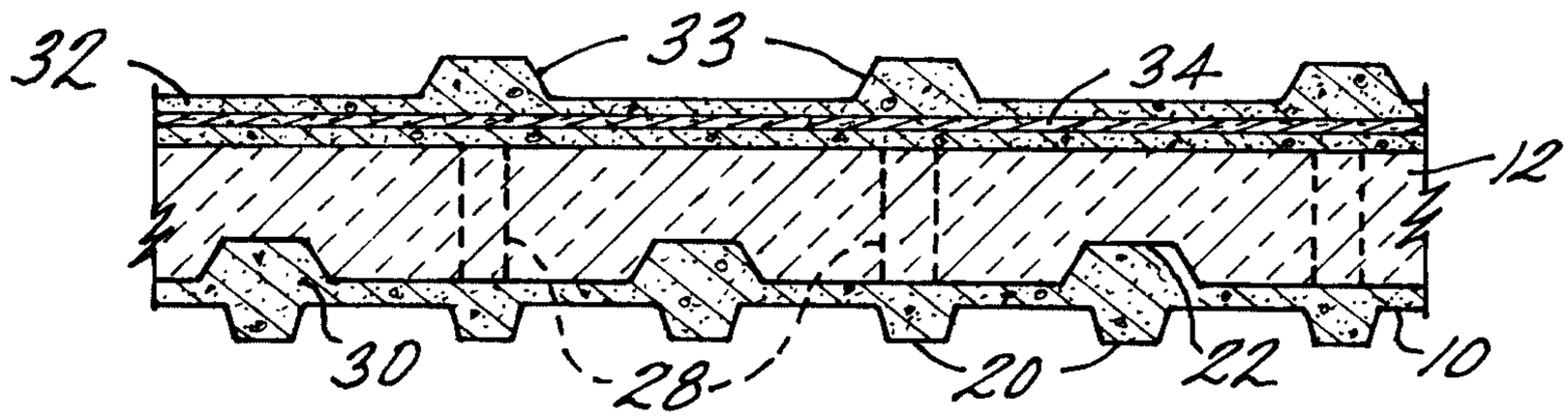


FIG. 5B

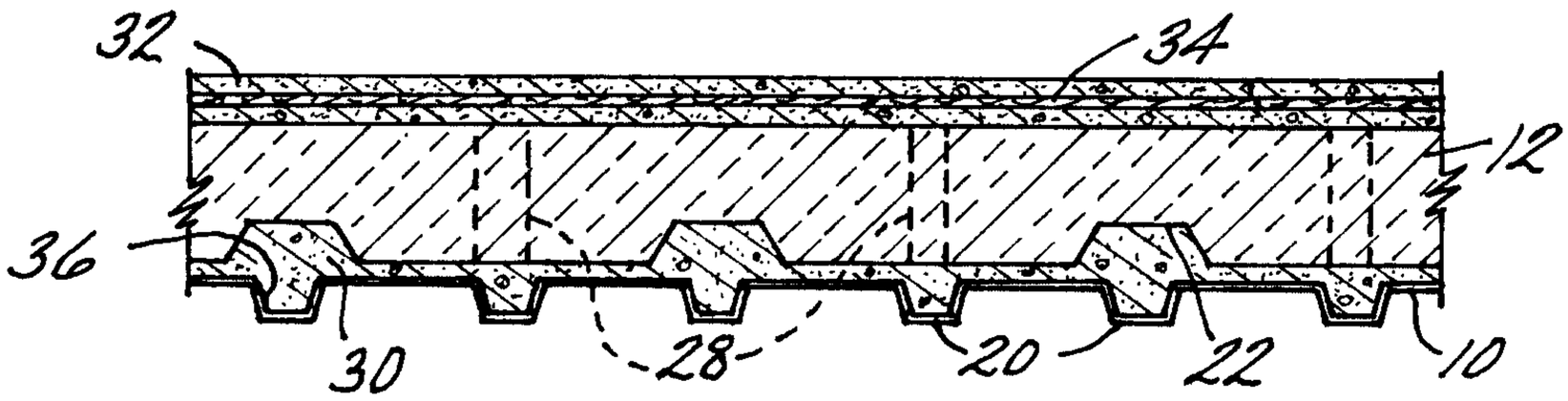


FIG. 6

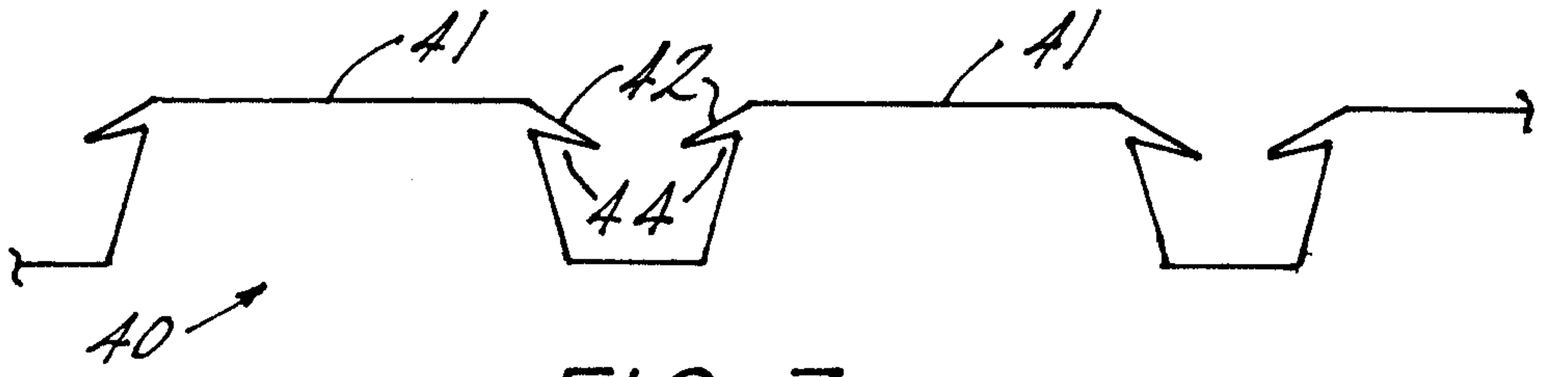


FIG. 7

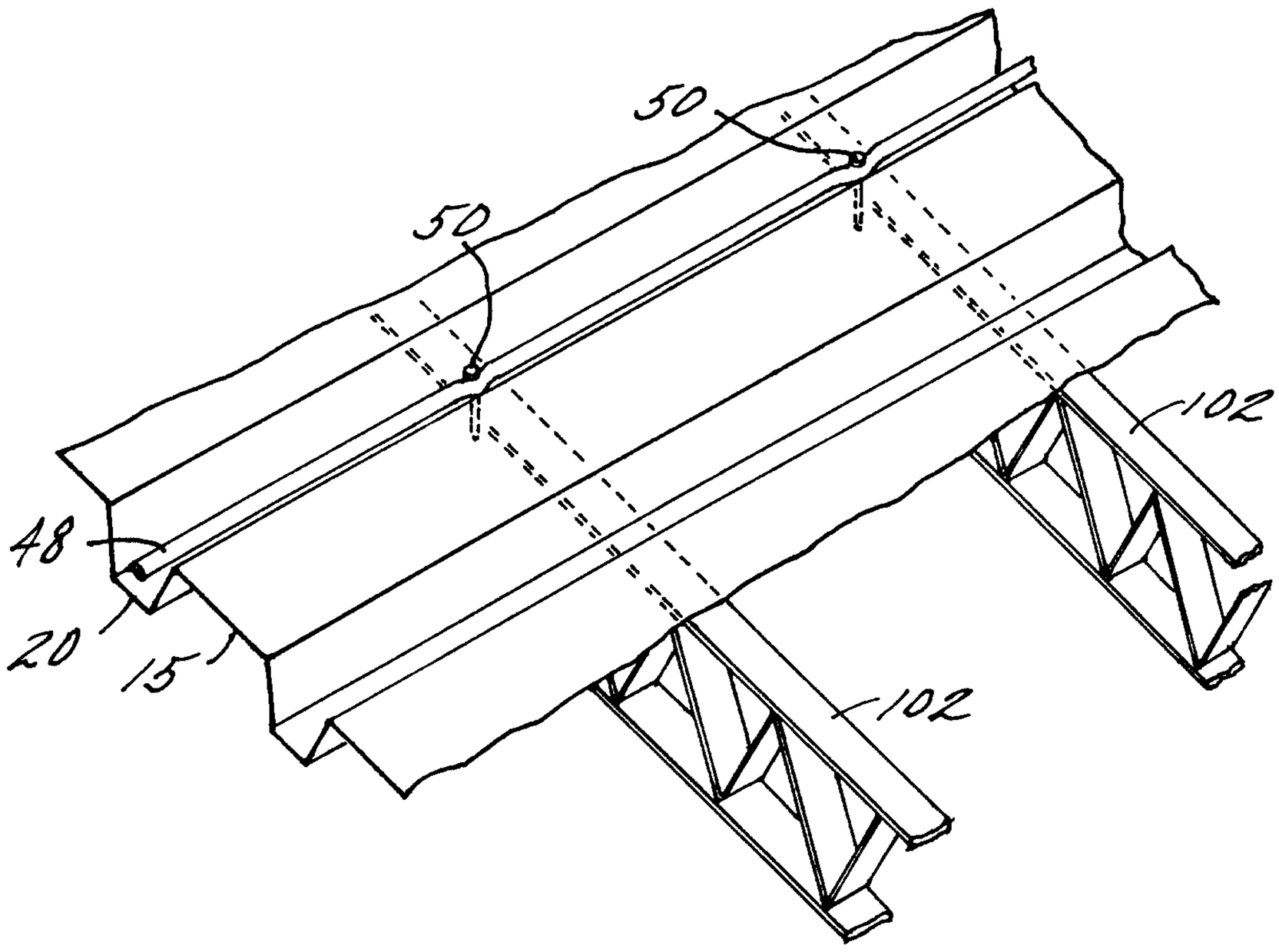


FIG. 8

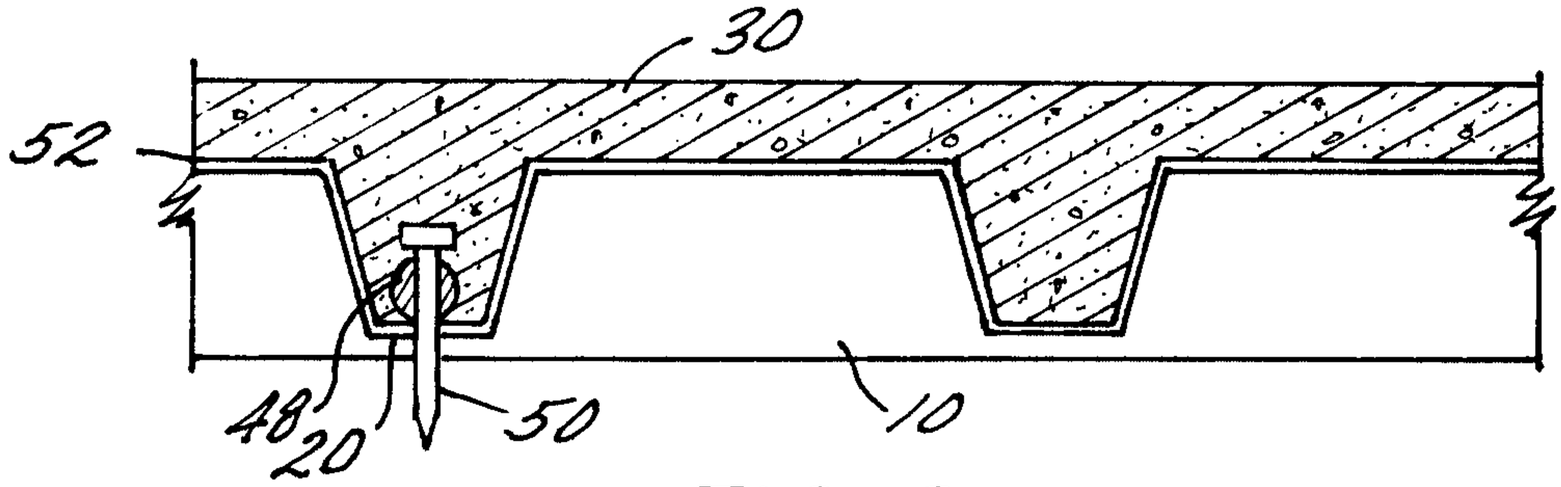


FIG. 9

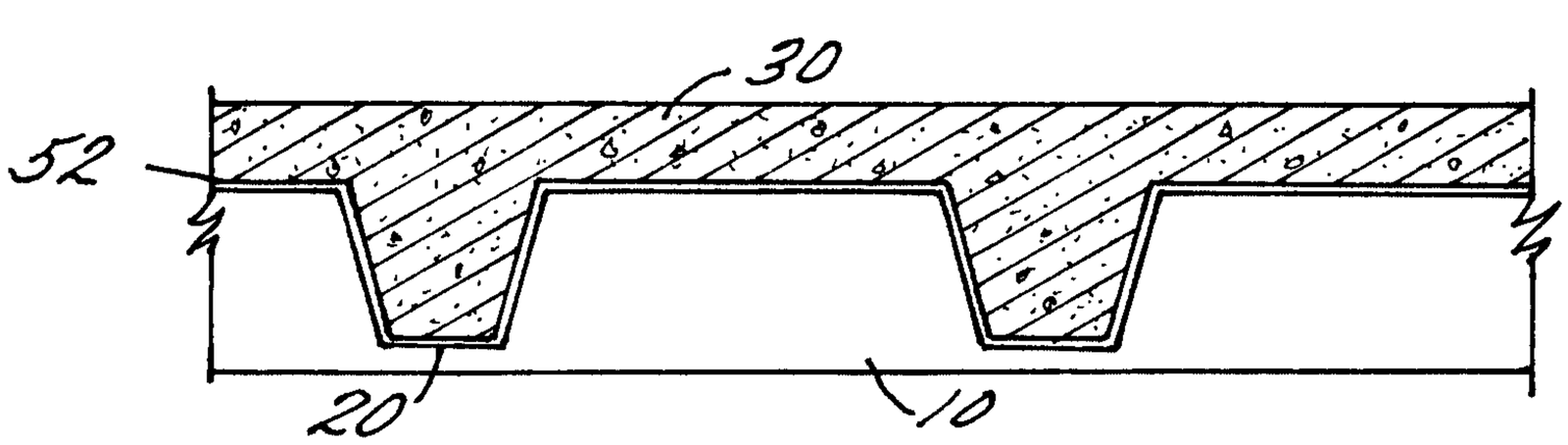


FIG. 10