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(54) THERMAL WALL SYSTEM

(75) Inventor: **Tim Ryan**, Greenville, TX (US)

Correspondence Address:
HOVEY WILLIAMS LLP
2405 GRAND BLVD., SUITE 400
KANSAS CITY, MO 64108 (US)

(73) Assignee: **WESTERN FORMS, INC.**, Kansas City, MO (US)

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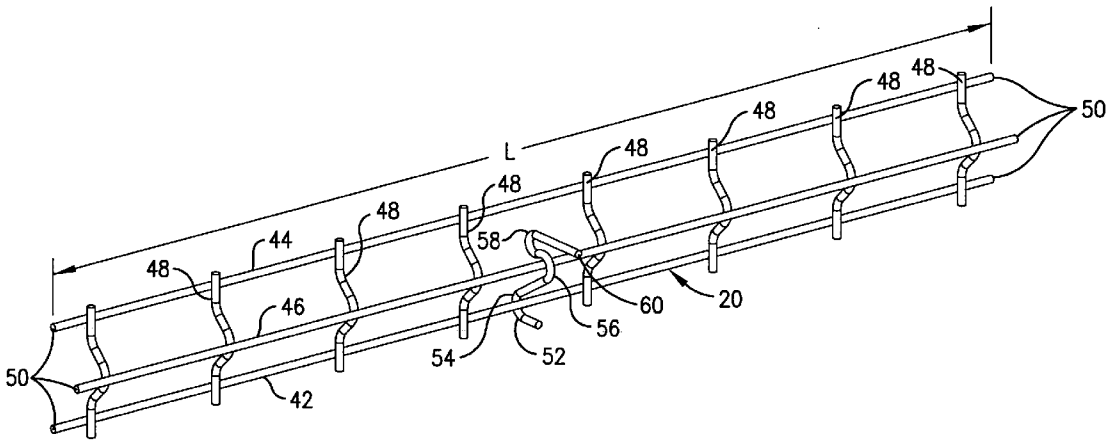
(57) **ABSTRACT**

A thermal wall system for constructing insulated concrete walls includes a pair of opposing forming walls, a mount extending between the forming walls for positioning the walls in spaced relationship, at least one spacing element mounted to the mount, and a body of thermally insulating material held by the spacing element in spaced relationship to at least one and preferably both of the forming walls. Concrete poured into the areas between the body and forming walls envelopes the spacing members and the insulating body, with the resultant concrete wall having the insulating body spaced from the exposed outer surfaces of the cured concrete of the wall a consistent depth corresponding to the depth of the spacing element. The mounts are preferably tie bars, which readily receive the spacing elements and structurally connect the spacing elements positioned on opposite sides of the body.



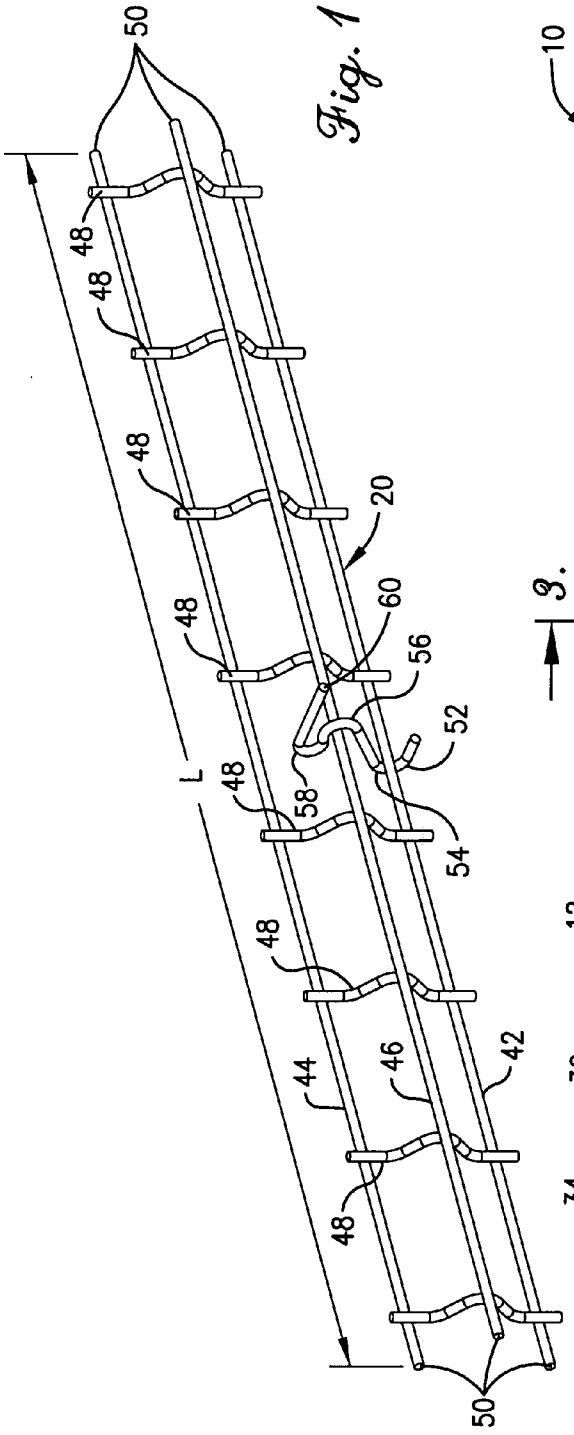

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Fig. 1.

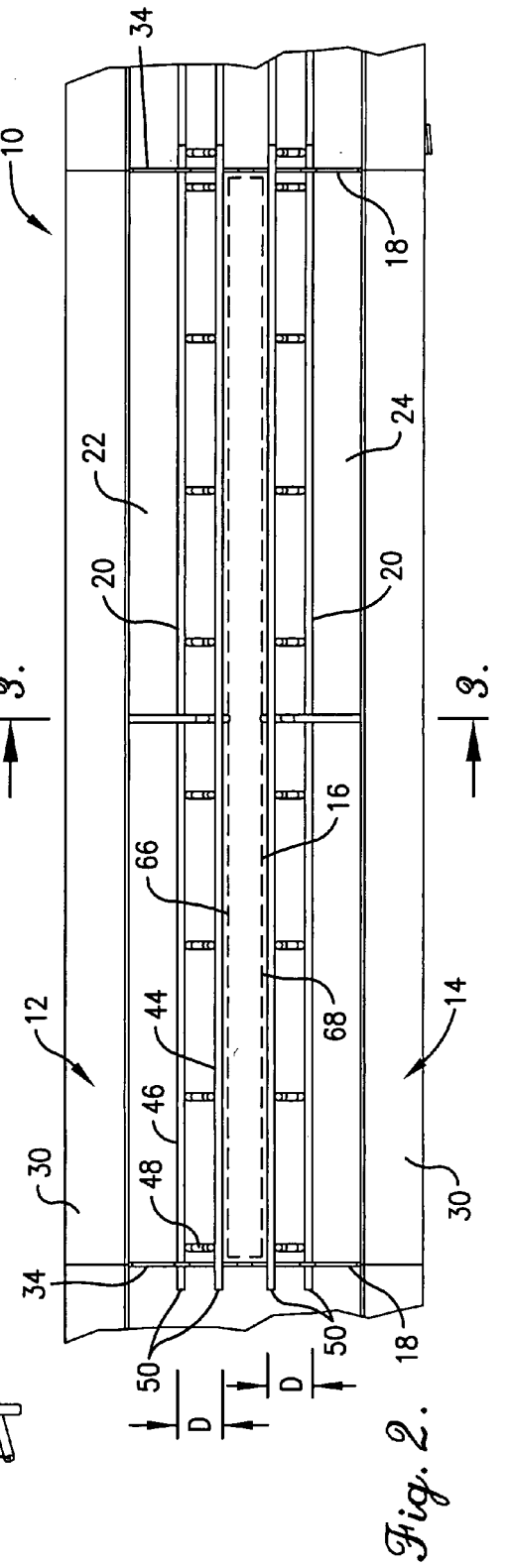
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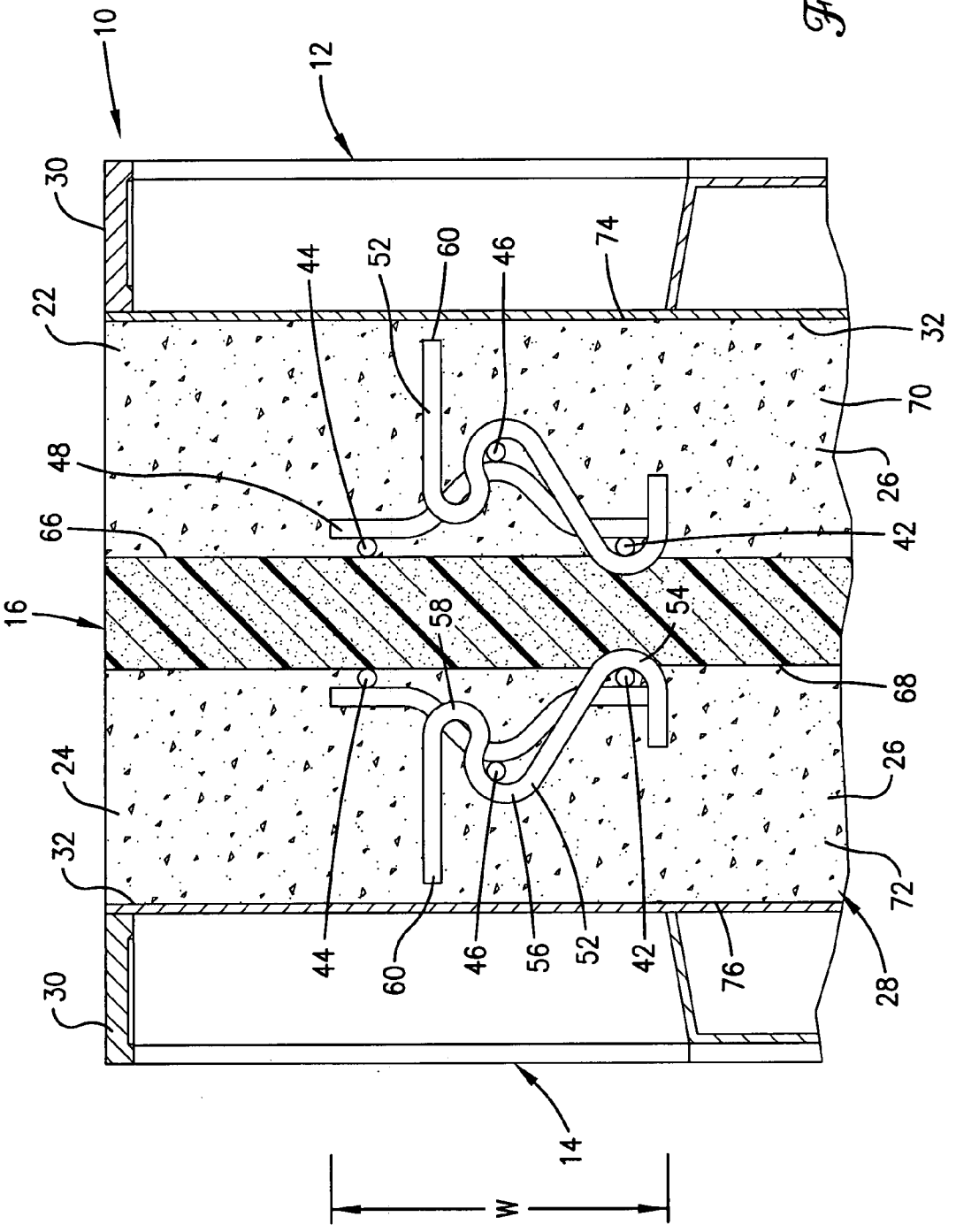
Fig. 2.

Fig. 3.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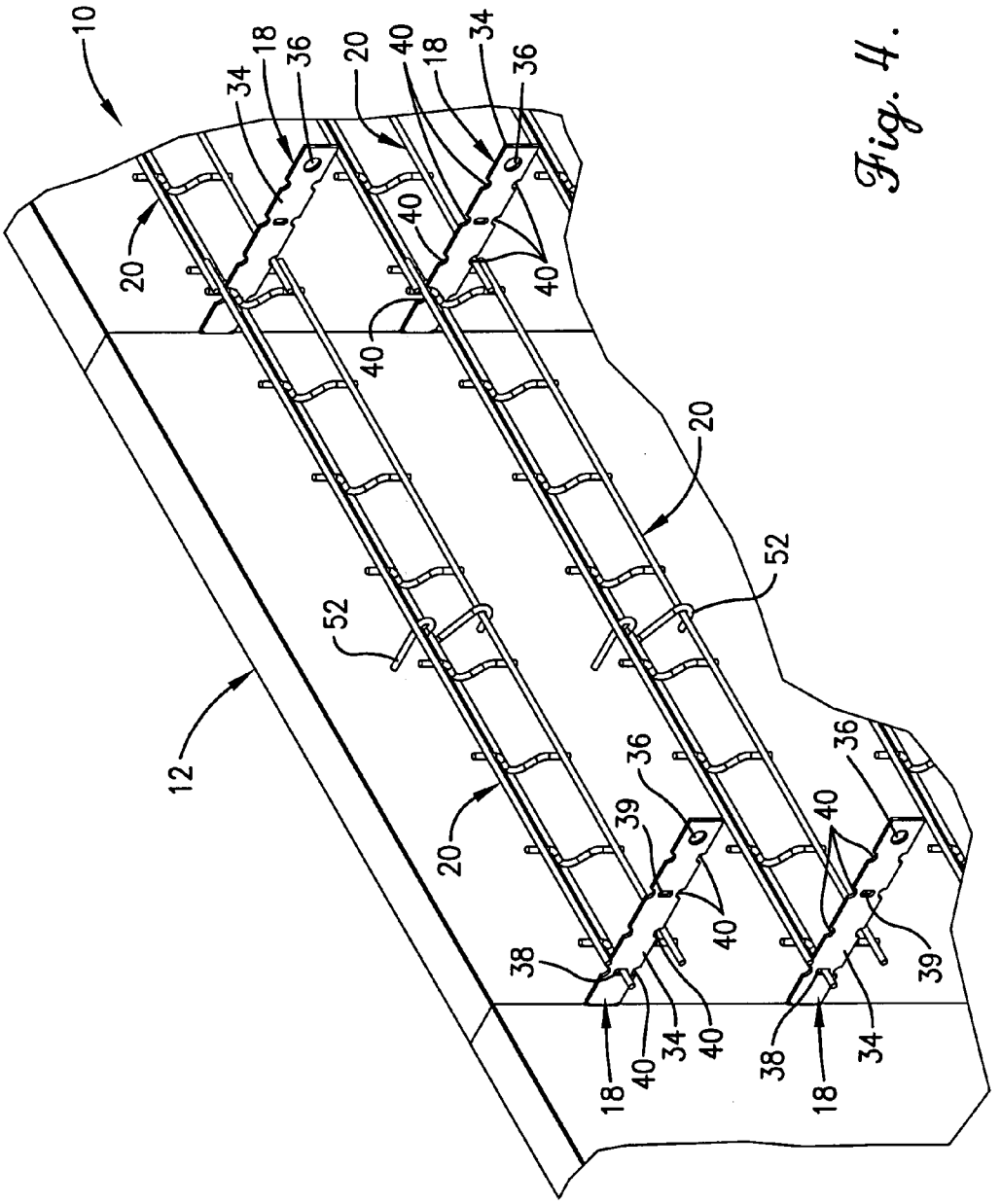

Fig. 4.

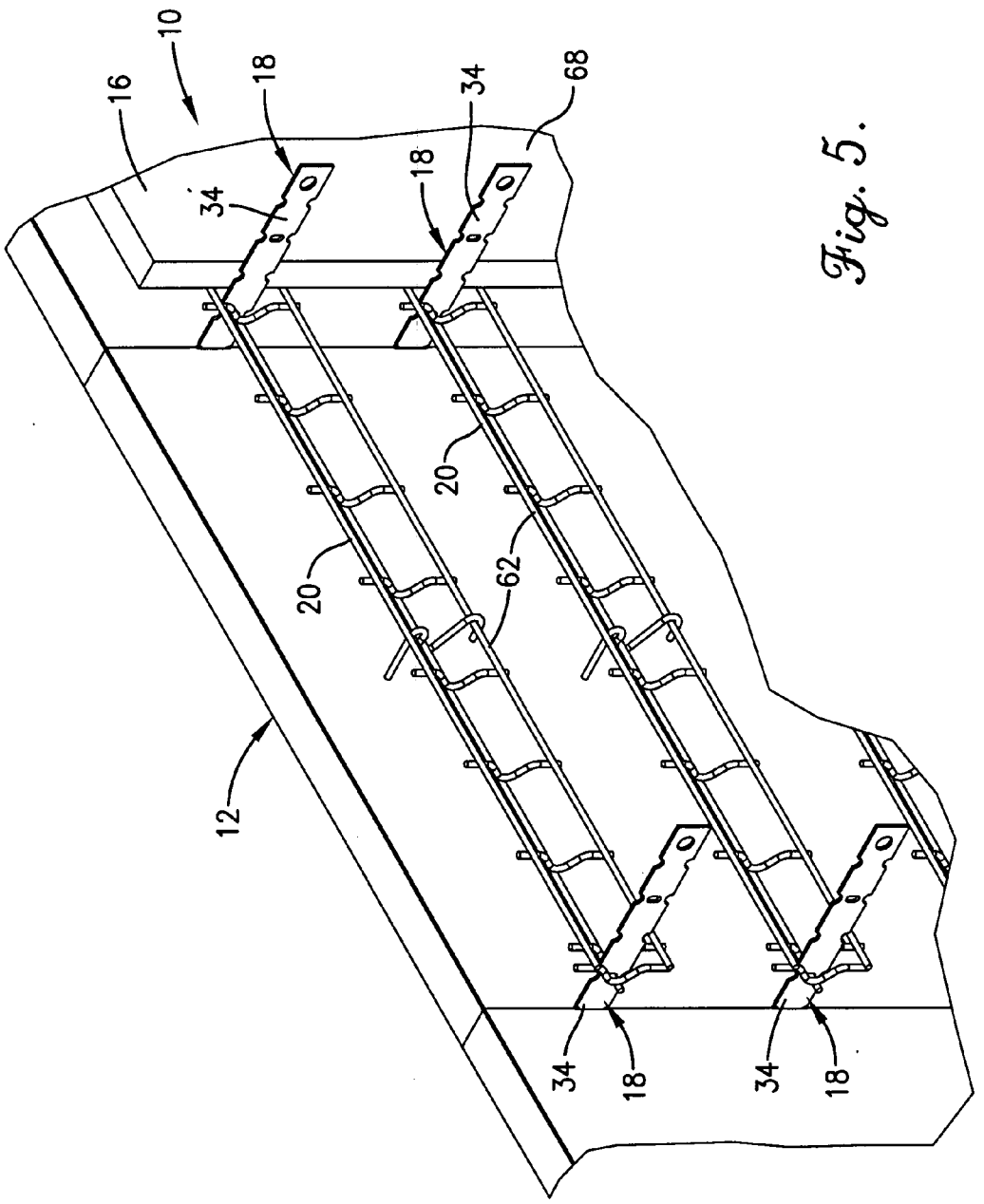

Fig. 5.

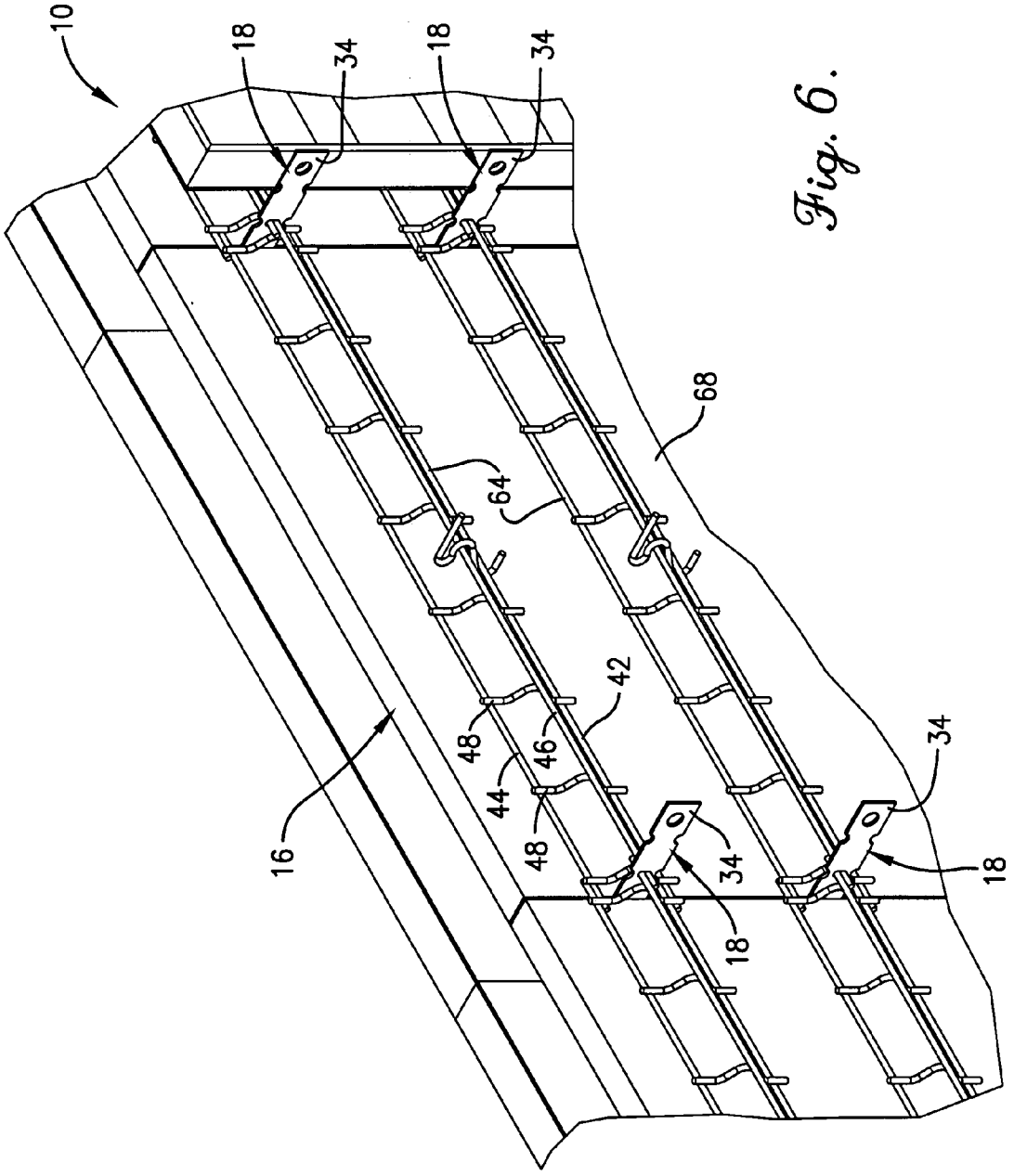

Fig. 6.

THERMAL WALL SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 60/758,650 filed Jan. 13, 2006.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention concerns a wall system for forming insulated concrete walls having at least one insulated panel received adjacent one and preferably a spaced pair of poured concrete walls, and having spacing members which both position the insulated panel for receiving the poured concrete and reinforce the resulting thermal wall. More particularly, the thermal wall system hereof preferably includes a pair of spaced and opposed forming panels connected by ties, a plurality of reinforcing members mounted to the ties, and a rigid insulating panel of relatively low thermal conductivity relative to concrete which is maintained in position to receive poured concrete walls into which the reinforcing members are embedded.

[0004] 2. Description of the Prior Art

[0005] Poured-in-place concrete walls have long been constructed by pouring concrete between opposing forming panels which make up respective removable forming wall structures. These forming wall structures are typically fabricated on the construction site of wood, or more advantageously use prefabricated metal forming panels which are assembled into the forming walls. Examples of this latter type of metal forming panel system are shown, for example, in U.S. Pat. Nos. 5,965,053 and 6,655,650, the disclosures of which are incorporated herein by reference. In these known systems, metal forming panels are connected by pins or the like and metal ties or bars are used to maintain the forming panels in a desired spaced relationship corresponding to the depth of the concrete wall to be constructed. Upon pouring and subsequent curing of the concrete, the forming panels are removed, leaving a concrete wall ready for use or further finishing.

[0006] As poured-in-place concrete walls have evolved, there has been a recognition of the need to improve the insulating properties of concrete walls in some applications. To this end, a number of different approaches to providing insulation to concrete walls have been proposed. These include those described in U.S. Pat. Nos. 5,570,550, 5,771,648, 6,202,375, 6,226,942, 6,247,280, 6,276,104, 6,279,285, 6,438,917, 6,519,904,6,622,452,6,625,947,6,647,686,6,686,303, and 6,935,081, the disclosures of which are incorporated herein by reference.

[0007] While the prior art provides approaches to the use of insulating panels in combination with concrete to provide insulated concrete walls, it is believed that an improved thermal wall system is needed which will facilitate the construction of high-quality walls by constructors in an economical and user-friendly system.

SUMMARY OF THE INVENTION

[0008] This object as well as other advantages are readily obtained and recognizable to those skilled in the art in connection with the thermal wall system of the present invention. That is to say, the thermal wall system of the present invention presents unique advantages in facilitating the construction of poured-in-place walls having an insulated panel, which is preferably sandwiched between two concrete layers. Not only is the thermal wall system hereof relatively easy to construct on site, but it provides good consistency of concrete thickness and positioning of the insulating panel within the concrete layers. Beneficially, the thermal wall system hereof provides an additional advantage of incorporating reinforcing metal such as steel into the system, whereby not only improved insulating properties but improved reinforcing capabilities are realized in an efficient and economical use of system components. The resulting thermal wall system produces a poured-in-place concrete wall which structurally connects two spaced concrete layers and protects the insulating panel from damage by positioning it between the concrete layers.

[0009] The thermal wall system of the present invention includes both a system of components used to construct an insulated concrete wall, the insulated concrete wall constructed therewith, and a method of constructing an insulated concrete wall. Broadly speaking, the system includes first and second opposed forming wall panels, one or more ties for connecting the panels in opposed relationship, an intermediate body of a thermally insulating material, such as polystyrene foam, and at least one spacing element positioned between the body of thermally insulating material and one of the panels. More preferably, at least one spacing element is positioned between the body of thermally insulating material and each of the forming panels, and a mounting element is provided for supporting the spacing elements. The mounting element preferably is provided as a form tie which extends between the forming panels whereby at least a portion of the tie remains embedded within the formed thermal wall, such that the spacing elements are structurally connected to the forming ties. One or more of the spacing elements may include a stand-off member which projects toward the proximate forming panel to provide additional resistance to deformation or displacement of the thermally insulating body and the forming panel during pouring and curing of the concrete.

[0010] The insulated concrete wall formed in accordance with the invention broadly includes a first layer of concrete which is hardened or hardenable to be self-sustaining, and a body of thermally insulating material adhered to and extending substantially across one side of the first layer of concrete, and further having at least one spacing element received and structurally embedded within the concrete layer and adjacent to the body of thermally insulating material. Preferably, the wall is provided with the body as a panel of rigid insulating material sandwiched between first and second layers of concrete, with one or a plurality of mounts such as tie bars embedded into and connecting the first and second layers. Spacing elements are positioned to be embedded within each of the first and second layers of concrete, and extend between and mounted to spaced-apart mounts, such that the mounts not only properly position the body of thermally insulating material between the forming panels, but also structurally reinforce the concrete layers and structurally connect the concrete layers. When tie bars are used as a component of the mounts, the spacing elements thus are structurally interconnected to other adjacent spacing ele-

ments in the same layer, but also provide structural reinforcement which connects both layers of concrete.

[0011] The associated method of the present invention broadly contemplates providing a plurality of forming panels which are positioned in opposing relationship as forming walls defining a concrete receiving space therebetween. Preferably, one forming wall is first assembled with a plurality of mounts extending from a concrete receiving face of the one forming wall. A first set of spacing elements is then mounted to the mounts in spaced relationship to the concrete-receiving face of the forming panel. The spacing elements may most preferably be mounted through wires thereon extending through holes provided in the mounts, such as tie bars. Once the first set of spacing elements is mounted, a body of a thermally insulating material is then positioned against the spacing elements. Most preferably, when tie bars are provided and the spacing elements are metal spacers, the reinforcing panels are positioned between laterally spaced tie bars and lie against the spacing elements. This method permits rapid and relatively simple mounting of the spacing elements, with the ability to provide relatively consistent spacing of the spacing elements. A second set of spacing elements is preferably then mounted to the mounts, such that the body of reinforcing material is effectively held between the first and second sets of spacing elements. The second forming wall is then assembled and preferably attached to the mounts, such that first and second spaced apart and opposed forming walls are provided, with concrete receiving spaces provided between the body of thermally insulating material and each of the forming walls. A portion of these concrete receiving spaces are occupied by the spacing elements, which are preferably connected on opposite sides of the body by the mounts. Concrete is then poured into the spaces, allowed to cure to a self-sustaining condition, and then the forming panels are removed. The protruding portions of the mounts may be thereafter trimmed, leaving an improved thermal wall system with the body of thermally insulating material sandwiched between and protected from impact by the concrete layers.

[0012] The result of the present invention is an improved thermal wall system which not only provides greater resistance to thermal transmission than an uninsulated concrete wall, but also provides reinforcement by the spacing elements. By virtue of the present invention, problems which might otherwise be associated with the thermal mass of the concrete in the wall are largely avoided; for example, even when direct sunlight increases the temperature of the outer layer of concrete in the constructed wall, the rigid insulating panel substantially slows the increase in temperature to the inner layer of concrete, and conversely the conduction of heat from the inner layer to the outer layer during periods of relatively cold ambient temperature. The spacing elements, when provided of steel wire or the like, thus not only aid in the placement and retention of the insulating body, but perform a reinforcing function which connects the portion of the tee bars remaining in the concrete so that they, together with the spacing elements, perform a new reinforcing function. In some applications, depending on the loads encountered and the number of spacing elements employed, the spacing elements may be substituted for conventional reinforcing bar commonly used in reinforced concrete applications, with consequent labor and material savings.

[0013] These and other benefits will be readily appreciated by those skilled in the art with reference to the drawings and description which follow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. **1** is a perspective view of a spacing element used in connection with the present invention, having an optional projection mounted thereon;

[0015] FIG. **2** is a fragmentary top plan view of a forming system in accordance with the present invention with the thermally insulating body shown in phantom lines for clarity to show tie bars serving as mounts and the relative positions of the spacing elements between opposing forming walls.

[0016] FIG. **3** is an enlarged, fragmentary vertical cross-sectional view taken along line **3-3** of FIG. **2** with the thermally insulating body included and after pouring of the concrete, showing the relative positions of the panels of the forming wall, the projection and spacing elements, the concrete layers and the insulating body during curing of the concrete layers;

[0017] FIG. **4** is a perspective view of a forming wall assembled in accordance with the method of the present invention, whereby a first forming wall of a plurality of adjacent forming panels is assembled with tie bars serving as mounts for a first set of the spacing elements prior to placement of the thermally insulating bodies;

[0018] FIG. **5** is a perspective view similar to FIG. **4**, but showing the placement of a thermally insulting body between two opposing forming panels; and

[0019] FIG. **6** is a perspective view similar to FIG. **5**, showing the placement of further thermally insulating bodies and the placement of a second set of the spacing elements prior to assembly of a second forming wall.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] Referring now to the drawings, a thermal wall system **10** for forming insulated poured-in-place concrete walls in accordance with the present invention is shown in FIGS. **2** and **3**. The thermal wall system **10** hereof broadly includes a first forming wall **12**, a second forming wall **14**, at least one thermally insulating body **16**, one or more mounts **18** coupled to at least one of the forming walls, and at least one spacing element **20**. Concrete receiving spaces **22** and **24** are defined by the placement of the body **16** and located between the body **16** and each of the forming walls **12** and **14**. Concrete **26** is then poured into the concrete receiving spaces and substantially encompasses the body **16** to provide, once cured, a self-sustaining insulated poured-in-place concrete wall **28**.

[0021] In greater detail, the forming walls **12** and **14** are provided of standard forming panels **30**, such as, for example, the aluminum forming panels sold under the trademark FLAGSHIP by Western Forms, Inc., of Kansas City, Mo. However, it is to be understood that other forms of a variety of configurations, including wooden forming panels, may be used in accordance with the present invention. The forming panels **30** include a concrete receiving face **32** thereon, and are typically provided with notches along the sides of the forms for receiving and mounting tie

bars **34** by the use of pins, wedges, and or the Pinlock™ fastener of Western Forms, Inc. as is well known in the art. Here, however, the tie bars **34** not only serve the function of interconnecting the opposing forming walls **12** and **14** in a desired spaced relationship for receiving concrete therein, but they further serve as the mounts **18** and structurally connect the spacing elements **20**. The tie bars **34** as used herein are of a standard longitudinally extending and symmetrical configuration as generally shown in FIG. **4** and known to those skilled in the art. The tie bars **34** are made of mild steel and are generally elongated and longitudinally symmetrical, having holes **36** adjacent each end for receiving pins therethrough, openings **38** and **39** in the bar longitudinally intermediate the holes **36**, and recesses **40** longitudinally spaced along the thin upper and lower sides thereof as oriented in FIG. **4**.

[**0022**] The spacing elements **20** are preferably also of mild steel wire but may be of other materials, such as plastic or stainless steel, depending on the needs of the job. The spacing elements **20** preferably include a plurality of elongated wire runners **42**, **44**, and **46** spot welded or otherwise secured to transversely extending wire bows **48**. In this regard, a bow **48** as used herein is meant as an element which may be arcuate or angular or a combination thereof, but serves simply to displace the runners **42**, **44** and **46** when they are aligned out of a co-planar relationship. The wire runners are preferably arrayed in a triangular relationship when viewed along their longitudinal extent, as in FIG. **3**, such that the spacing elements have a longitudinal dimension L, a width W, and a depth D. The longitudinal dimension L is preferably greater than either the width W or depth D, and further the width W is preferably greater than the depth D. Such spacing elements **16** advantageously have the ends **50** of the runners **42**, **44** and **46** extending beyond the longitudinal extent of the bows **48**, so that the ends **50** can be readily placed in the openings **38** of the tie bars **34**, as shown in FIGS. **4**, **5** and **6**. One suitable spacing element **20** is provided by Meadow Burke of Fort Worth, Tex. under the name Slab Bolster having depths varying between ¾ inch and 3 inches. The runners are preferably arrayed in substantially parallel and non-coplanar orientation as shown in FIGS. **1-3**. Optionally, such spacing elements **20** may be modified by further including a projection **52** as shown in FIGS. **1** and **2**. Such a projection **52** aids in ensuring that the spacing element **20** is not deformed due to loads applied thereon during pouring of the concrete, and includes three bends **54**, **56** and **58** in opposite directions to facilitate connection to the runners **42** and **44**, and a stem **60** which extends toward a respective adjacent one of the forming panels **30** such that even when the body is displaced laterally, only the tip of the stem **60** may be positioned thereagainst. In many uses, however, the addition of the projection **52** will not be necessary, which has an added benefit of providing a smoother finished concrete surface, lower cost, and less thermal conductivity.

[**0023**] The body **16** is provided as a member having a substantially reduced thermal conductivity relative to concrete while being resistant to substantial compression during pouring and curing of the concrete, and is preferably provided of a sheet of foamed synthetic resin material, such as polystyrene foam. One such polystyrene foam sheet commonly used in the construction industry which is sufficiently rigid and durable is known as "blue board", but other rigid foam sheets may also be used. It is preferable that the body **16** occupy as much area vertically and horizontally between the mounts **18** as possible to provide optimal insulating properties.

[**0024**] In constructing the thermal wall system **10** hereof, a plurality of forming panels **30** are positioned edge to edge horizontally, with tie bars **34** positioned vertically along the seam between side edges of the forming panels **30** and held by pins or the like to comprise the first forming wall **12**. The spacing elements **20** may be arrayed substantially horizontally as shown in FIGS. **4**, **5** and **6**, or alternatively diagonally if desired to provide reinforcement extending vertically as well as horizontally. The spacing elements **16** are positioned so that ends **50** of at least one of the runners thereof are received into the openings **38** of the tie bars. Additional wire may be used to "tie" the ends **50** to the tie bars **34**, but this is ordinarily not necessary. When wood forms are used at one end of a forming panel, such as for a particular shape or opening, a hole may be drilled into the wood form at desired locations for receiving one of the ends **50**. It is to be noted that the bows **48** of the spacing elements **20** are desirably spaced from the faces **32** of the forming panels **30**. The spacing elements **20** so placed comprise a first set **62** of the spacing elements **20** which lie within a first concrete receiving space **22**. As noted, the spacing elements **20** are preferably of metal wire, but may also be formed of synthetic resin or other flexible material providing additional tensile strength, particularly constructions such as those of fiberglass, aramid or Kevlar fibers.

[**0025**] The body **16** is then set against the first set **62** of spacing elements **20**, and may be temporarily held by a worker or a brace until one or more additional spacing elements **20** comprising a second set **64** of spacing elements **20** is positioned in the other of the openings **39** of the tie bars **34** as shown in FIGS. **5** and **6**. The second set **64** of spacing elements **20** thus serves to hold the body **16** in an upright orientation, and substantially centrally located intermediate the forming walls **12** and the other forming wall **14** to be erected thereafter. Importantly, the spacing elements **20** are designed to lie adjacent to the body **16** without penetrating through from one side of the body and through the other side. For example, when a rigid sheet of foamed polymer such as polystyrene is provided as the body **16**, it will typically be substantially planar and most preferably substantially rectangular in shape and present two major surfaces, a first surface **66** for receiving thereagainst the first set **62**, and a second surface **68** for receiving thereagainst the second set **64**. The thermal integrity of the system is enhanced by the fact that the spacing elements of the first set **62** do not penetrate through the body **16** from the first surface **66** and out of the second surface **68**, but rather merely rest against the first surface **66**, while the second set **64** has a similar relationship of lying against the second surface **68** without penetrating through the body **16** and out of the first surface **66**, such that the body **16** is substantially imperforate. The body **16**, preferably being of a foamed synthetic resin such as polystyrene foam or other material have a lesser thermal conductivity and thus a greater insulating property than concrete, thus helps to insulate the resulting wall **28**. Once the second set **64** is mounted to the tie bars **34**, the second forming wall **14** may be erected in the same manner as described above with regard to the first forming wall **12**. Again, the bows **48** of the second set **56** remain spaced from the face **32** of the forming panels **30** comprising the second forming wall to define a concrete

receiving space **24**. Flowable concrete **26** is then poured around the body **16** and into the spaces **22** and **24** with a first layer **70** received and formed by the first space **22** and a second layer **72** received and formed by the second space, thereby surrounding the body **16** and embedding the spacing elements **20** and portions of the tie bars **34** serving as mounts therein. The concrete **26** adheres to the body **16**, and preferably envelopes it. The concrete **26** is permitted to cure to a desired hardness, whereupon the forming walls **12** and **14** may be removed. Removal of the forming walls **12** and **14** reveals respective exposed concrete faces **74** and **76** corresponding to the first and second layers **70** and **72**, and preferably the spacing elements will be not only embedded in the first and second layers **70** and **72** but also concrete will be located between and space the spacing elements from the respective concrete faces. As noted above, the projection **52** may be omitted in many if not most instances, but when used, the tip of the stem **60** is most preferably recessed interiorly of the concrete faces **74** and **76** and thus the tip of the stem **60** is not exposed. The protruding portions of the tie bars **34** (typically the portion of the tie bars which are positioned between adjacent forming panels **30**) is then trimmed.

[**0026**] In the resulting insulated poured in place concrete wall **28**, the portion of the tie bars **34** which remain structurally connect the spacing elements **20** of the first and second sets **62** and **64** on opposite sides of the body **16** and position the spacing elements adjacent to other ones of the spacing elements **20** in the set. This connection helps in the reinforcing function now performed by the spacing elements **20**. As a result, additional reinforcing members such as steel reinforcing bars or wire often can be eliminated because the spacing elements **20** perform this function. Moreover, the tie bars **34** serve to provide a structural connection between spacing elements **20** of the first set **62** and the second set **64**. The body **16** is also benefitted by the consistency of spacing away from the surface of the concrete in both the first layer **70** and the second layer **72** of the finished wall **28**. From a standpoint of quality and ease of construction, the system **10** hereof also provides substantial improvement and economies. It is not necessary, in most instances, to construct elaborate and wasteful structures for holding the insulating body in place. Rather, the worker can use readily available components without substantial additional labor or modification, and obtain multifunctional use of the spacers to aid during construction and provide reinforcement of the completed wall **28**.

[**0027**] Although preferred forms of the invention have been described above, it is to be recognized that such disclosure is by way of illustration only, and should not be utilized in a limiting sense in interpreting the scope of the present invention. Obvious modifications to the exemplary embodiments, as hereinabove set forth, could be readily made by those skilled in the art without departing from the spirit of the present invention.

[**0028**] The inventor hereby states his intent to rely on the Doctrine of Equivalents to determine and assess the reasonably fair scope of his invention as pertains to any apparatus not materially departing from but outside the literal scope of the invention as set out in the following claims.

1. A thermal wall system for constructing insulated poured-in-place concrete walls, the system comprising:

first and second opposed, spaced-apart forming walls for receiving poured concrete therebetween;

a body of a thermally insulating material received between said first and second forming walls;

a mount operatively coupled to said first forming wall and extending from said first forming wall toward said second forming wall; and

a first spacing element operatively coupled to said mount and positioned between said first and second forming walls and adjacent said body of a thermally insulating material to define a first concrete-receiving space between said first forming wall and said body of a thermally insulating material.

2. A thermal wall system as set forth in claim 1, wherein said mount connects said first and second forming walls in a predetermined, spaced relationship.

3. A thermal wall system as set forth in claim 2, including a second spacing element operatively coupled to said mount and positioned between said said second forming wall and adjacent said body of a thermally insulating material to define a second concrete-receiving space between said second forming wall and said body of a thermally insulating material.

4. A thermal wall system as set forth in claim 3, wherein said first and second spacing elements comprise a plurality of longitudinally extending runners interconnected by at least one bow oriented transversely to said runners.

5. A thermal wall system as set forth in claim 3, wherein said first and second spacing elements extend along respective first and second surfaces of the body of a thermally insulating material without penetrating through the body.

6. A thermal wall system as set forth in claim 5, including a plurality of said first spacing elements comprising a first set arranged in substantially parallel, spaced relationship along said first surface, and a plurality of said second spacing elements comprising a second set arranged in substantially parallel, spaced relationship along said second surface.

7. A thermal wall system as set forth in claim 6, wherein said body of a thermally insulating material is a substantially planar sheet of foamed synthetic resin material.

8. A thermal wall system as set forth in claim 7, including a plurality of said planar sheets arranged in end-to-end relationship.

9. A thermal wall system as set forth in claim 8, and including a plurality of mounts, wherein said mounts are positioned intermediate adjacent ones of said plurality of planar sheets.

10. A thermal wall system as set forth in claim 5, wherein said mounts connect respective ones of the spacing elements of the first set with respective ones of the spacing elements of the second set.

11. A thermal wall system as set forth in claim 1, wherein said spacing element includes a plurality of interconnected, elongated runners which are positioned such that all of the runners are not coplanar.

12. A thermal wall system as set forth in claim 11, wherein said runners are oriented to be substantially parallel and said spacing element further comprises a projection coupled to said runners and extending transversely therefrom.

13. An insulated concrete wall comprising:

first and second layers of concrete;

a body of a greater thermally insulating value than concrete positioned intermediate said first and second layers of concrete, said body having respective first and second surfaces wherein said first surface is positioned in engagement with said first layer of concrete and said second surface is positioned in engagement with said second layer of concrete;

a mount extending between and structurally connecting said first and second layers of concrete; and

first and second spacing elements respectively embedded within said first and second layers of concrete and connected to said mount.

14. An insulated concrete wall as set forth in claim 13, wherein said body of a thermally insulating material is substantially imperforate.

15. An insulated concrete wall as set forth in claim 14, wherein said body is substantially planar.

16. An insulated concrete wall as set forth in claim 13, wherein said spacing elements include at least three interconnected runners which are arranged so that all three runners are not in substantially coplanar alignment.

17. An insulated concrete wall as set forth in claim 11, wherein said runners are oriented substantially parallel.

18. A method of constructing an insulated concrete wall, comprising the steps of:

providing first and second opposed forming walls adapted to receive flowable concrete therebetween;

connecting said forming walls in a predetermined, spaced relationship to define a concrete receiving space therebetween;

positioning a body of a material having a greater thermal resistance than concrete in the concrete receiving space;

mounting a first spacing element in the concrete receiving space in engagement with the body to space the body from the first forming wall;

mounting a second spacing element in the concrete receiving space in engagement with the body to space the body from the second forming wall, said first and second spacing elements being mounted without perforating the body;

pouring flowable concrete in the concrete receiving space and between the body and both the first and second forming walls, thereby embedding the spacing elements in the concrete; and

allowing the concrete to harden and removing the forming walls.

19. The method of claim 18, further including the step of structurally connecting the first and second spacing elements.

20. The method of claim 18, including the steps of providing a plurality of said first spacing elements and orienting said first spacing elements in spaced, substantially parallel relationship relative to each other.

21. The method of claim 18, including the step of orienting said first and second spacing element to extend substantially parallel to one another in substantially horizontal orientation.

22. The method of claim 18, wherein said first spacing element includes a plurality of runners extending longitudinally and having at least one end, and including a mounting element extending between the forming walls having an opening therein, and wherein said mounting step includes the step of inserting an end of one of said runners into the opening of said mounting element.

* * * * *