



(86) Date de dépôt PCT/PCT Filing Date: 2012/07/11
(87) Date publication PCT/PCT Publication Date: 2013/01/24
(45) Date de délivrance/Issue Date: 2020/06/02
(85) Entrée phase nationale/National Entry: 2014/01/10
(86) N° demande PCT/PCT Application No.: US 2012/046146
(87) N° publication PCT/PCT Publication No.: 2013/012624
(30) Priorités/Priorities: 2011/07/18 (US61/508,865);
2012/02/28 (US13/406,561)

(51) CI.Int./Int.Cl. F16L 59/135 (2006.01),
F16L 3/00 (2006.01), F16L 59/14 (2006.01)

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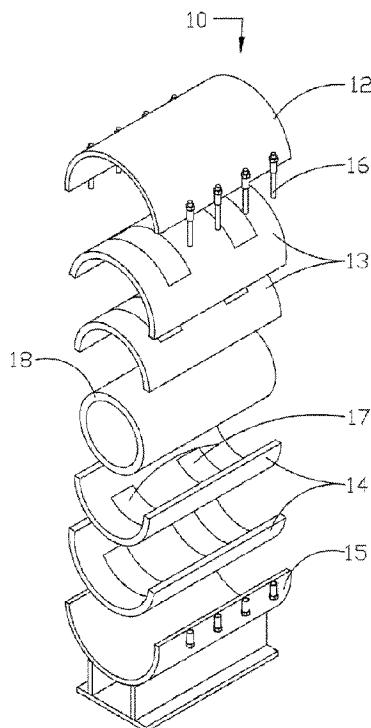
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(54) Titre : PROCEDE ET SYSTEME POUR ISOLATION DE TUYAU RENFORCEE

(54) Title: METHOD AND SYSTEM FOR REINFORCED PIPE INSULATION



(57) Abrégé/Abstract:

A reinforced insulation material having one or more sheets of insulation material having a plurality of voids in each sheet, wherein the sheets are operably connected to each other in a layered configuration, the voids mate to each other to create cylindrical or rectilinear pathways for insertion of adhesive or synthetic material to adhere the sheets into a layered or sandwiched configuration, The voids may be a variety of shapes including circles, squares, rectangles or other suitable shapes that upon formation of the layered sheets Sine up to permit insertion of material or dowels to create a reinforced assembly. The layers may be formed into a variety of shapes including a semicircular shape to go around a pipe, or a block of material. The finished assembly withstands compressive forces and provides insulation when in place around pipes or under tanks.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization

International Bureau



(10) International Publication Number

WO 2013/012624 A1

(43) International Publication Date

24 January 2013 (24.01.2013)

(51) International Patent Classification:

F16L 59/00 (2006.01)

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(21) International Application Number:

PCT/US2012/046146

(22) International Filing Date:

11 July 2012 (11.07.2012)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/508,865 18 July 2011 (18.07.2011) US
13/406,561 28 February 2012 (28.02.2012) US

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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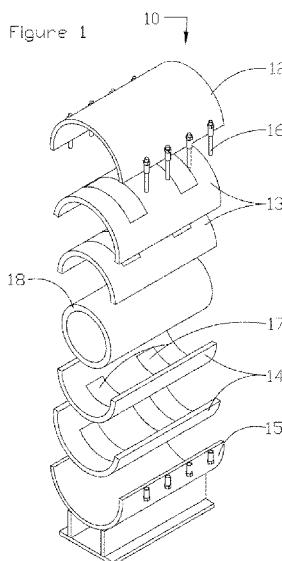
Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

— with international search report (Art. 21(3))

(54) Title: METHOD AND SYSTEM FOR REINFORCED PIPE INSULATION



(57) **Abstract:** A reinforced insulation material having one or more sheets of insulation material having a plurality of voids in each sheet, wherein the sheets are operably connected to each other in a layered configuration, the voids mate to each other to create cylindrical or rectilinear pathways for insertion of adhesive or synthetic material to adhere the sheets into a layered or sandwiched configuration. The voids may be a variety of shapes including circles, squares, rectangles or other suitable shapes that upon formation of the layered sheets Sine up to permit insertion of material or dowels to create a reinforced assembly. The layers may be formed into a variety of shapes including a semicircular shape to go around a pipe, or a block of material. The finished assembly withstands compressive forces and provides insulation when in place around pipes or under tanks.

METHOD AND SYSTEM FOR REINFORCED PIPE INSULATION

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Background of the Invention:

[0002] This Invention relates to insulated pipes and tank bases. In particular this invention relates to a method and system for insulating pipes with flexible reinforced material as well as the insulation of tank bases.

Brief Summary of the Invention:

[0003] Currently, pipe and other conduit used in various industrial applications including refineries are insulated by wrapping insulation in a continuous overlapping pattern. When the insulation approaches the location near where the pipe is supported, it must be stopped and restarted before and after the pipe support to maintain the load bearing characteristics of the pipe support. In this region where the pipe is supported, the wrapped insulation is positioned about the pipe in increased diameters of insulation to provide adequate insulation and maintain the proper load bearing characteristics. This is wasteful and creates areas of compromised insulation prone to thermal leakage and breaking of the insulation due to movement of the pipes caused by stresses placed on the pipe due to fluids or gases moving through the pipe. There thus exists a need to configure flexible insulation material in a manner to withstand compressive forces while maintaining a low profile about a pipe or other longitudinal member. In addition current

methods of insulating tank bases require the use of very thick insulation that increases the overall height of a given tank. The use of the new insulation material reduces the tank height thus saving significantly on the materials required to build the tank.

[0004] In accordance with a preferred embodiment of the invention, there is shown a reinforced insulation material having one or more sheets of insulation material having a plurality of voids in each sheet, wherein the sheets are operably connected to each other in a layered configuration, the voids on each sheet are oriented in a mating pattern that generally forms cylindrical regions on the layered configuration, and a synthetic material inserted into the voids of each sheet to connect the sheets to each other.

[0005] In accordance with a preferred embodiment of the invention, there is shown a reinforced insulation material having a plurality of sandwiched sheets of insulation material, each sheet having a plurality of voids, the voids on each sheet oriented in a mating pattern to the voids on the other sheets to form cylindrical voids when connected together and a synthetic material inserted into the voids of each sheet to connect the sheets.

[0006] In accordance with a preferred embodiment of the invention, there is shown a reinforced insulation material having one or more sheets of insulation material having a void in each sheet, wherein the sheets are operably connected to each other, the void on each sheet oriented in a mating pattern to the void on said other sheets to form a three dimensional void when connected together, and a synthetic material inserted into the voids of each sheet to connect the sheets.

Brief Description of the Drawings:

[0007] The drawings constitute a part of this specification and include exemplary embodiments to the invention, which may be embodied in various forms. It is to be understood that in some instances various aspects of the invention may be shown exaggerated or enlarged to facilitate an understanding of the invention.

5 **[0008]** Figure 1 shows an exploded view of a pipe insulation assembly according to a preferred embodiment of the invention.

[0009] Figure 2 shows an exploded view of a pipe insulation assembly according to another preferred embodiment of the invention.

10 **[0010]** Figure 3 shows a cross sectional view of a pipe insulation assembly and pipe according to a preferred embodiment of the invention.

[0011] Figure 4 shows a side view of a pipe insulation assembly and pipe according to a preferred embodiment of the invention.

[0012] Figure 5 shows a cross section along lines B-B of Figure 3.

15 **[0013]** Figure 6 shows a cross sectional view of a pipe insulation assembly and pipe according to a preferred embodiment of the invention.

[0014] Figure 7 shows a side view of a pipe insulation assembly and pipe according to a preferred embodiment of the invention.

[0015] Figure 8 shows a cross section along lines A-A of Figure 6.

20 **[0016]** Figure 9 shows a plan view of a section of insulation and hole pattern according to a preferred embodiment of the invention.

[0017] Figure 10 shows a side cross sectional view of a series of sandwiched insulation sheets along the lines A-A of Figure 9 according to a preferred embodiment of the invention.

[0018] Figure 11 shows a plan view of a section of insulation and hole pattern according to a preferred embodiment of the invention.

[0019] Figure 12 shows a side cross sectional view of a series of sandwiched insulation sheets along the lines C-C of Figure 11 according to a preferred embodiment 5 of the invention.

[0020] Figure 13 shows a perspective view of three sandwiched insulation sheets having a hole pattern according to a preferred embodiment of the invention.

[0021] Figure 14 shows a perspective view of three sandwiched insulation sheets having a reinforced patten according to a preferred embodiment of the invention.

[0022] Figure 15 shows three sandwiched insulation sheets according the prior art.

[0023] Figure 16A shows a side cross sectional view of a mold that may be used in producing reinforced insulation according to a preferred embodiment of the invention. Figure 16B shows an exploded view of Figure 16 A.

Detailed Description of the Preferred Embodiments:

[0024] Turning now to Figure 1, there is shown an exploded view of a pipe support and insulation assembly according to a preferred embodiment of the invention.

[0025] Bottom cradle 15 is a conventional pipe cradle having a semicircular configuration for the reception of a cylindrical pipe 18. Cylindrical pipe 18 must be insulated while at the same time the insulation must be able to withstand the loads and stresses that are applied to the pipe at the support location.

[0026] Insulation upper sheets 13 and insulation lower sheets 14 are configured in semicircular pieces to fit around cylindrical pipe 18. The insulation upper sheets 13 and insulation lower sheets 14 are shown as two separate sheets but may be of any of a number of sheets depending on the application. Insulation upper sheets 13 and insulation lower sheets 14 are configured with a pattern of rectilinear voids or block stiffeners 17 as to permit stiffener material to be inserted into insulation upper sheets 13 or insulation lower sheets 14 to be stacked while still maintaining a longitudinal rectangle of space through the series of sheets. As more fully described below, the rectangular spaces may be filled with stiffener which may be comprised of a variety of materials as described below. Once insulation upper sheets 13 are stacked and suitable stiffening material is added, the insulation upper sheets 13 form a rigid semicircular member that goes around the outer diameter of half of cylindrical pipe 18.

[0027] An insulation composite consisting of a flexible sheet type insulation with structural insulation inserts of the present invention solves these problems. The flexible sheet type insulation, while vastly superior to other insulations with regards to thermal performance, has very low design compressive strength values. This renders the

flexible sheet type insulation poorly suited for situations which require the insulator to resist compressive forces. In order to increase the flexible sheet type insulation's compressive strength values, structural inserts must be placed in the insulation.

[0028] Turning now to Figure 2, there is shown an exploded view of a pipe support and insulation assembly according to another preferred embodiment of the invention. Insulation upper sheets 23 and insulation lower sheets 24 are configured in semicircular pieces to fit around cylindrical pipe 28. The insulation upper sheets 23 and insulation lower sheets 24 are shown as two separate sheets but may be of any of a number of sheets depending on the application. Insulation upper sheets 23 and insulation lower sheets 24 are configured with a pattern of holes as more fully shown in Figures 5 and 9 to permit the mating sheets on insulation upper sheets 23 or insulation lower sheets 24 to be stacked while still maintaining a longitudinal cylinder of space through the series of sheets. As more fully described below, the cylindrical spaces may be filled with stiffener which may be comprised of a variety of materials as described below. Once insulation upper sheets 23 are stacked and suitable stiffening material is added, the insulation upper sheets 23 form a rigid semicircular member that goes around the outer diameter of half of cylindrical pipe 28.

[0029] Turning to Figure 1, the two semicircles of insulating material are fixedly attached about cylindrical pipe 18 by top cradle 12 and bottom cradle 15 via bolts 16. Any number of mechanisms may be used to connect top cradle 12 and bottom cradle 15 such as clamps, ties or other means. Further, top cradle 12 and bottom cradle 15 may be of a clamshell configuration with a hinged side and have bolts or other fixation mechanism to connect the opposing side. Once configured, the insulation upper sheets

13 and insulation lower sheets 14 form an impermeable thermal layer about cylindrical pipe 18 at the point of contact with top cradle 12 and bottom cradle 15. By using layers of insulation, such as aerogel based insulation layers, thin layers of highly thermal insulation may be configured into a stiff internal shell about cylindrical pipe 18 for 5 affixation in top cradle 12 and bottom cradle 15. One commercially available such insulation is sold under the trademark, Cryogel®. This stiffening of the insulation as more fully described below, creates an insulating layer that is both thermally sound and capable of handling the loads applied to the pipe during operation.

[0030] Similarly, lower insulation sheets 14 are configured for reception of stiffener 10 and once constructed may be placed about the lower half of cylindrical pipe 18.

[0031] As shown in Figure 2, the two semicircles of insulating material are fixedly attached about cylindrical pipe 28 by top cradle 22 and bottom cradle 25 via bolts 26. Any number of mechanisms may be used to connect top cradles 22 and bottom cradle 25 such as clamps, ties or other means. Further, top cradle 22 and bottom cradle 25 15 may be of a clamshell configuration with a hinged side and have bolts or other fixation mechanism to connect the opposing side. Once configured, the insulation upper sheets 23 and insulation lower sheets 24 form an impermeable thermal layer about cylindrical pipe 28 at the point of contact with top cradle 22 and bottom cradle 25. By using layers of insulation, such as aerogel based insulation layers, thin layers of highly thermal insulation may be configured into a stiff internal shell about cylindrical pipe 28 for 20 affixation in top cradle 22 and bottom cradle 25. This stiffening of the insulation as more fully described below, creates an insulating layer that is both thermally sound and capable of handling the loads applied to the pipe during operation.

[0032] The inserts can be mated with the flexible insulation using several different methods as noted above. The most cost effective methods appear to be either injecting polyurethane foam into cavities cut into the flexible sheet type insulation, which expands and hardens during the curing process, naturally bonding to the flexible insulation or 5 creating structural shapes and then gluing the inserts into the cavities.

[0033] Top cradle 22 and bottom cradle 25 are bolted together with bolts 26 to form a rigid insulating covering to cylindrical pipe 28.

[0034] The flexible sheet type insulation with structural inserts can be manufactured into different shapes. The two most common shapes being the constant radius arc 10 (pipe covering) and a flat block. The inserts' density and spacing between one another is load dependent. The higher the load, the spacing between the inserts should be decreased or the density should be increased or a combination of both. The ideal composite configuration has the lowest density inserts with the greatest amount of space between one another in order to minimize the negative impact on the overall 15 thermal performance.

[0035] Figure 3 shows a side view of a pipe and insulation assembly with block stiffeners 17 positioned in the insulation.

[0036] Figure 4 shows a side elevational view of insulation upper sheets 13 and insulation lower sheets 14 positioned about the pipe and set in bottom cradle 15 that is 20 secured with bolts 16.

[0037] Figure 5 shows a cross sectional view of a completed series of sheets with block stiffeners 17 positioned in the rectilinear voids previously described. As is readily apparent, the individual sheets have different sizes of voids to accommodate the

increased diameter as each sheet is placed one on top of the other. This results in a greater amount of stiffener material in the outer sheet than the inner sheet.

[0038] Turning to Figure 6, a second embodiment is shown in cross sectional view of a completed series of sheets with block stiffeners 27 positioned in the cylindrical voids previously described. As is readily apparent, the individual sheets have cylindrical voids in different positions so that when positioned together they create a single cylindrical tube in which stiffener material may be added. Thus, each sheet of insulation material preferably has a pattern of holes drilled or cut in the material. Each sheet of material has a similar pattern of holes configured in such a way as to create cylindrical tubes when two or more sheets are stacked together. As is readily apparent, to configure a series of sheets that conform to a cylindrical pipe, the hole pattern on each sheet has to be successively done in a wider spaced pattern for the outer sheets as compared to the inner sheets. This allows for the increased diameter of the sheet material that progresses from the inner sheet to the outer sheet in a stack.

[0039] Figure 7 shows a side elevational view of insulation upper sheets 23 and insulation lower sheers 24 wrapped around a pipe, secured by top cradle 22 and bottom cradle 25 via bolts 26.

[0040] Figure 8 shows a longitudinal cross sectional view along A-A of Figure 6 having a series of sheets and block stiffeners 27 affixed about the pipe.

[0041] Thus, the hole pattern may be varied in a group of sheets to be honeycombed, rectilinear or offset as shown in Figure 9, but each successive sheet will be slightly different in spacing to accommodate the changed radius of curvature for that sheet's location in the stack.

[0042] Figure 10 shows a side cross sectional view along A-A of Figure 9 of a flat block embodiment where the insulation material is configured in a rectilinear block for placement under a structure needing insulation below it. The stiffener material is inserted into the cylindrical tube created by the series of holes in each successive layer 5 to create a strong semi-rigid block that can withstand downward compressive forces as shown. In alternative embodiments where a flat or substantially flat reinforced insulation is needed, the hole pattern may be substantially the same from sheet to sheet so as to line up in cylindrical voids when placed in a stack of two or more sheets of insulation.

[0043] The hole pattern may be varied depending on the surface load of the pipe 10 line or the tank being supported. When more strength is needed, the hole pattern may be more dense than in other situations requiring lesser strength. Figure 9 shows a hole pattern that is honeycombed in configuration, but any of a variety of sizes or patterns may be employed and still accomplish the preferred result.

[0044] Figure 11 shows a plan view of a sheet having a rectilinear or block void 87 15 in insulation material 84. A series of similar sheets may be stacked for either a circumferential configuration around a pipe or stacked in a single block for use under a tank.

[0045] As shown in Figure 12, which is a side cross sectional view along C-C of Figure 11, the fully assembled group of sheets has a solid block of stiffener material 20 disposed within the block to create a single piece resistant to downward compressive forces as shown. The stiffener material is inserted into the cylindrical tube created by the series of holes in each successive layer to create a strong semi-rigid block that can withstand downward compressive forces as shown. In alternative embodiments where

a flat or substantially flat reinforced insulation is needed, the hole pattern may be substantially the same from sheet to sheet so as to line up in cylindrical voids when placed in a stack of two or more sheets of insulation. As is readily apparent, to configure a series of sheets that conform to a cylindrical pipe, the hole pattern on each sheet has

5 to be successively done in a wider spaced pattern for the outer sheets as compared to the inner sheets. This allows for the increased diameter of the sheet material that progresses from the inner sheet to the outer sheet in a stack. Thus, the hole pattern may be varied in a group of sheets to be honeycombed, rectilinear or offset as shown in Figure 9, but each successive sheet will be slightly different in spacing to accommodate

10 the changed radius of curvature for that sheet's location in the stack. In alternative embodiments where a flat or substantially flat reinforced insulation is needed, the hole pattern may be substantially the same from sheet to sheet so as to line up in cylindrical voids when placed in a stack of two or more sheets of insulation.

[0046] Figure 13 shows a perspective view of a series of sheets that have been drilled with cylindrical holes for placement of reinforcing material. Once the material is applied, the insulation sheets form a stiff box with dowel like supports throughout the composite material.

[0047] Figure 14 shows a similar effect with the block voids that run through the series of sheets.

[0048] Figure 15 shows prior art with simply a group of sheets piled onto each other. The prior art has the disadvantage of the sheets lacking any reinforcing quality and typically large numbers of sheets are required to achieve a similar insulating quality as those of the present invention.

[0049] Turning now to Figures 16A and 16B, there is shown a cross sectional view of a mold used to form one half of the cylindrical group of sheets that might be positioned about a pipe. Base 6 has a semicircular receptacle that is shaped to fit the outer diameter of the completed group of sheets. Successive sheets are positioned on top of each other on the mold in such a fashion as to line up the holes to form cylindrical tubes. This requires as previously noted for each successive sheet to have a slightly different hole pattern to fit the smaller radius presented at each level of the insulation assembly. Once the sheets are in place on the mold, a mating injector block 3 is placed over the inside layer of insulation with ports lined up for each cylindrical tube.

10 Reinforcing material 2 is placed inside the injector block 3 and pressurized through input port 1 so that reinforcing material 2 is pushed into the various holes in the insulation. The insulation sheets are blocked off by end stops 4 so that reinforcing material is maintained within the sandwiched sheets.

[0050] As can be readily appreciated, reinforcing material may flow between the 15 sheets in some preferred instances further reinforcing the sheets and adhering them to each other. Figure 16 B shows an exploded view of the injection mold apparatus.

[0051] Once the hole or block pattern is created in the group of sheets that form one of the two semicircular insulation assemblies or other shapes, stiffeners must be added to the group of sheets to create the desired rigidity. The stiffener may be of any of a 20 variety of materials, but preferably, it is an injection of resin into the cylindrical tubes that, once hardened, creates the structural integrity required. The resin may be of any of a variety of thermoplastic or adhesive type flowable material so long as it fills in the cylindrical voids in the pattern of holes for the group of sheets.

[0052] In a preferred embodiment, thermoplastic or other resin is injected into a mold that is configured to hold the upper group of sheets or lower group of sheets for the desired diameter of pipe. Once the sheets are aligned and placed in the mold, plastic, resin or other suitable hardening material is injected into the mold and fills the 5 cylindrical voids. Additionally, it is preferred to inject sufficient material to not only fill the cylindrical voids but to flow material between the sheets for added rigidity. By doing this, a series of hardened rods or cylinders are created transverse to the plane of the sheets as well as material between and on the surface of each sheet that then forms a portion of the curved configuration of the assembled sheets.

10 **[0053]** When fully injected and hardened, the several sheets have a series of radial stiffener spokes perpendicular to the outer diameter of the subject pipe, and a group of semicircular stiff sheets between each of the insulation sheets. This creates a very strong insulating layer as shown in Figures 10 and 12 capable of withstanding increased compressive forces applied across the insulation layers when positioned in the cradles 15 about the pipe.

[0054] In alternative embodiments, the stiffeners could be individual rigid members such as pegs or dowels made of any of a variety of materials. Each cylindrical void would be filled with one or more such pegs or dowels to create a reinforced group of sheets. The pegs or dowels could be affixed with glues, thermoplastic or other 20 adhesives placed around the pegs or dowels.

Claims

1. A reinforced insulation material comprising:
 - a) a plurality of flexible sheets of the same insulation material having a plurality of voids in each sheet, wherein said sheets are operably connected to each other in a layered configuration via mating voids through said sheets;
 - b) said voids on each sheet oriented in a mating pattern that substantially forms cylindrical regions through said layered configuration; and
 - c) a synthetic flowable material inserted through said voids of each sheet that substantially solidifies to connect said sheets to each other and form a substantially rigid unified solid body.
2. The reinforced insulation material of claim 1 wherein said insulation is aerogel.
3. The reinforced insulation material of claim 1 wherein said body is formed into a substantially semicircular shape.
4. The reinforced insulation material of claim 1 wherein said layered configuration is formed in a rectilinear block.
5. The reinforced insulation material of claim 1 wherein said voids are substantially rectilinear.
6. The reinforced insulation material of claim 1 wherein said voids are substantially circular.
7. The reinforced insulation material of claim 1 further comprising stiffening rods inserted into said voids.
8. A reinforced insulation material comprising:

- a) a plurality of sandwiched flexible sheets of the same insulation material, each sheet having a plurality of voids;
- b) said voids on each sheet oriented in a mating pattern to said voids on said other sheets to form cylindrical voids through said sheets when connected together; and
- c) a dowel inserted into said voids of each sheet that connects said sheets to form a substantially rigid unified body.

9. The reinforced insulation material of claim 8 further comprising flowable synthetic material applied partially between said sheets.

10. The reinforced insulation material of claim 8 further comprising flowable synthetic material inserted in said cylindrical voids around each dowel.

11. The reinforced insulation material of claim 8 further comprising adhesive material partially inserted between said sheets.

12. The reinforced insulation material of claim 8 wherein said unified body is configured in a semicircular arrangement.

13. The reinforced insulation material of claim 8 further comprising an end block on at least one edge of said sandwiched sheets.

14. The reinforced insulation material of claim 8 further comprising a plurality of voids on each sheet in a honeycombed pattern.

15. A reinforced insulation material comprising:

- a) a plurality of flexible sheets of the same insulation material having a void in each sheet, wherein said sheets are operably connected to each other via material inserted into said voids;

- b) said void on each sheet oriented in a mating pattern to said void on said other sheets to form a three dimensional void when connected together; and
- c) said material comprised of a flowable synthetic material inserted into the voids of each sheet that substantially solidifies to connect said sheets in a unified generally non-compressible body.

16. The reinforced insulation material of claim 15 further comprising synthetic material applied between said sheets.

17. The reinforced insulation material of claim 15 wherein said three dimensional void is generally curved at the inner and outer surfaces of said connected sheets.

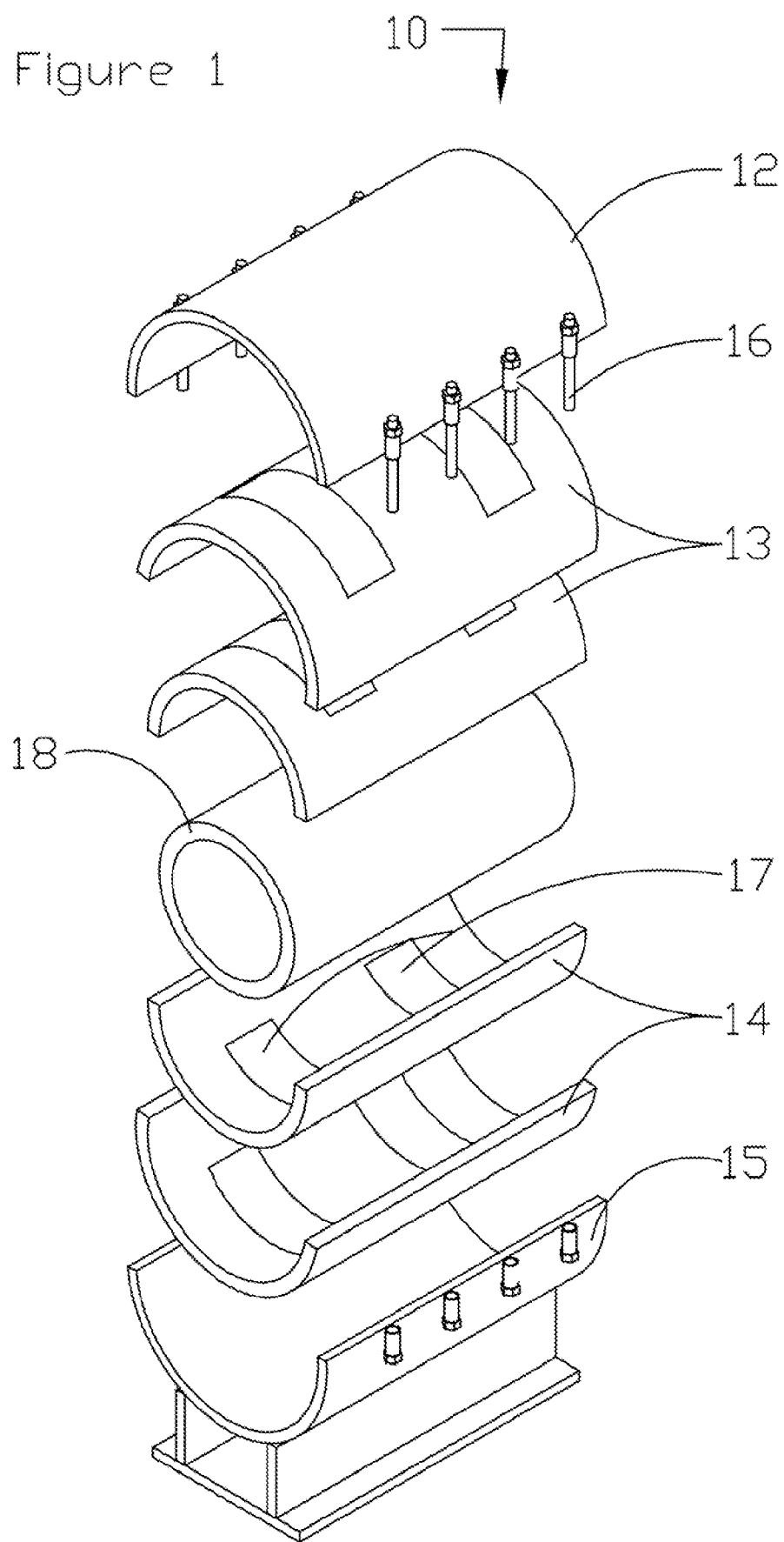
18. The reinforced insulation material of claim 15 further comprising a substantially rectangular block of reinforced material.

19. The reinforced insulation material of claim 15 further comprising a plurality of said voids in said sheets matably oriented to each other.

20. The reinforced insulation material of claim 15 wherein said sheets are configured into a semicircular shape.

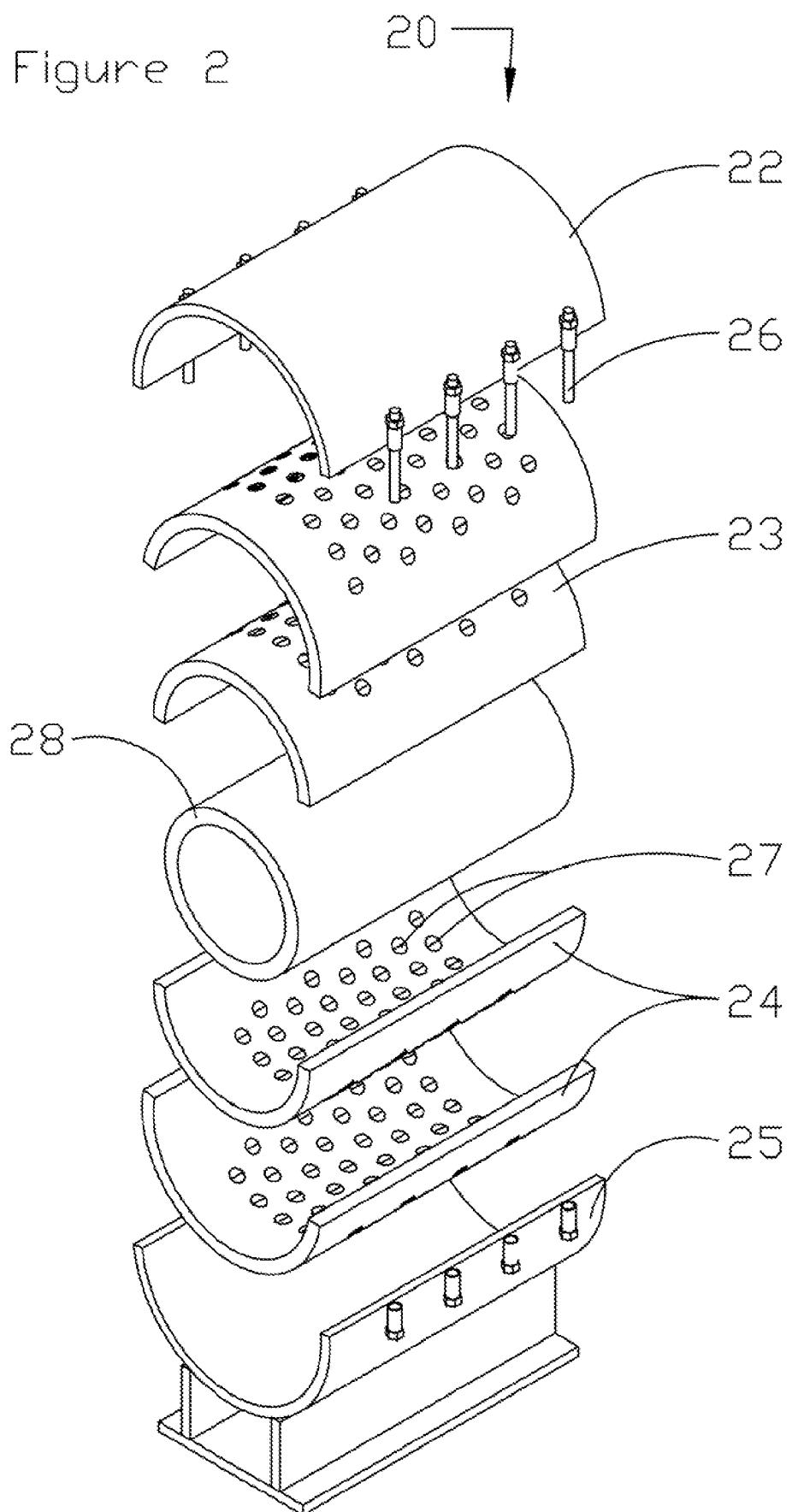
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Figure 1



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Figure 2



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Figure 3

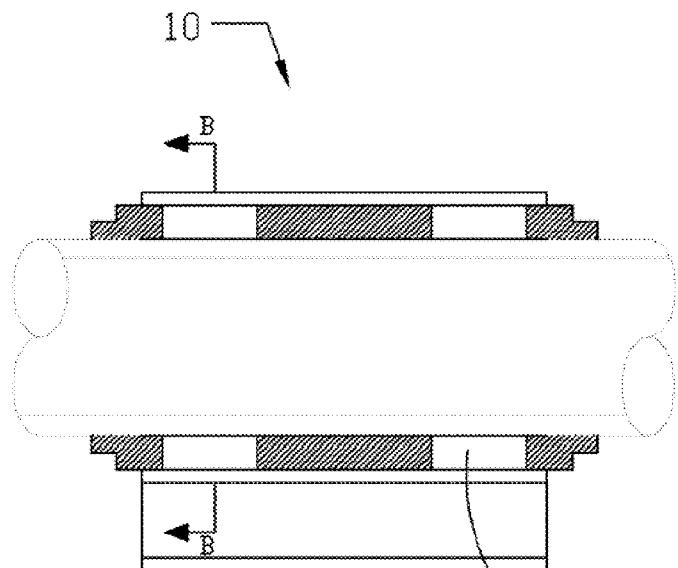


Figure 4

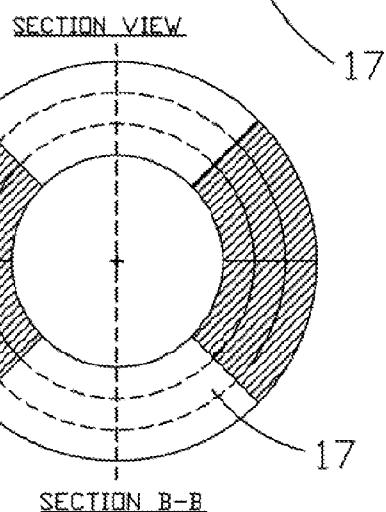
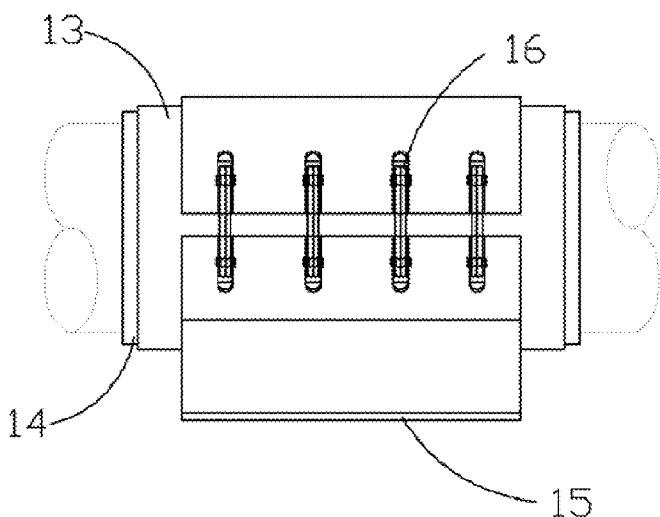


Figure 5

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Figure 6

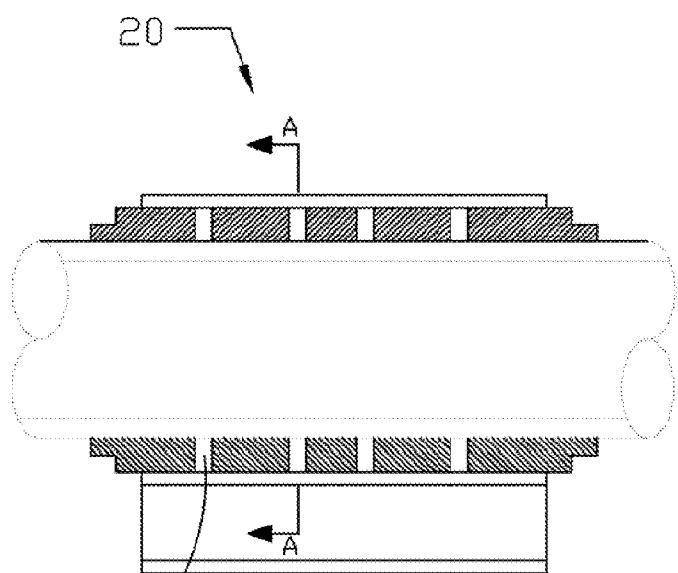
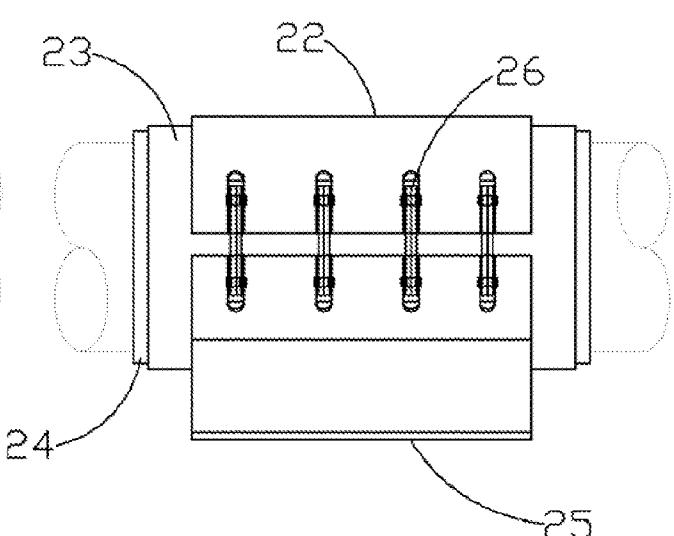


Figure 7



SECTION VIEW

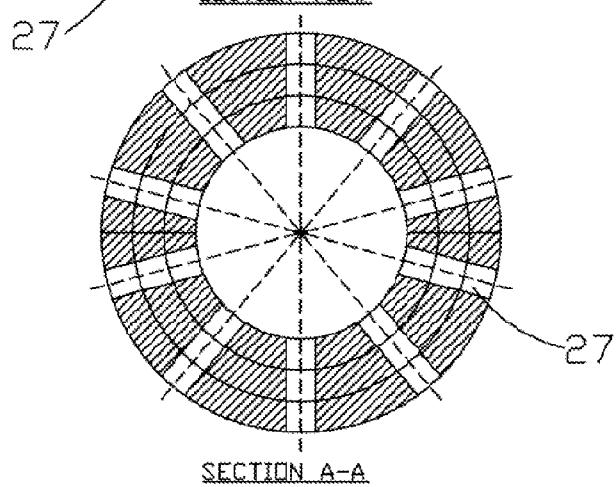
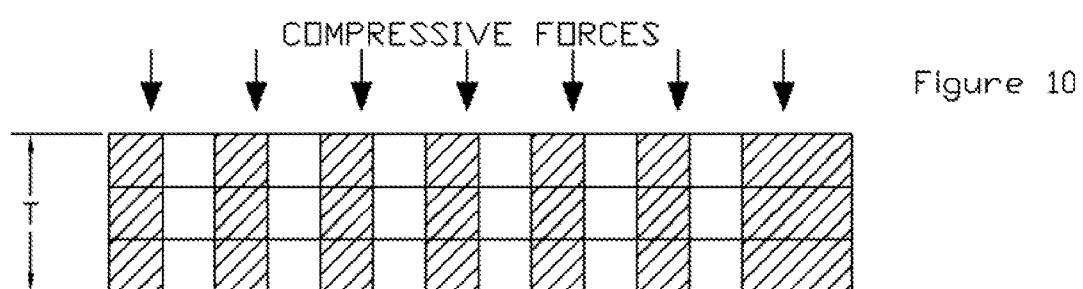
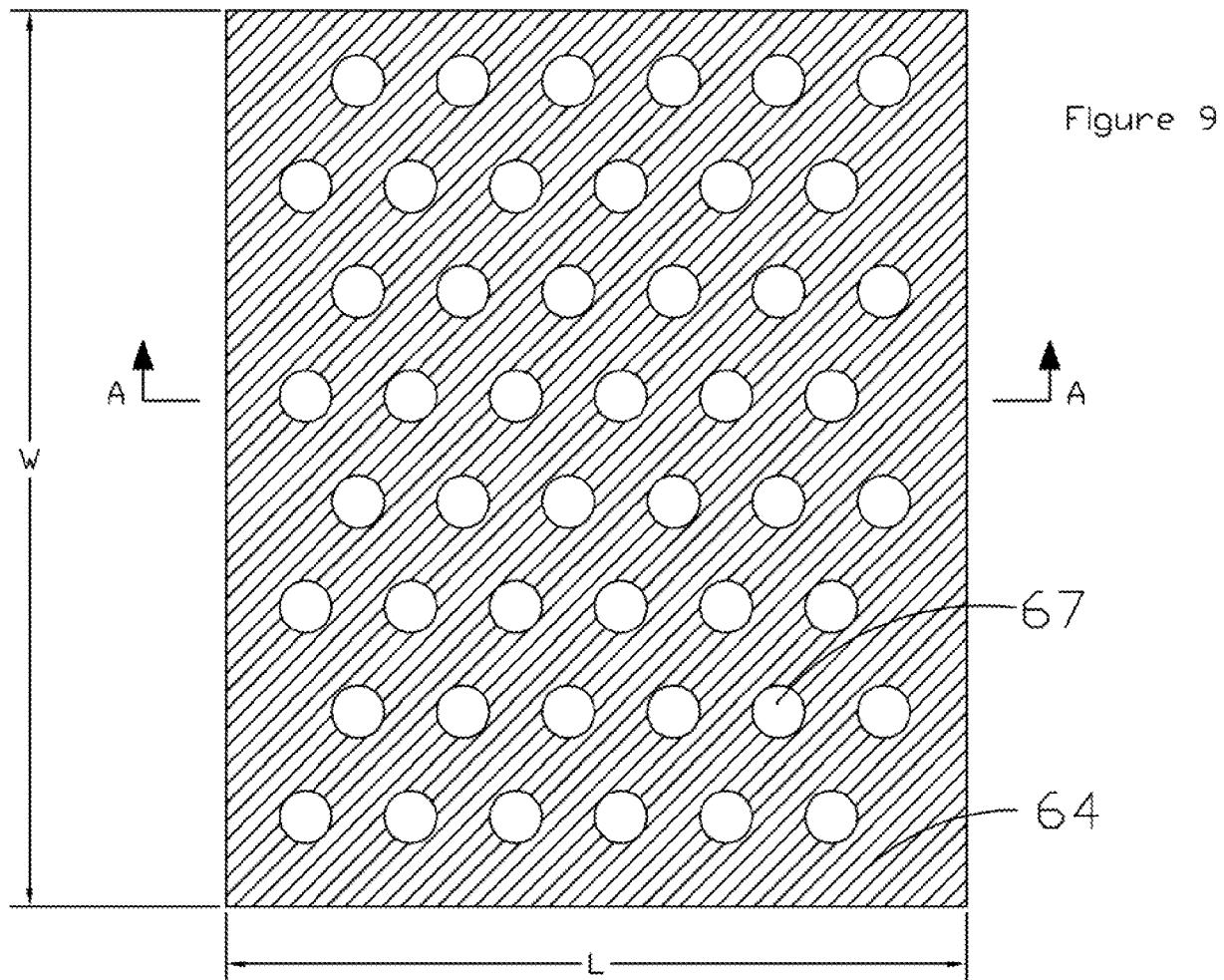
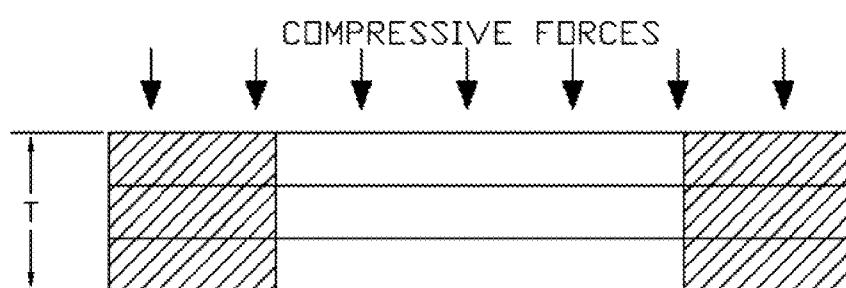
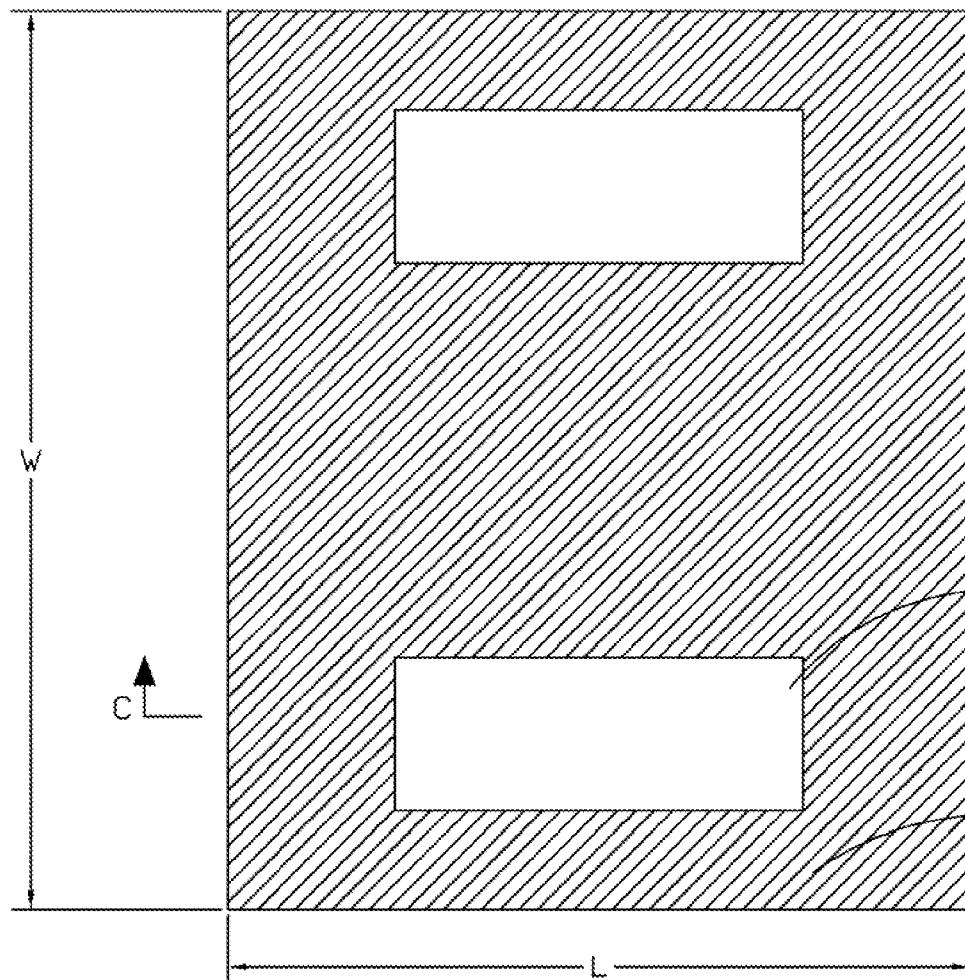


Figure 8

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SECTION A-A



SECTION C-C

Figure 13

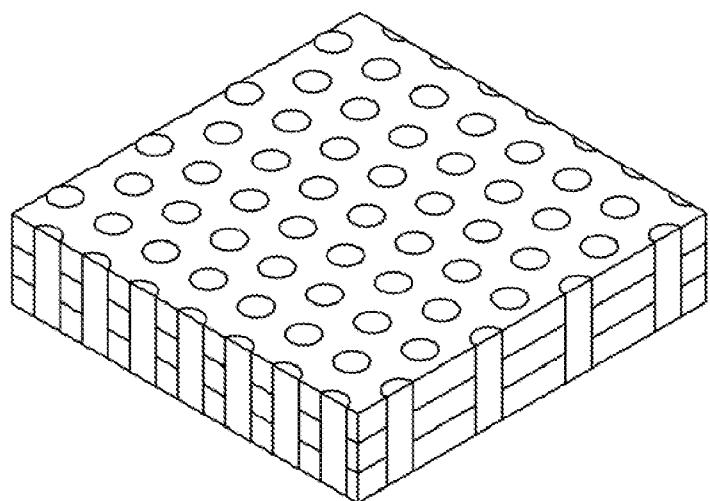


Figure 14

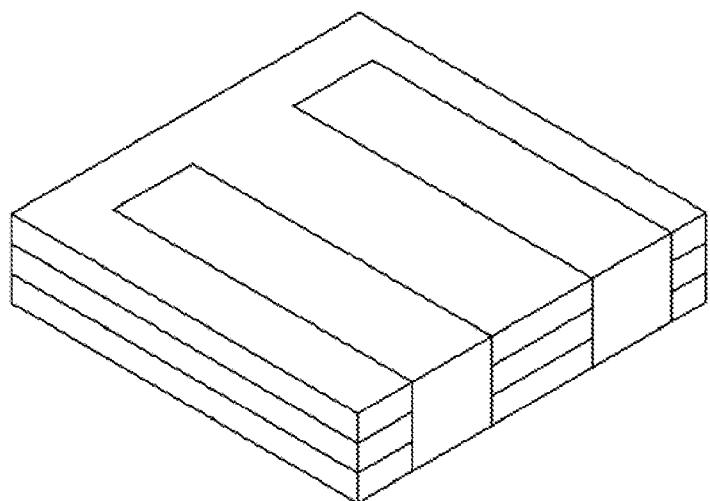
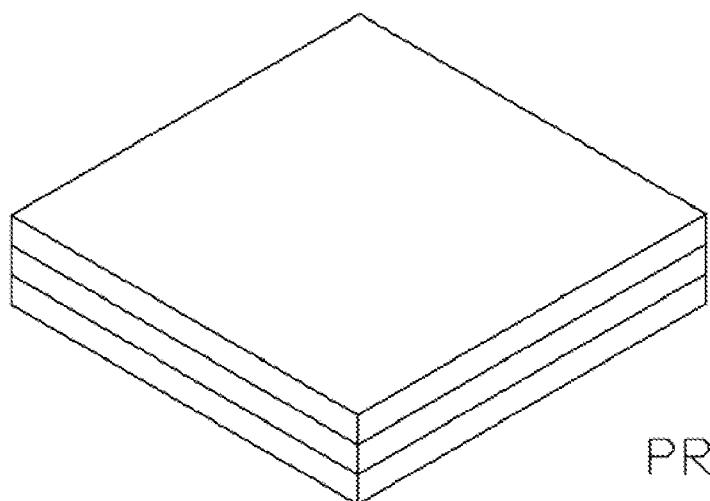


Figure 15



PRIOR ART

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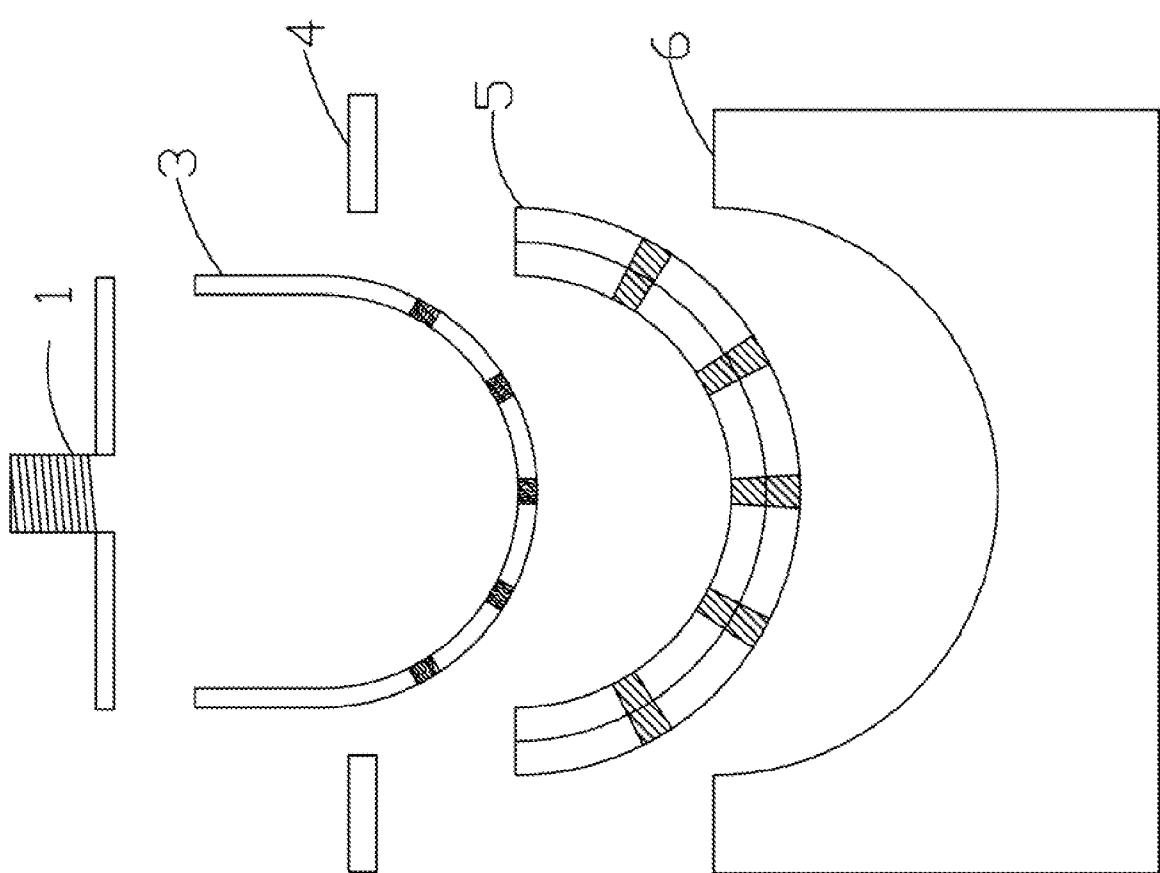


Figure 16 B

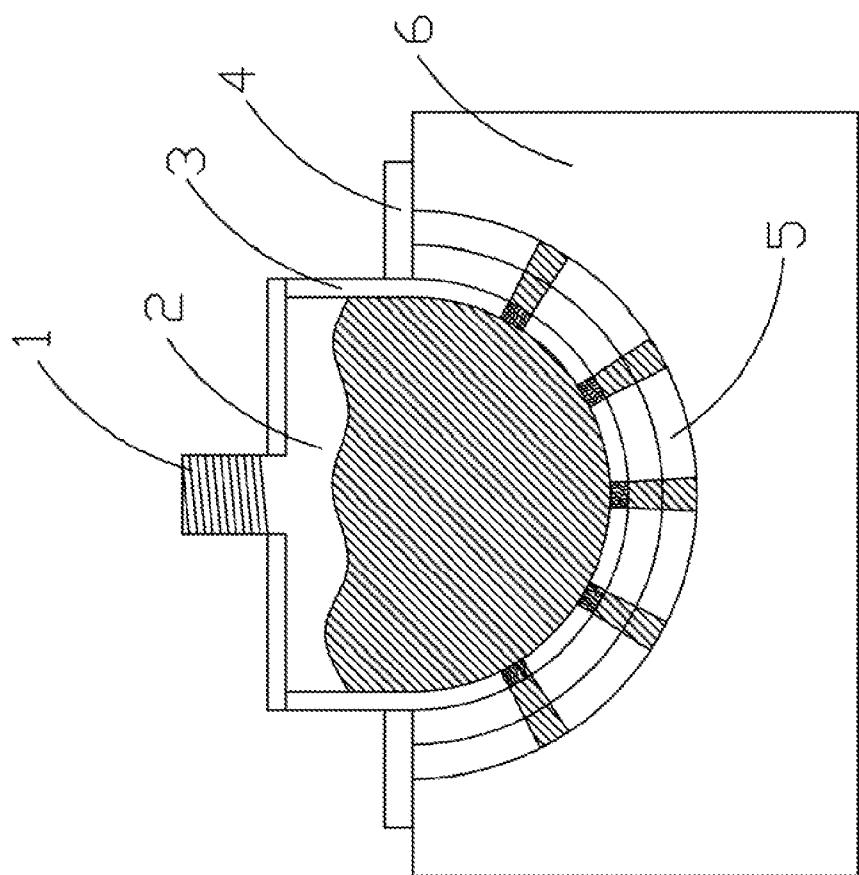


Figure 16 A

