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(54) **SOLAR THERMAL COLLECTOR CABINET AND SYSTEM FOR HEAT STORAGE**

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Publication Classification

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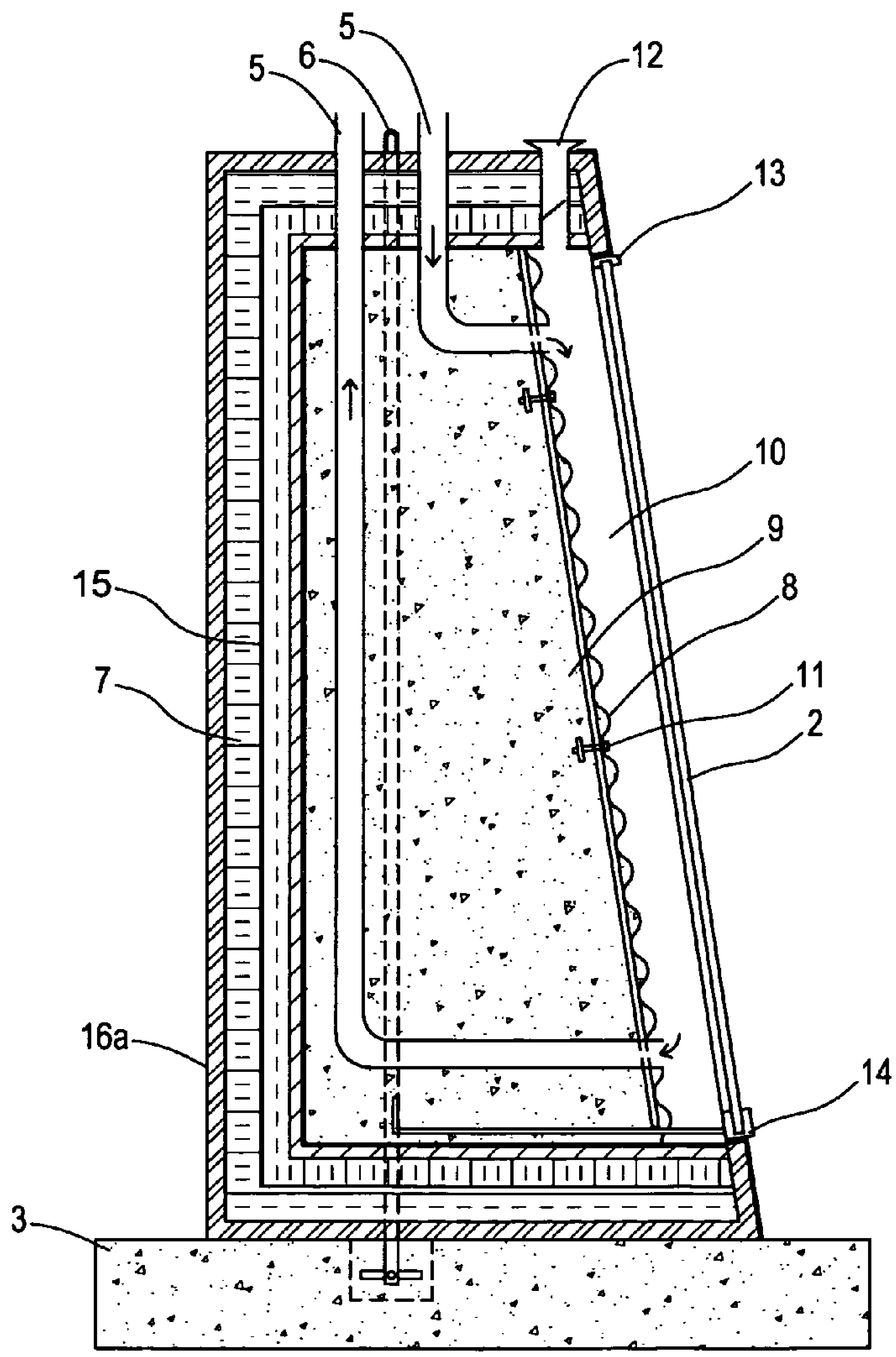
F24J 2/34 (2006.01)

(52) **U.S. Cl.** **126/617**

(57) **ABSTRACT**

A solar thermal collection cabinet is disclosed that includes a thermal mass comprising concrete mix and metallic pieces. The cabinet includes a corrugated metallic surface with a black finish that faces solar radiation. A plurality of metallic bolts attaches the black corrugated surface to the thermal mass, to enable good heat conduction to the thermal mass. Channels through the thermal mass enable heat transfer fluid to circulate through the thermal mass, the heat transfer fluid exchange heat for direct utilization, or to transfer heat to a thermal storage reservoir through suitable heat exchanger means. Alternatively, the thermal storage reservoir continuously receives and returns heat exchange fluid whereby over extended periods of time the system approaches a thermal steady state.



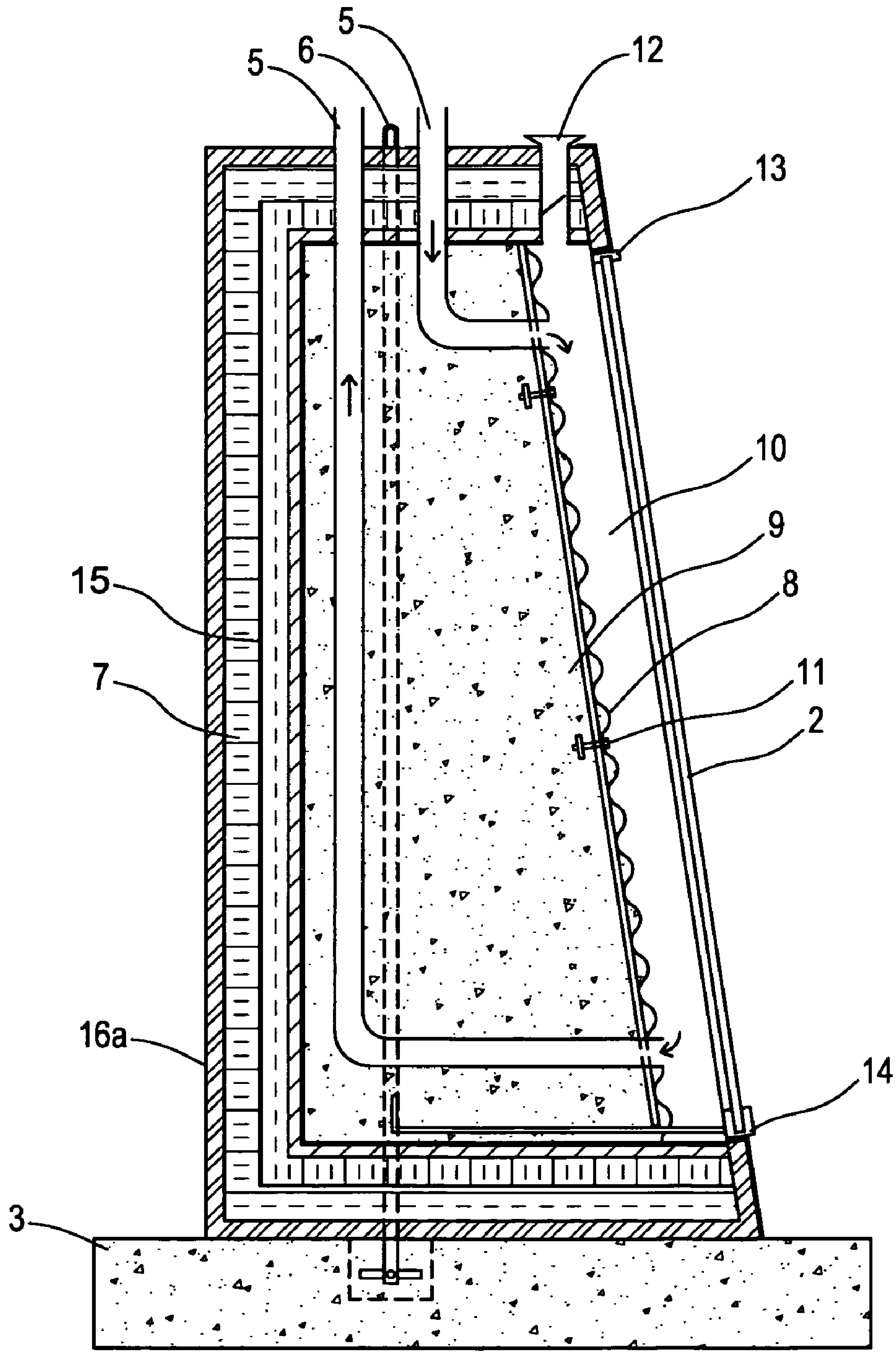


FIG. 1

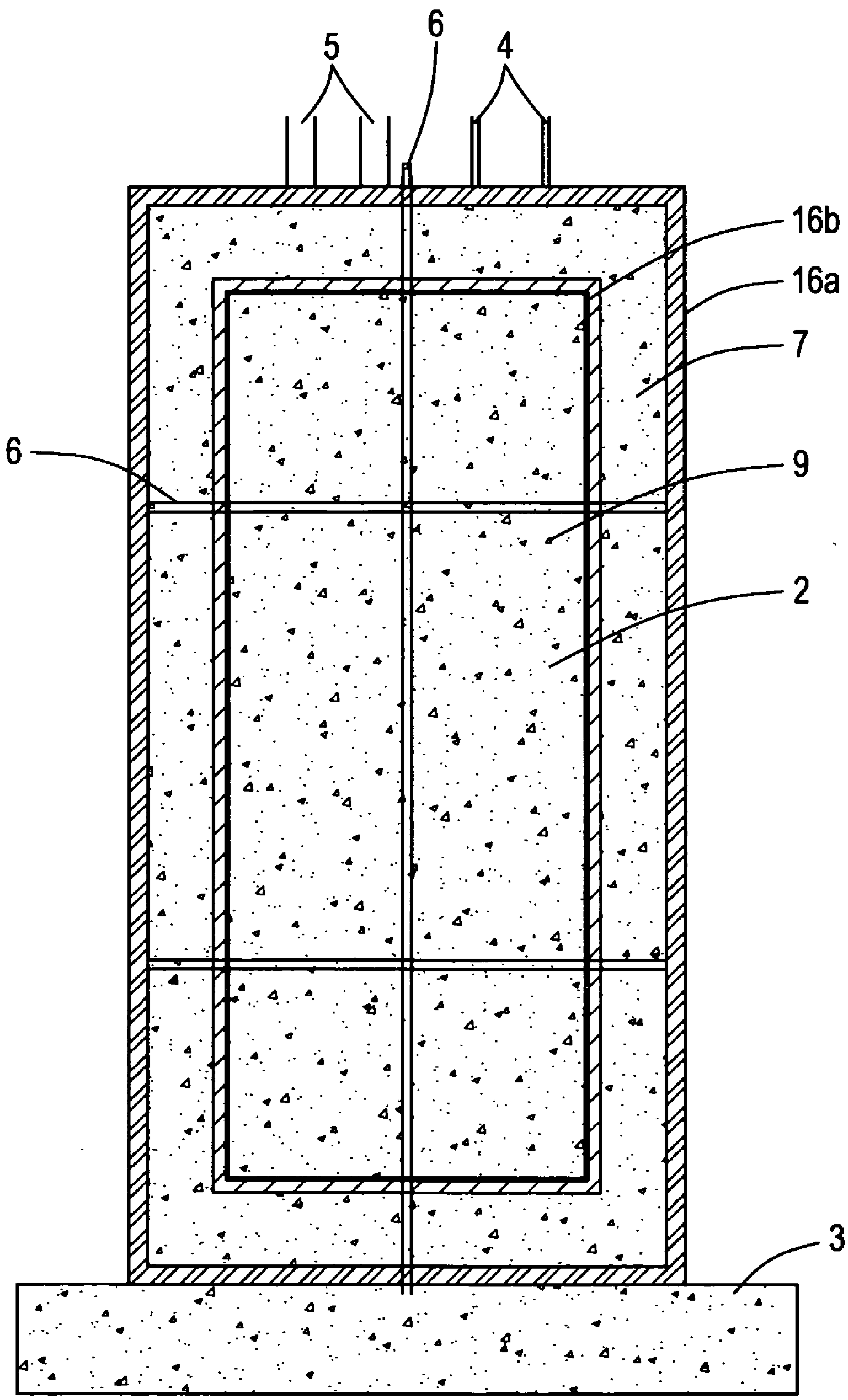


FIG. 2

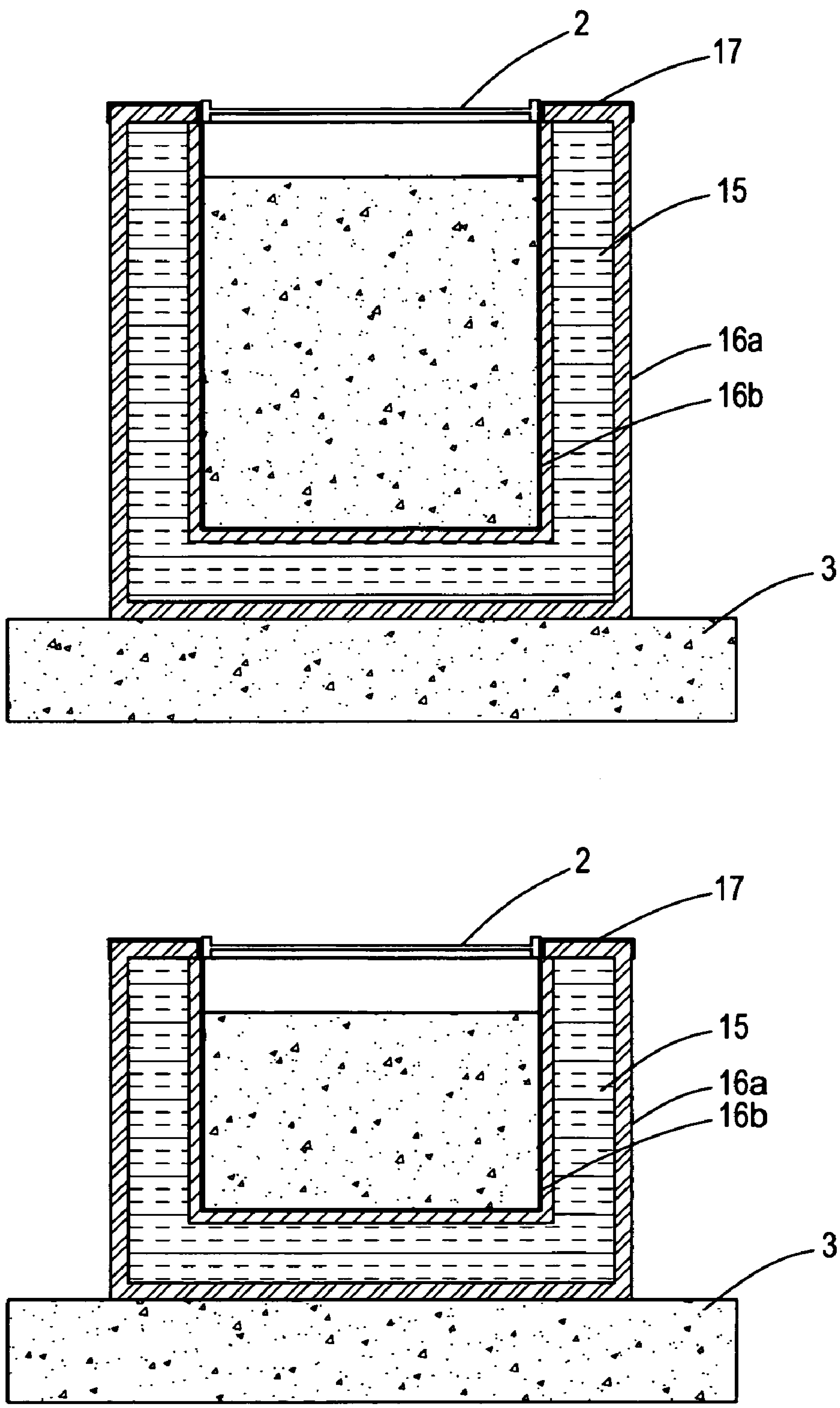


FIG. 3

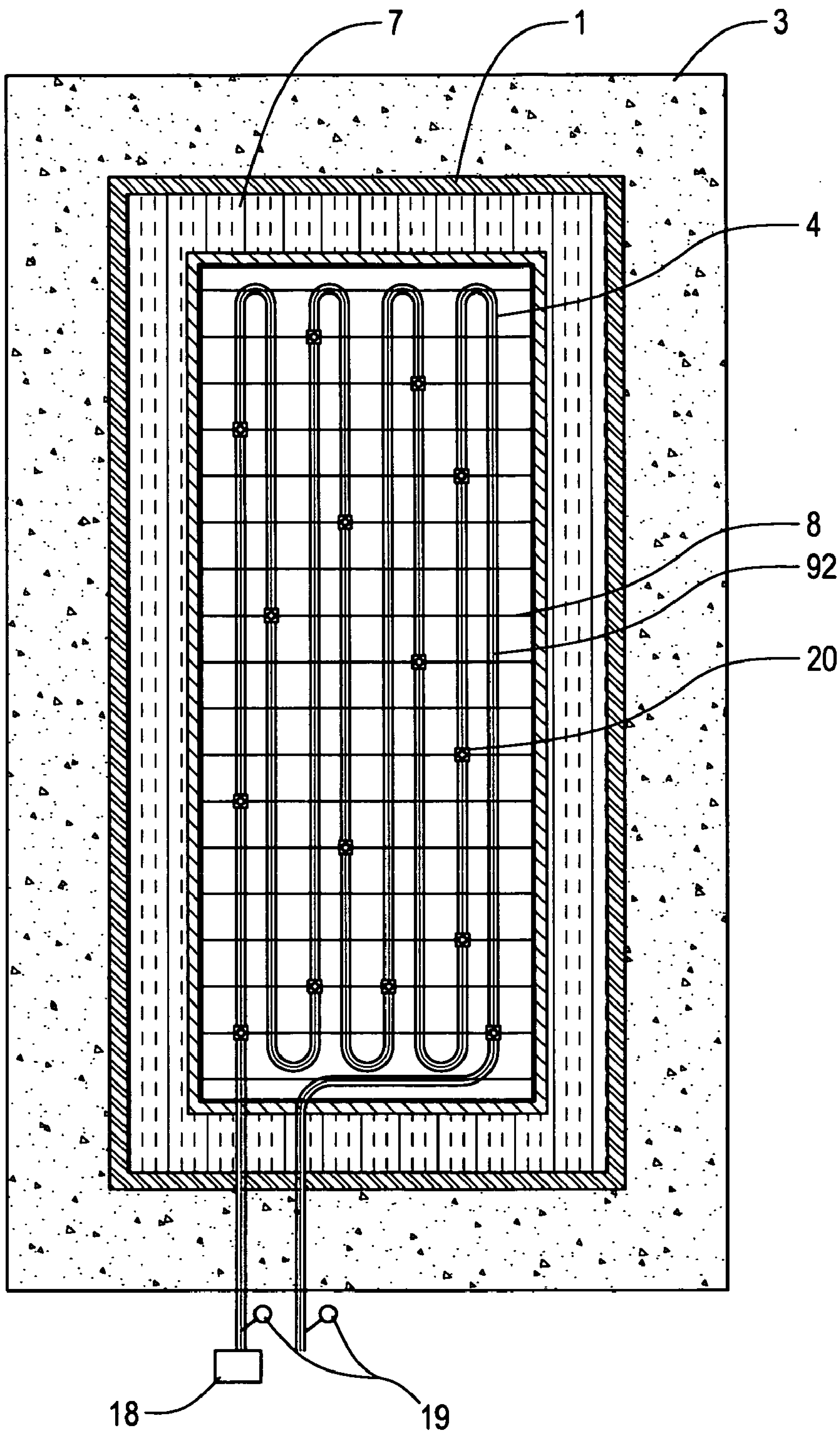


FIG. 4

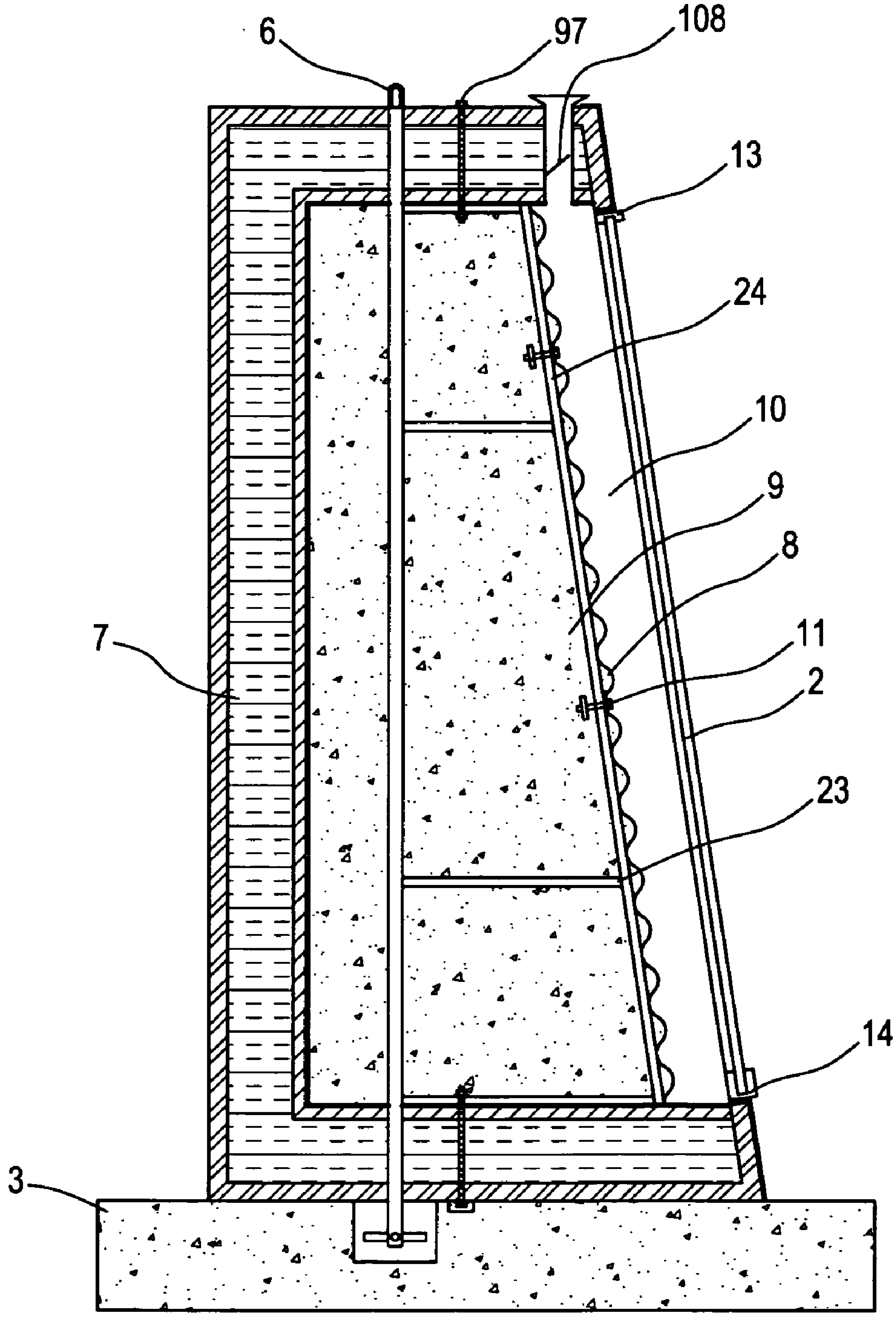


FIG. 5

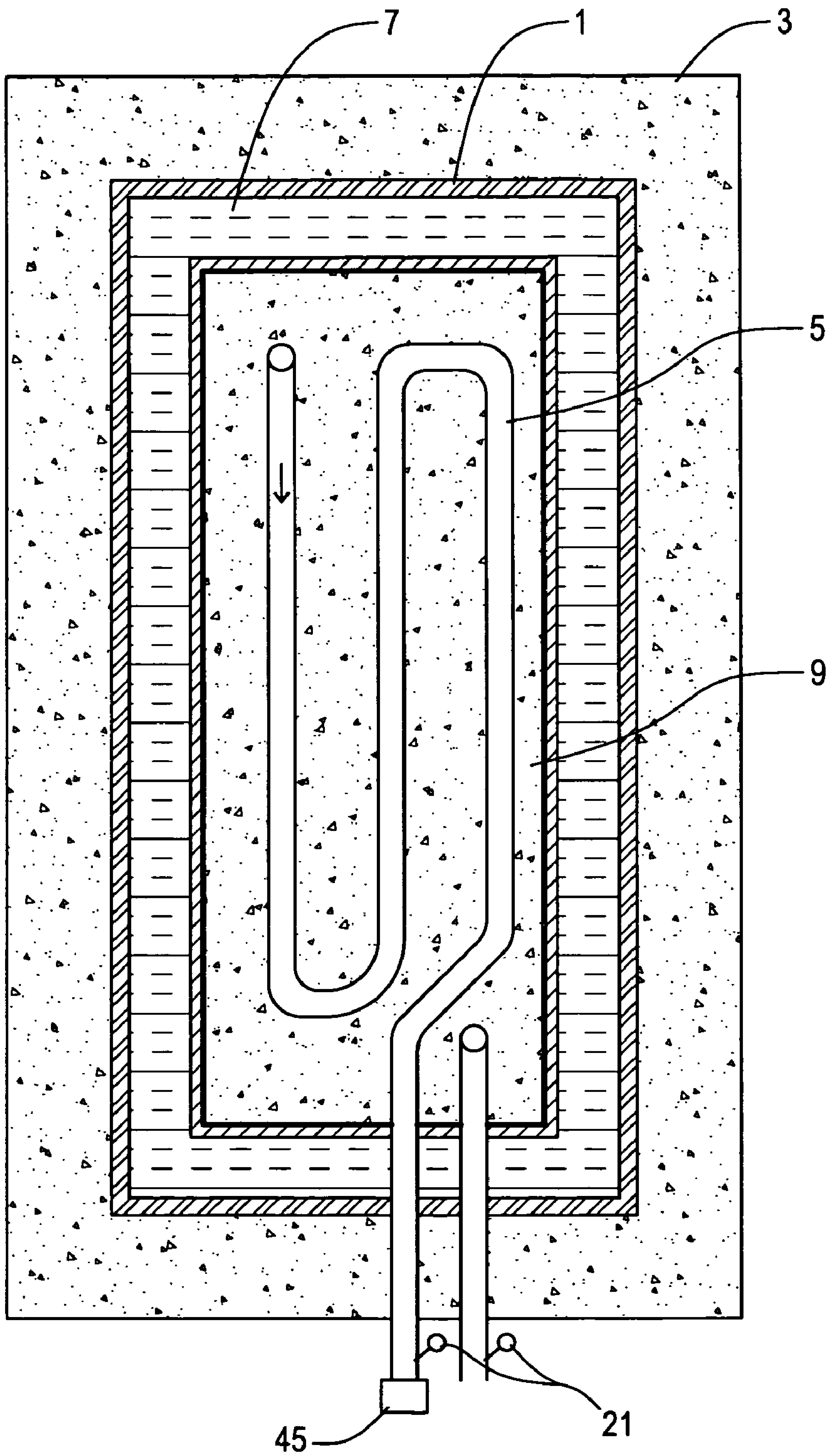
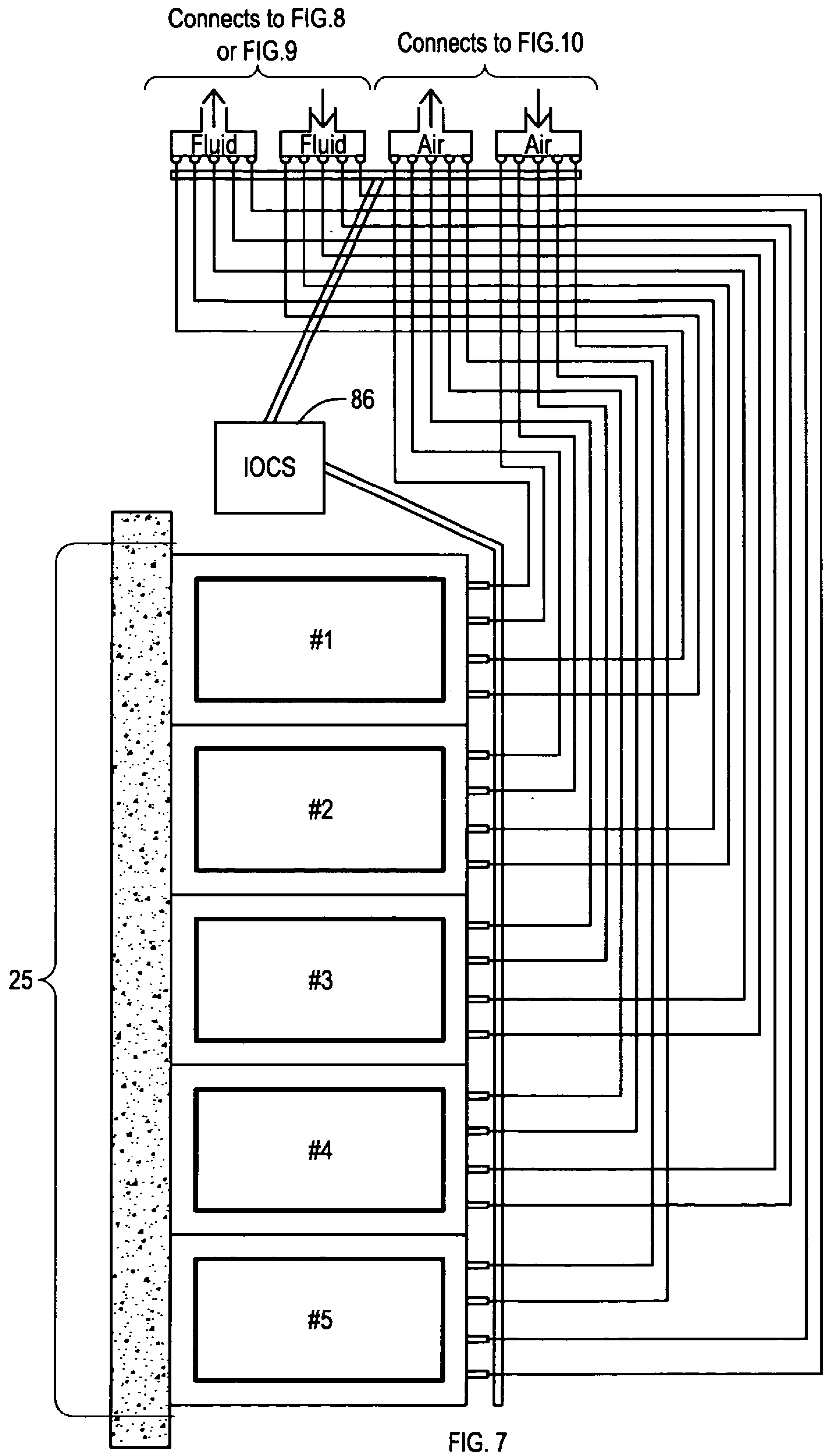


FIG. 6



Connects to FIG.8
or FIG.9
Connects to FIG.10
Fluid
Fluid
Air
Air
86
IOCS
#1
#2
#3
#4
#5
25

FIG. 7

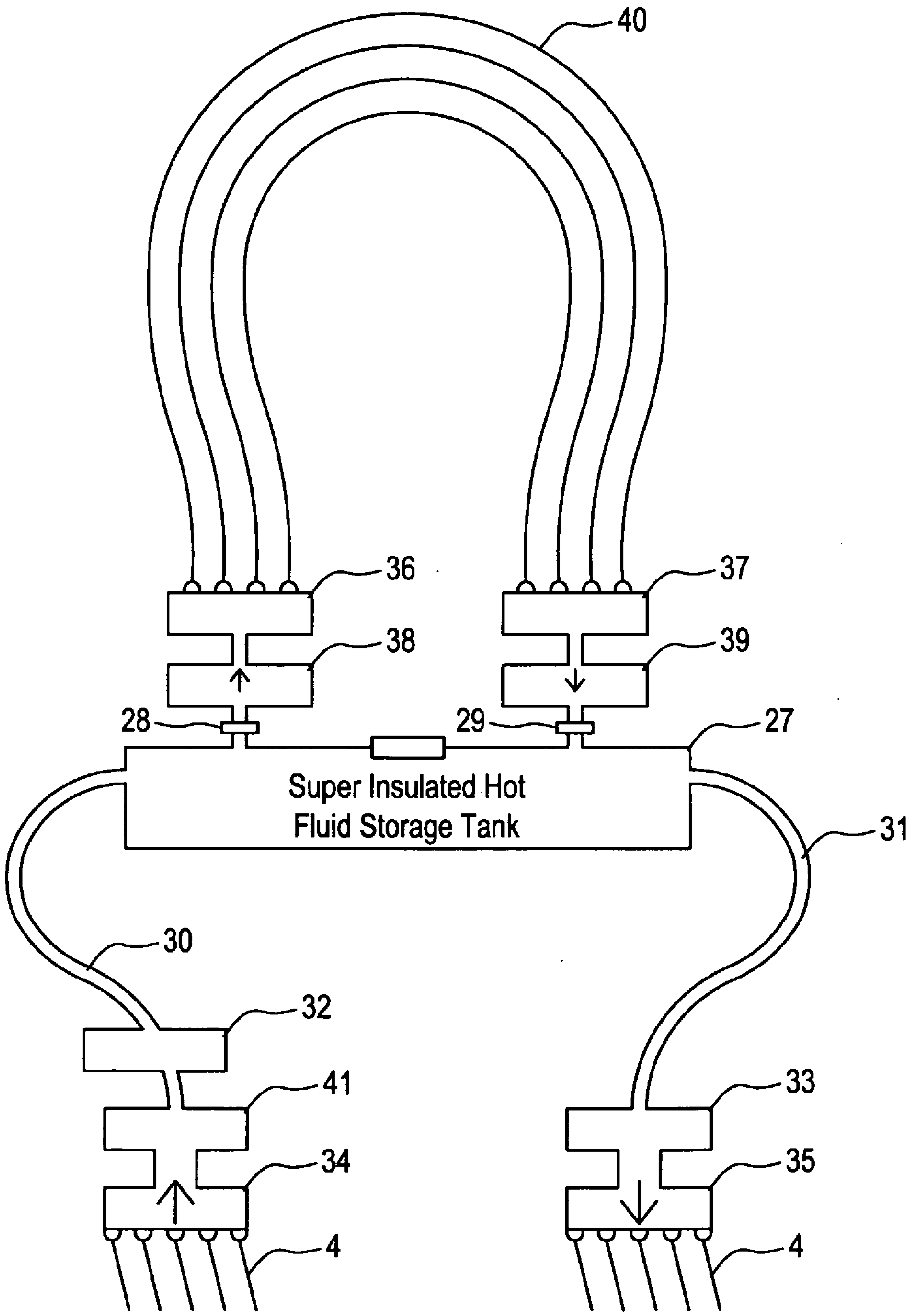

40
36
37
38
39
28
29
27
Super Insulated Hot
Fluid Storage Tank
31
30
32
41
33
34
35
4
4

FIG. 8

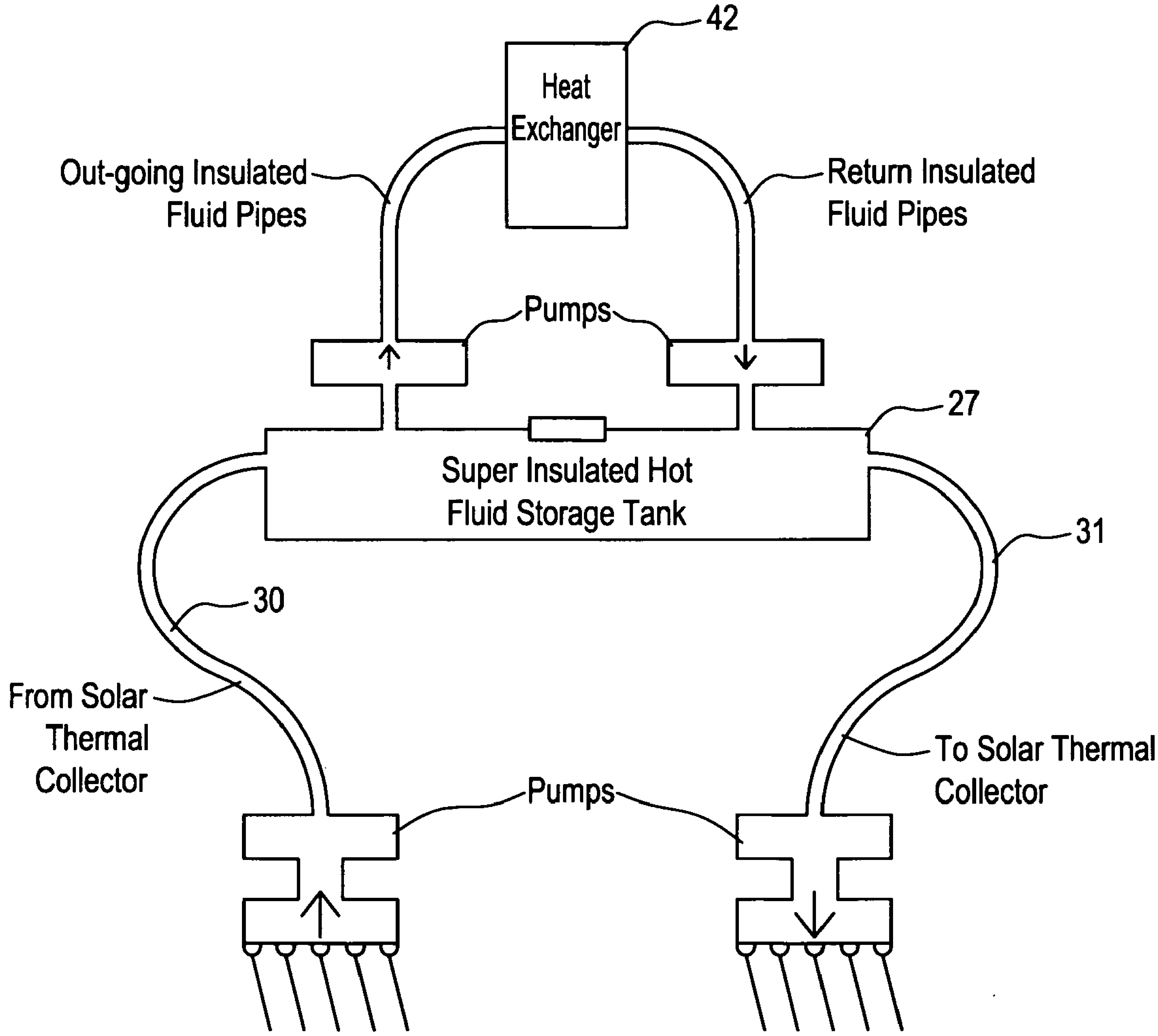

42
Heat Exchanger
Out-going Insulated Fluid Pipes
Return Insulated Fluid Pipes
Pumps
27
Super Insulated Hot Fluid Storage Tank
31
30
From Solar Thermal Collector
To Solar Thermal Collector
Pumps

FIG. 9

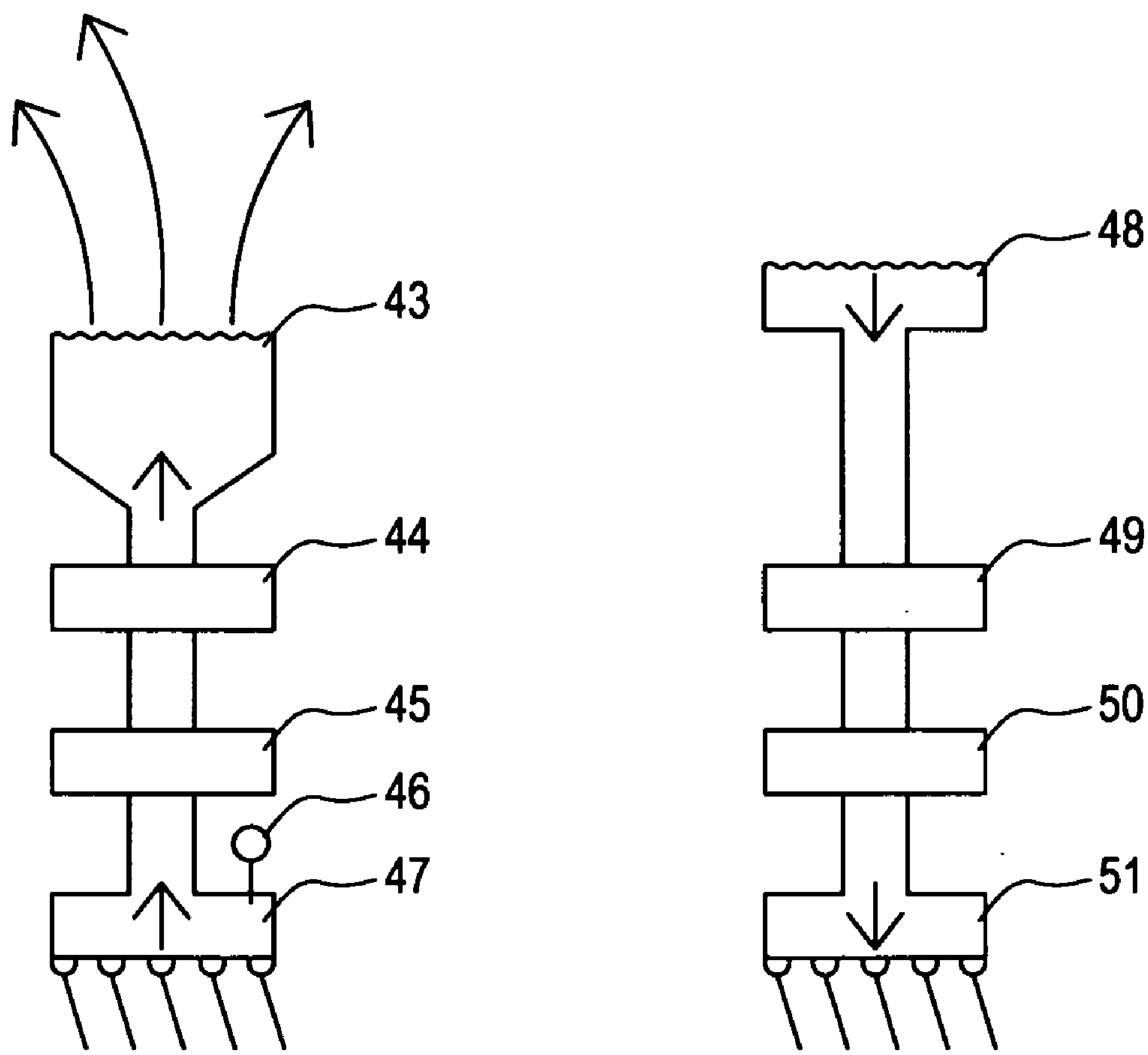


FIG. 10

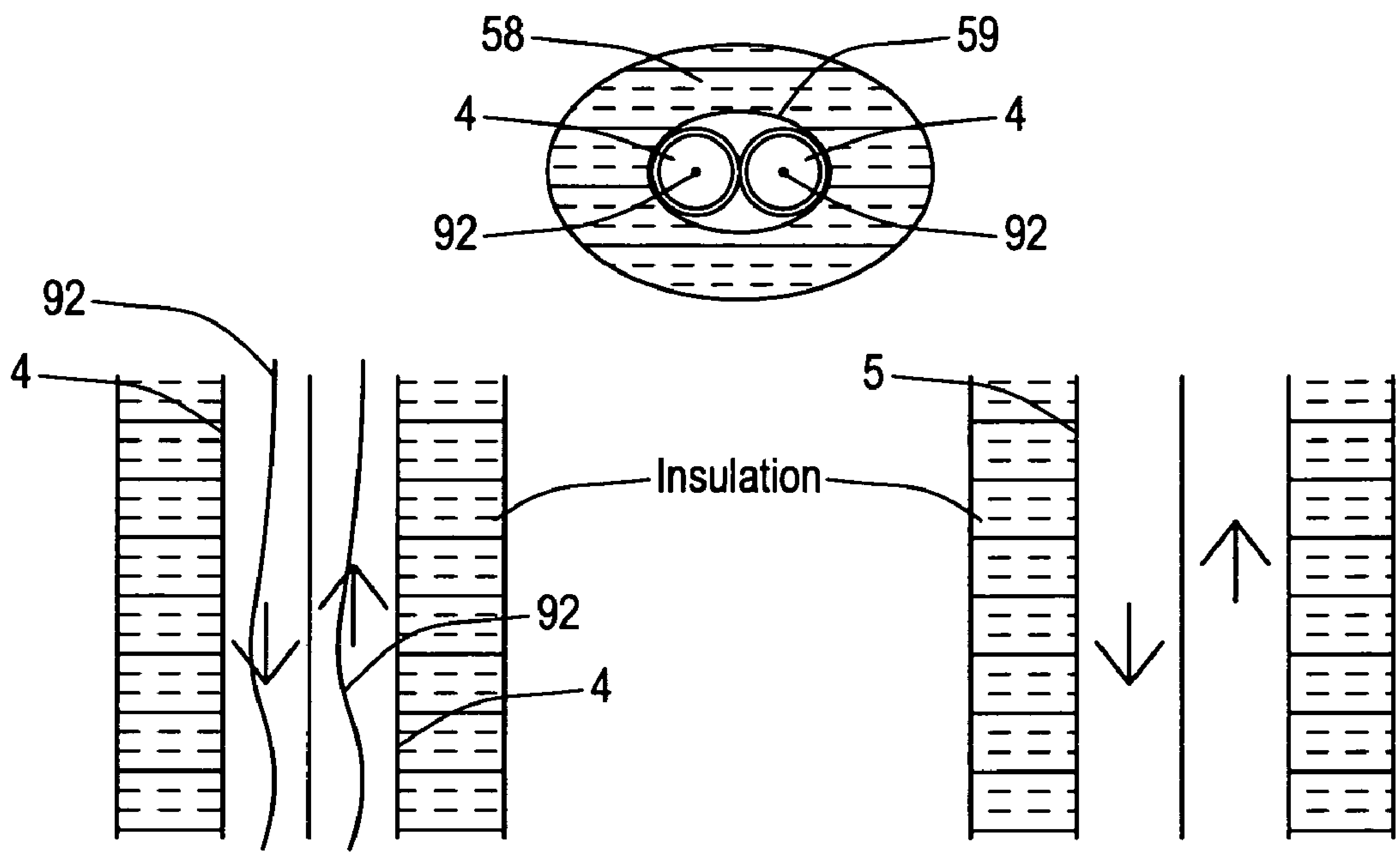


FIG. 11

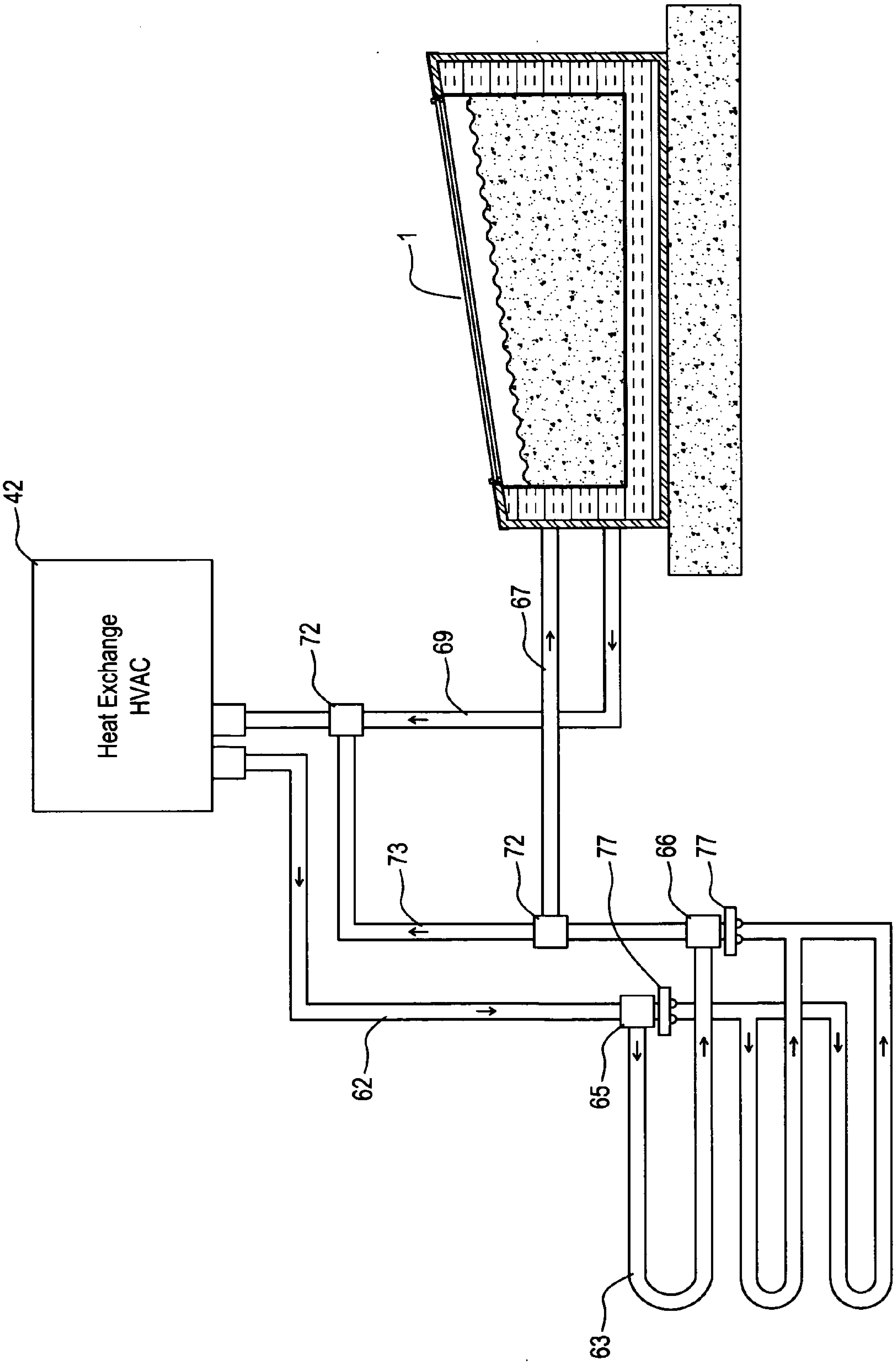


FIG. 12

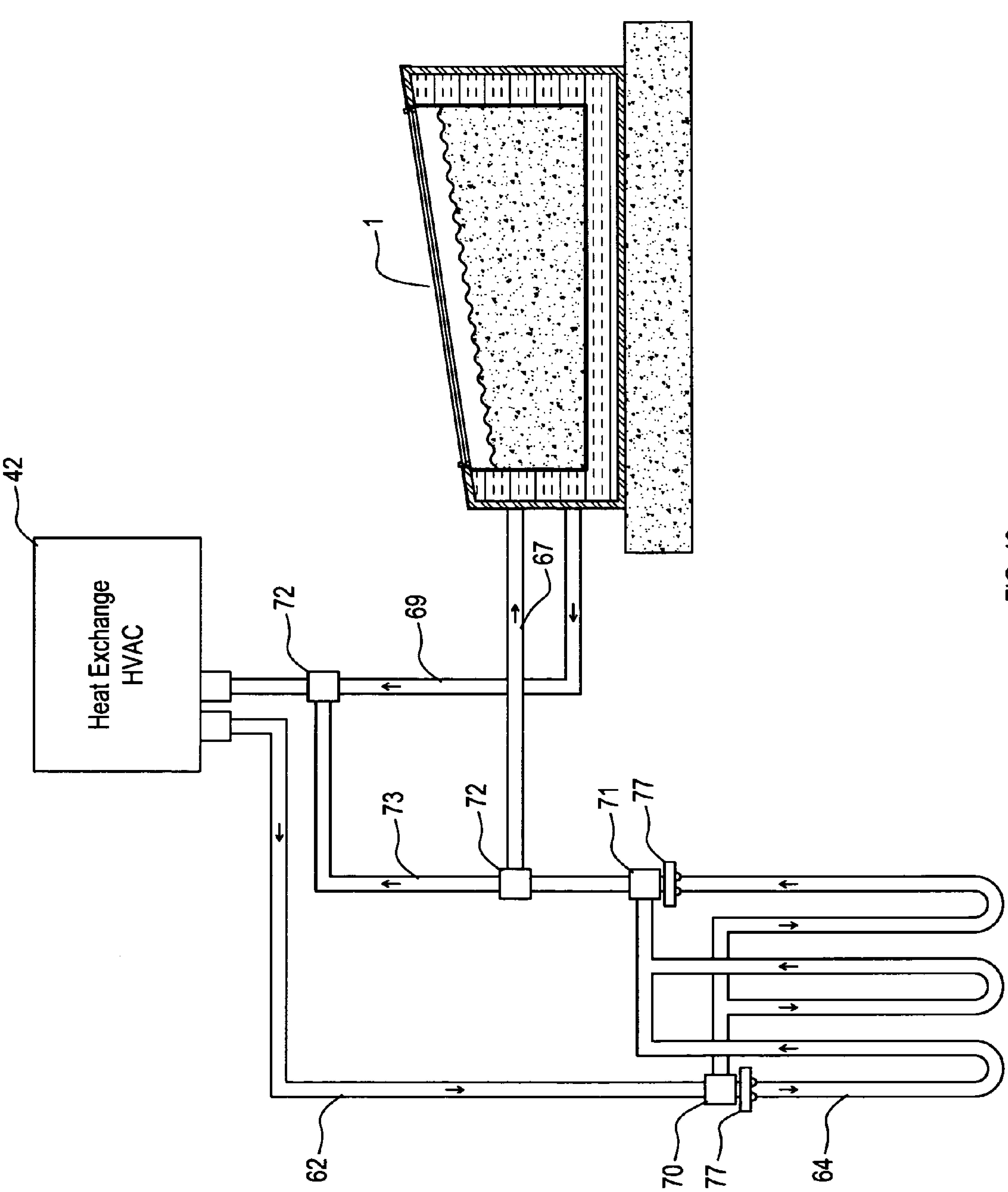


FIG. 13

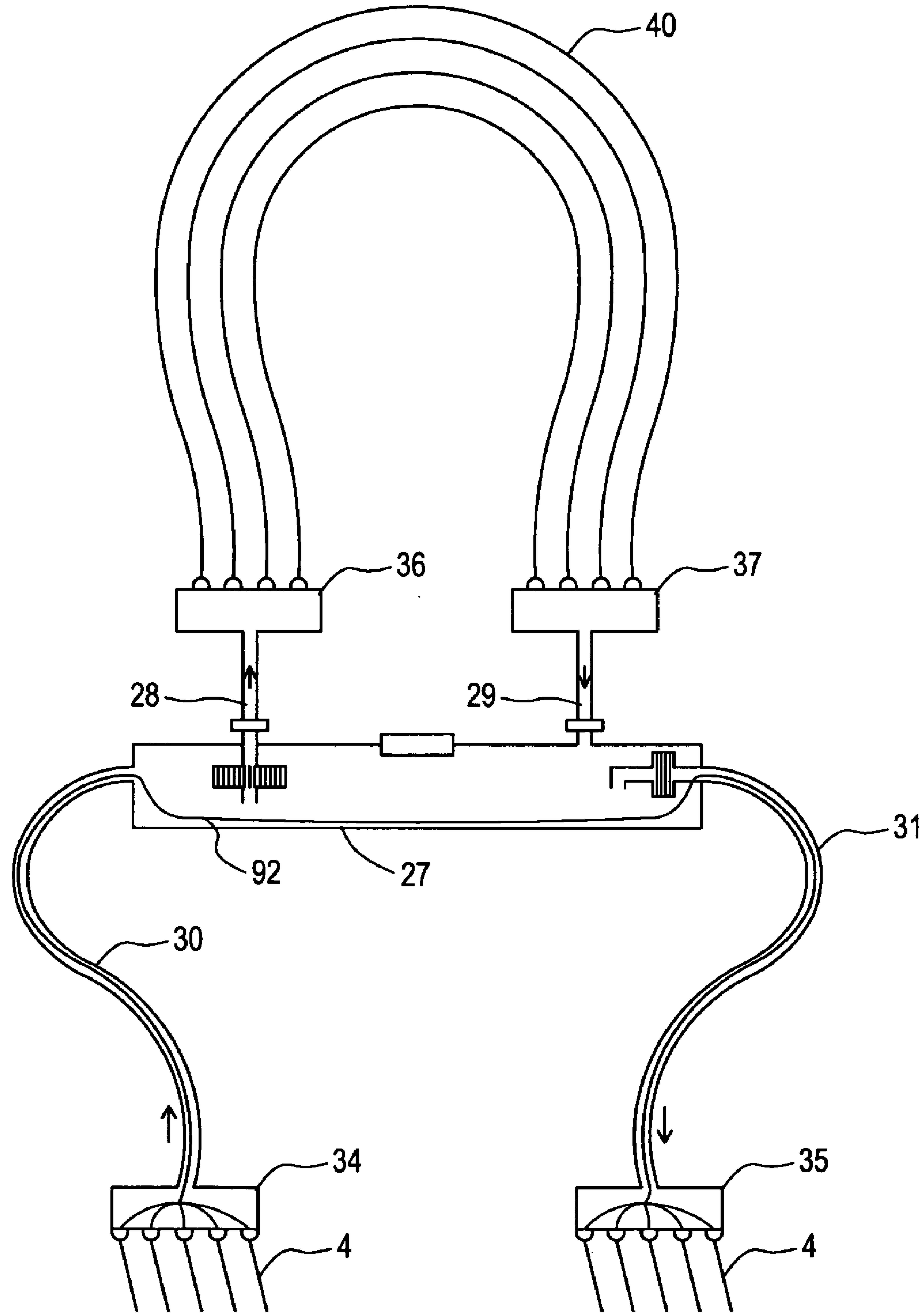


FIG. 14

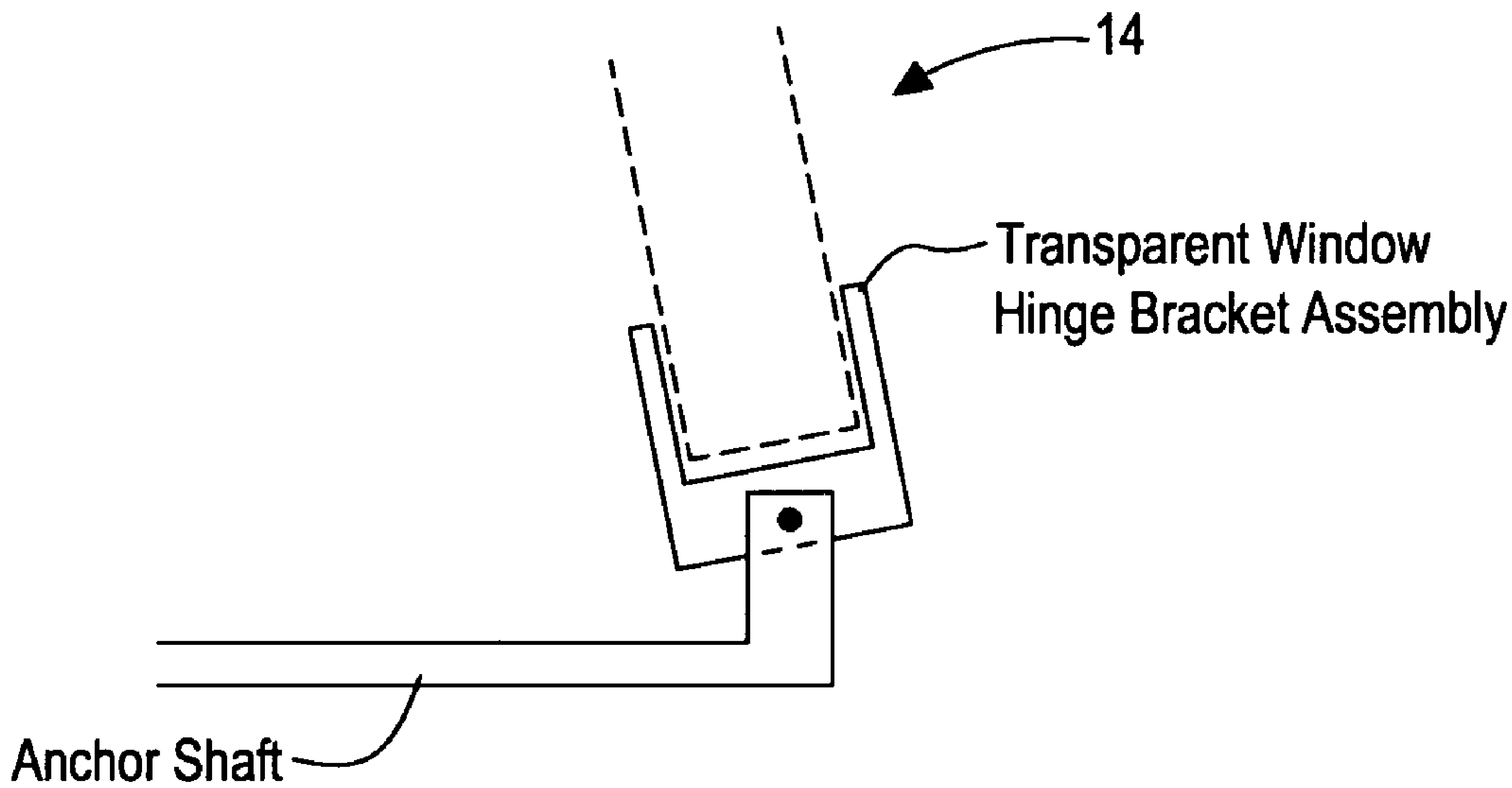

14
Transparent Window
Hinge Bracket Assembly
Anchor Shaft

FIG. 15

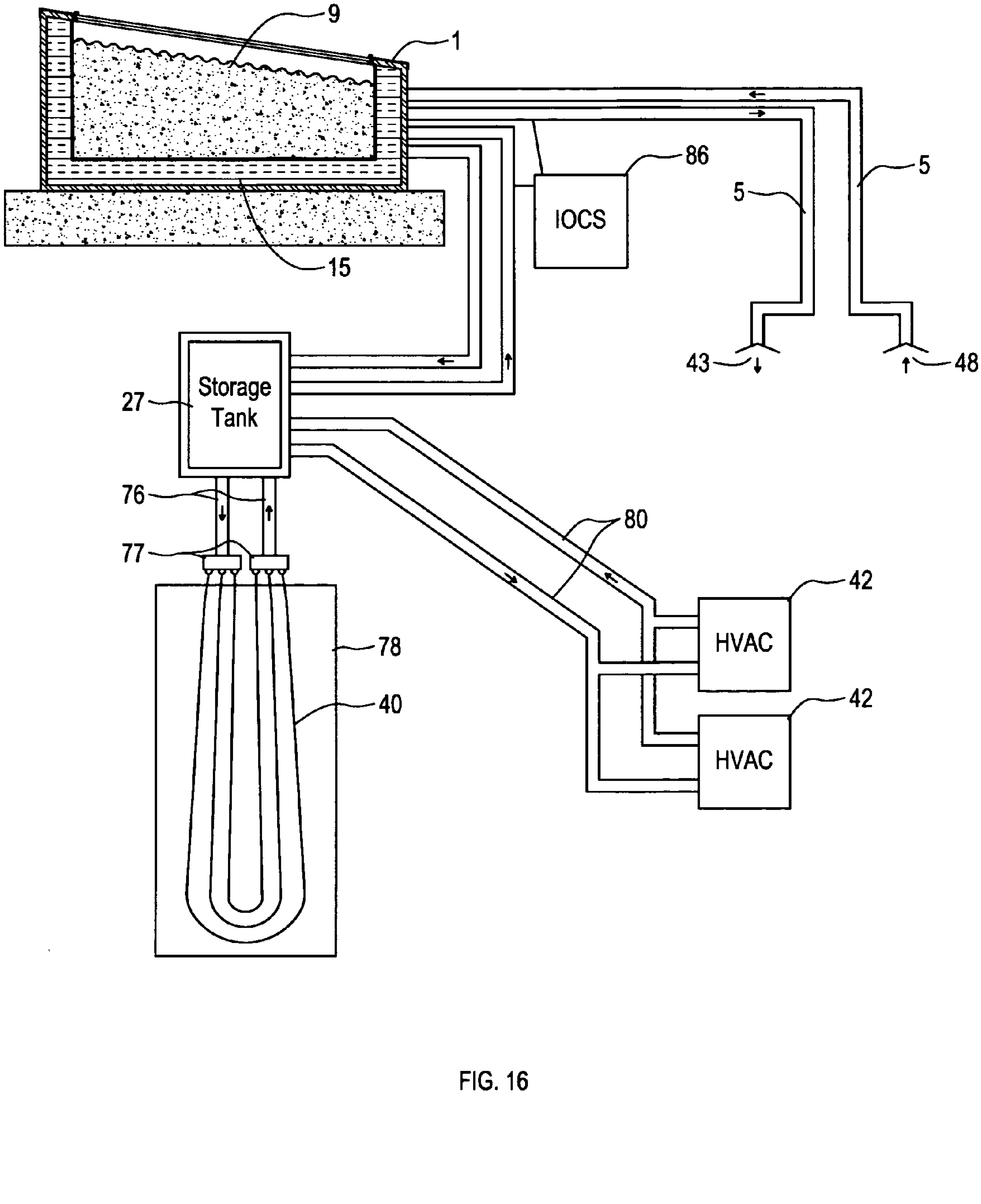

9
1
86
IOCS
5
5
15
43
48
27
Storage Tank
76
77
80
42
HVAC
42
HVAC
78
40

FIG. 16

MOBILE CONFIGURATION

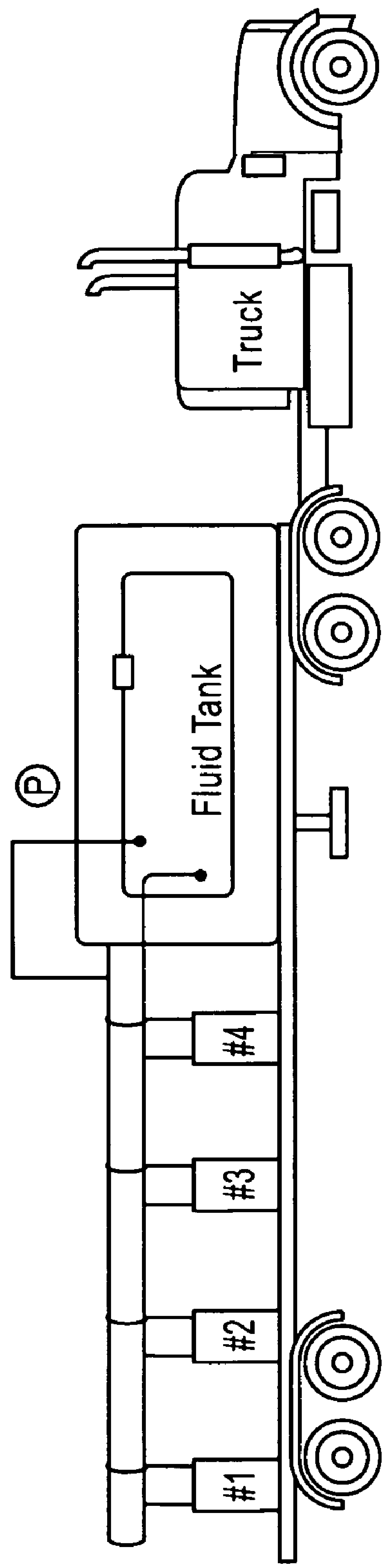


FIG.17

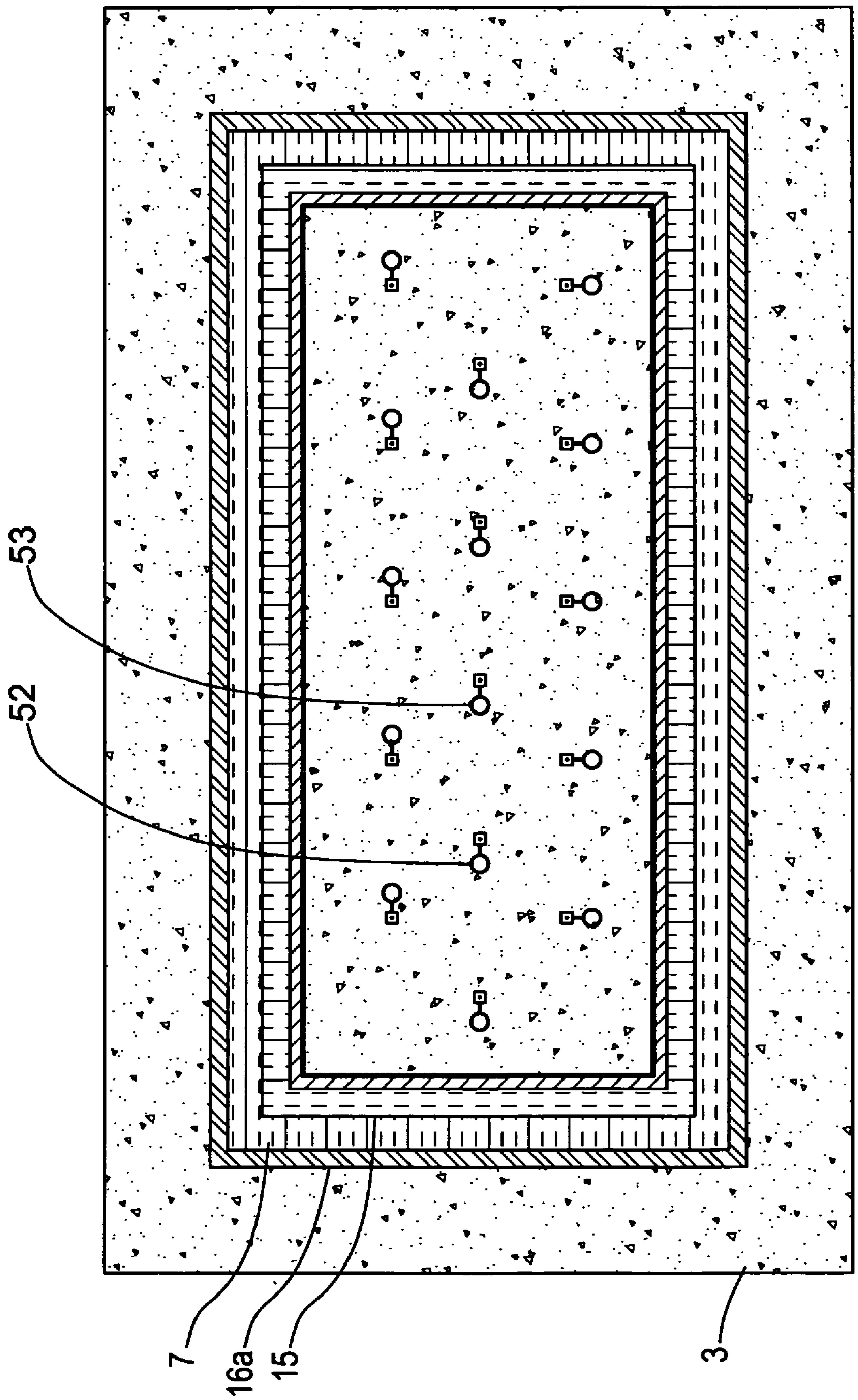


FIG 18

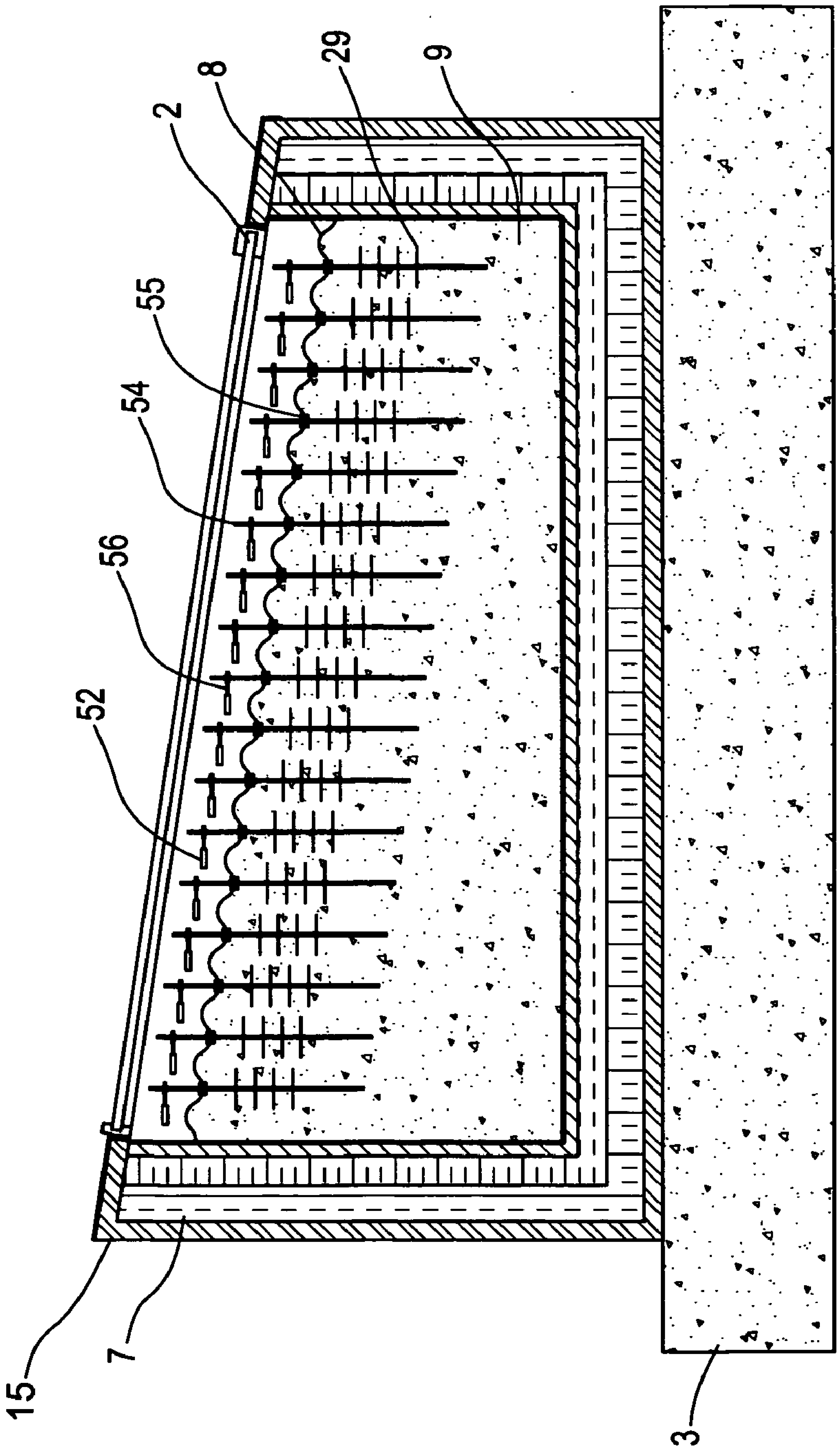


FIG. 19

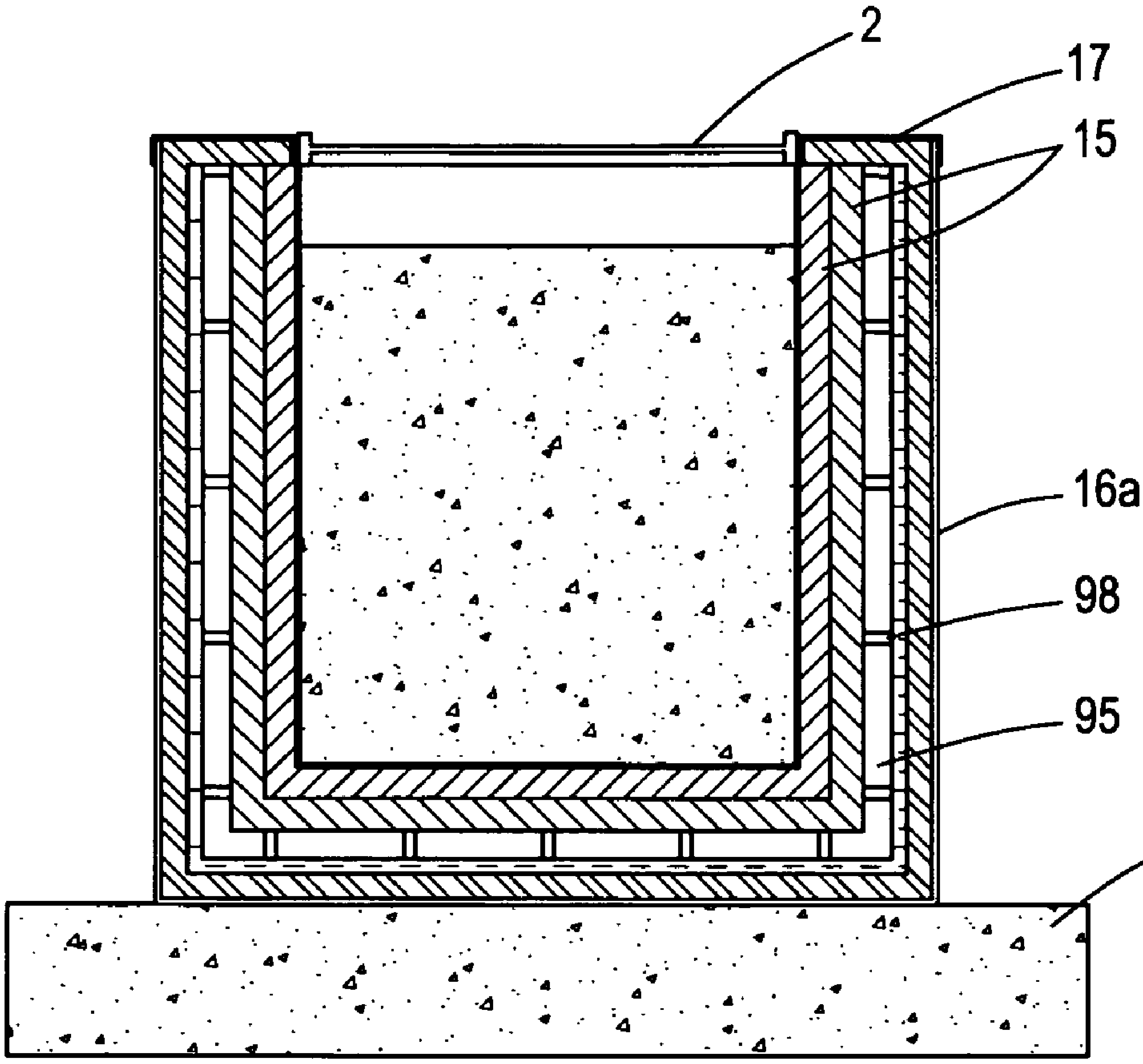


FIG. 20

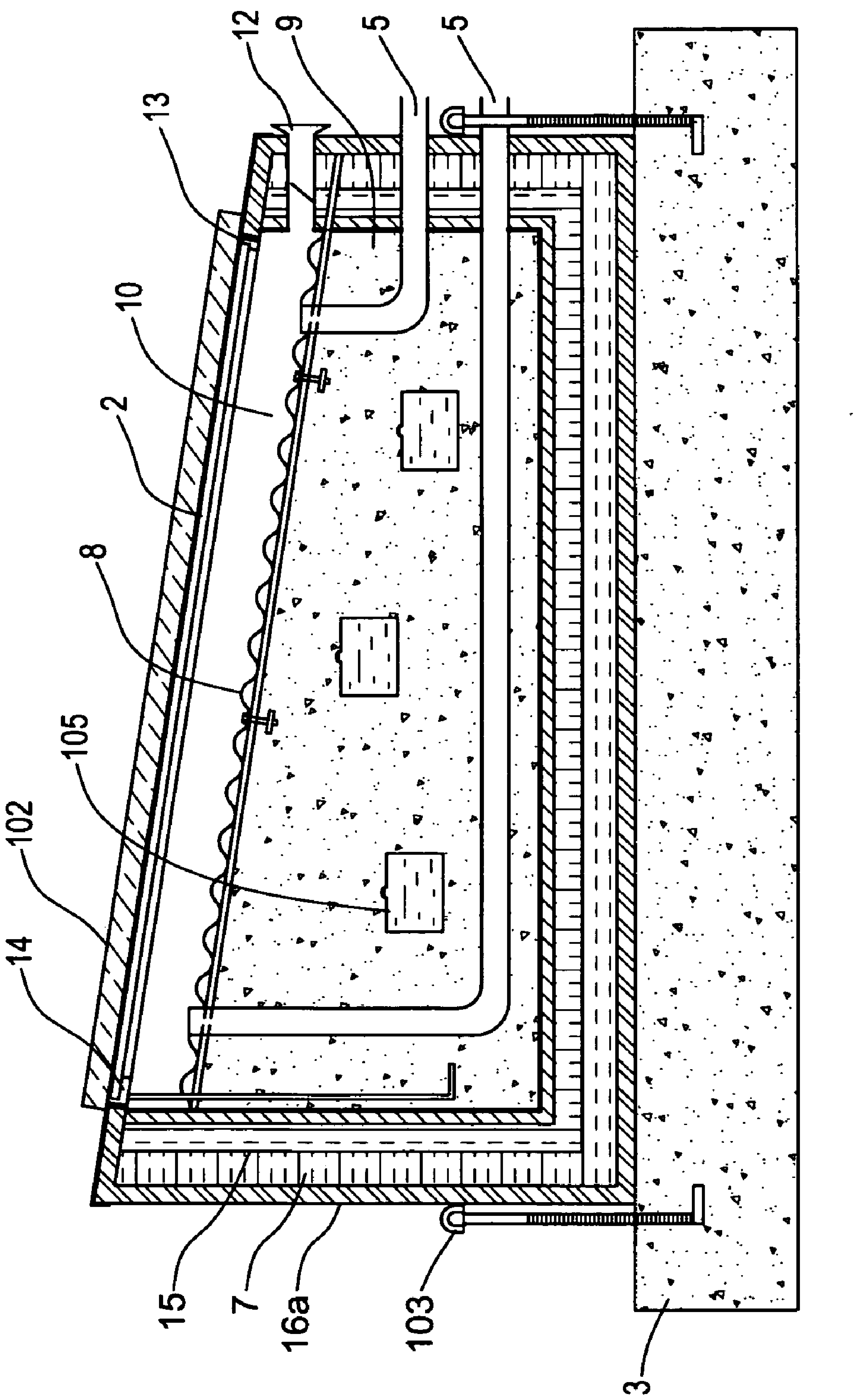


FIG. 21

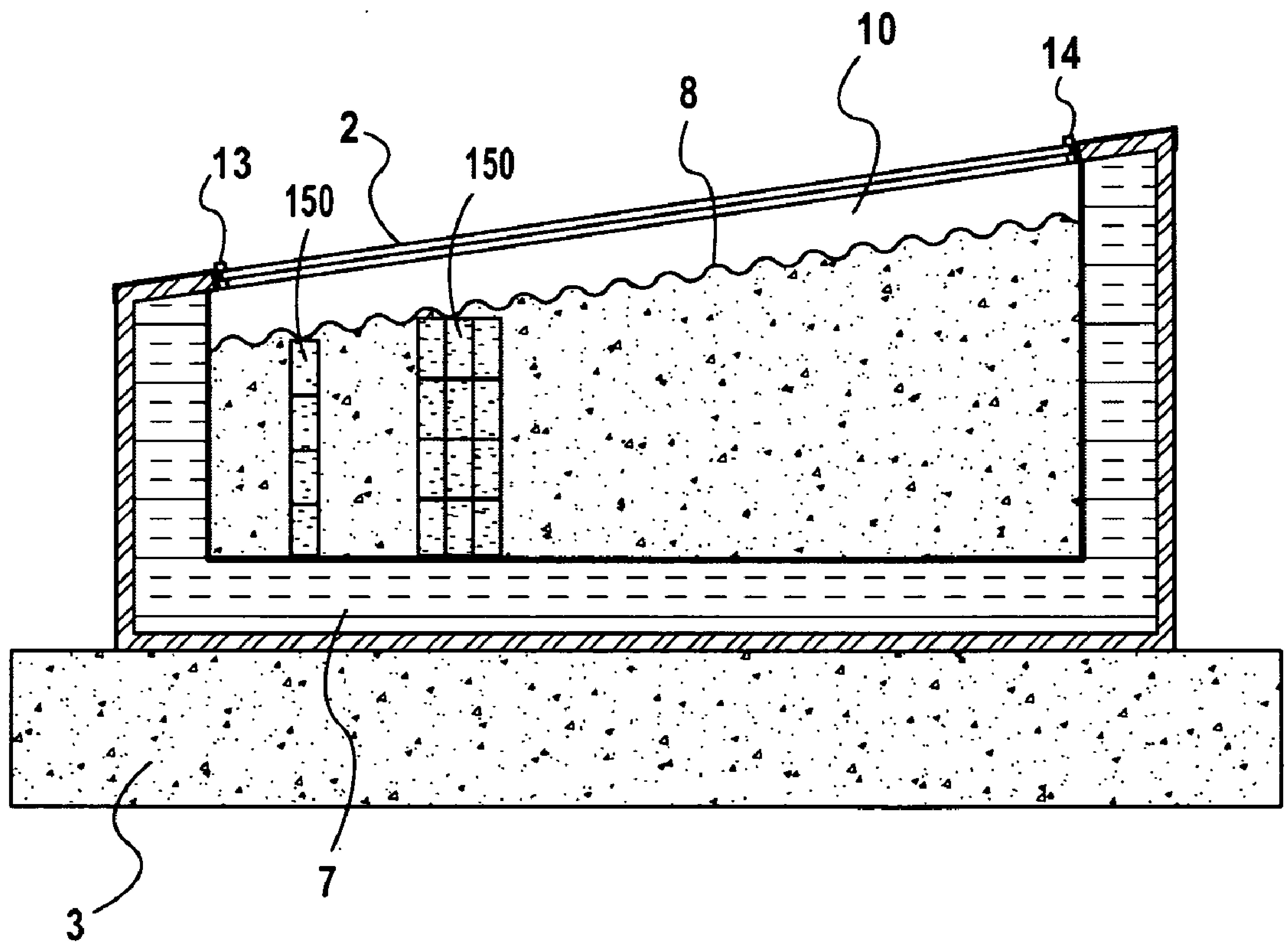


FIG.22

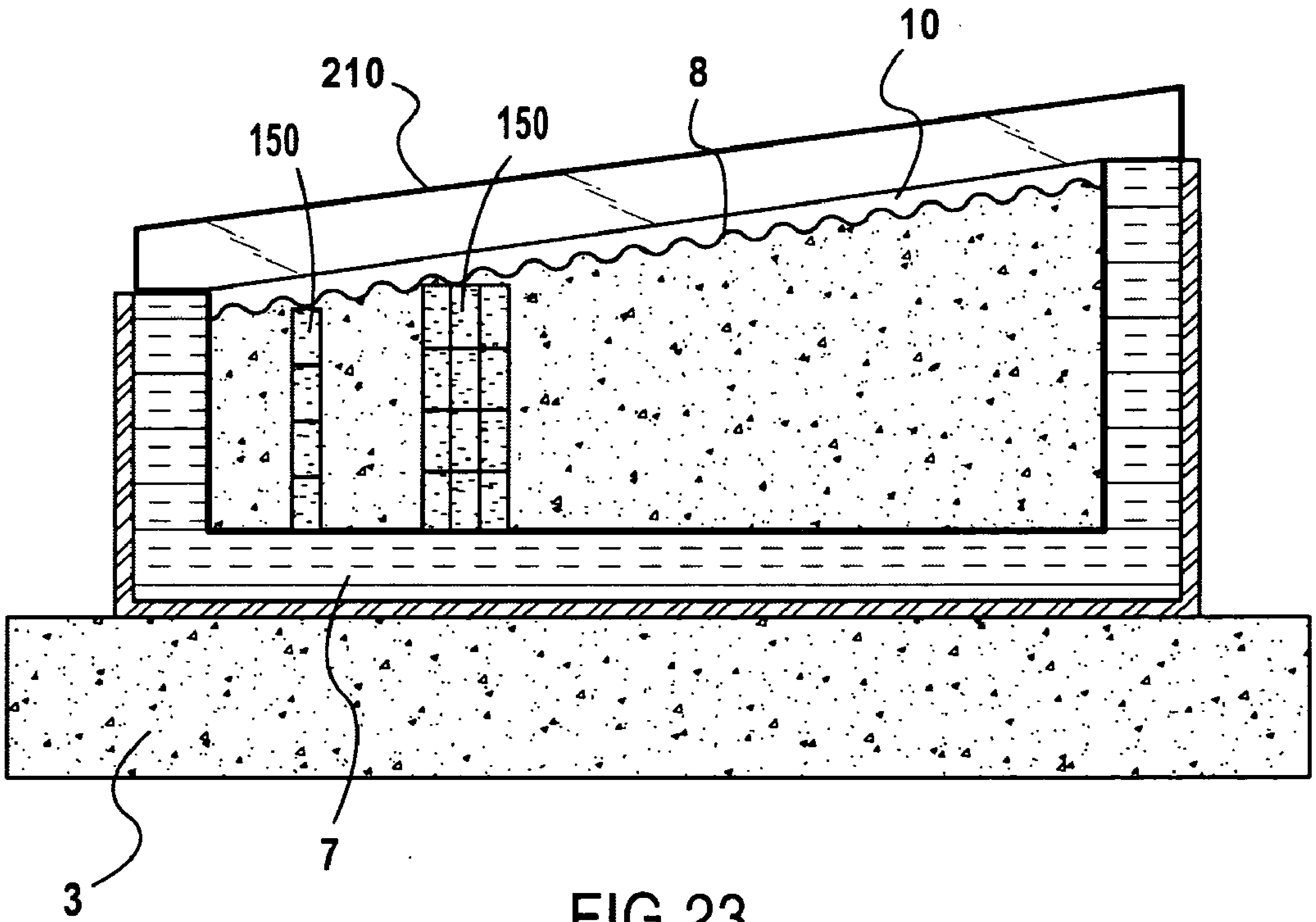


FIG.23

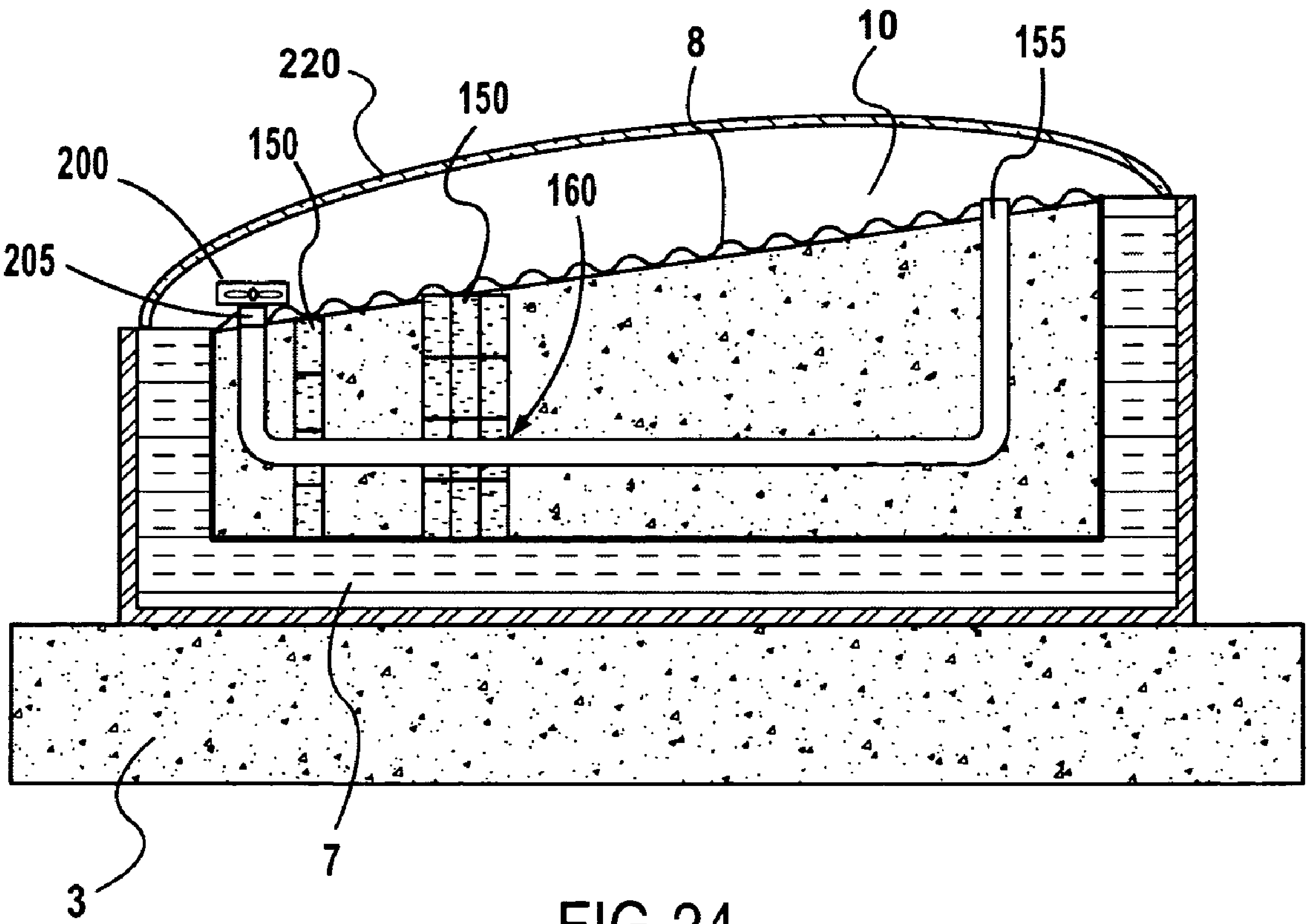


FIG.24

SOLAR THERMAL COLLECTOR CABINET AND SYSTEM FOR HEAT STORAGE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. patent application Ser. No. 12/322,944 filed Feb. 10, 2009, and claims benefit of the filing date of that application under 35 U.S.C. §120.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] The invention was not Federally sponsored.

BRIEF SUMMARY OF THE INVENTION

[0003] This invention relates to apparatus that collects and stores radiant solar energy and to systems that deliver solar energy to conventional environmental systems. Solar energy is collected using solar thermal collector cabinets backed with corrugated black body metallic plates for additional heat transfer absorption. Banks of the solar thermal collector cabinets are combined in parallel arrangements to increase the overall heat collection. The banks of solar collector cabinets can be combined with the heating mode of HVAC systems to supply heating to existing or new buildings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIG. **1** shows the solar thermal collector cabinet according to the instant invention (**1**) from the side, in upright position.

[0005] FIG. **2** shows a solar energy collector cabinet of the instant invention from the back view, in upright position.

[0006] FIG. **3** shows the end view of the solar cabinet of FIG. **1** in horizontal position.

[0007] FIG. **4** shows details of the fluid pipes that transfer solar heat within the solar collector cabinet of FIG. **1**, in combination with a black-body corrugated surface, as viewed from the top.

[0008] FIG. **5** illustrates the transparent window hinge/latch assembly of the solar collector cabinet of FIG. **1**, as viewed from the side, in upright position.

[0009] FIG. **6** shows the rigid walls and rigid and reflective insulation of the solar collection cabinet of FIG. **1**, in viewed from the front. Air pipe (**5**) is shown embedded in the thermal mass (**9**).

[0010] FIG. **7** illustrates a schematic of a thermal battery consisting of five solar thermal collector cabinets connected together, including a computer Input Output Control System (**86**) (IOCS).

[0011] FIG. **8** is a schematic showing banks of thermal solar collector cabinets connected to a fluid storage tank where heat is stored for long term storage, and delivery using a radiant heat loop system.

[0012] FIG. **9** is a schematic showing banks of thermal solar collector cabinets connected to a fluid storage tank where heat is stored for long term storage, and delivery using a heat exchange apparatus.

[0013] FIG. **10** shows the air manifolds and distribution, out going and return.

[0014] FIG. **11** shows a metal heat transfer conduit installed within the fluid pipe, as seen from the sides and top.

[0015] FIG. **12** shows the solar thermal collector cabinet (**1**) in combination with a conventional HVAV heat exchanger and horizontal geothermal heat collector.

[0016] FIG. **13**, shows another embodiment of the solar thermal collector cabinet (**1**) in combination with a conventional HVAV heat exchanger and vertical geothermal heat collector.

[0017] FIG. **14** is a schematic showing banks of thermal solar collector cabinets connected to a fluid storage tank where heat is stored for long term storage, and delivery using a radiant heat loop system, such as in FIG. **8**, further including metallic conductors within the fluid exchange pipes, to assist in conduction of heat to the storage tank.

[0018] FIG. **15** illustrates structural features of the transparent window (**2**) and its attachment to the solar collector cabinet (**1**).

[0019] FIG. **16** shows the solar collector cabinet (**1**) in combination with conventional HVAC systems and radiant heat exchange systems, further including a fluid storage tank or reservoir.

[0020] FIG. **17** illustrates a portable thermal battery comprising four solar thermal collector cabinets with a portable fluid tank, mounted on a trailer, and transported by a truck.

[0021] FIG. **18** shows magnifying glasses secured to the solar collector cabinet and adapted to focus radiant energy onto the thermal mass, including details of the insulation layers.

[0022] FIG. **19** shows a side view of the magnifying glasses, attached to shafts, focused onto the corrugated black body plate, with scrap aluminum secured onto the shafts and embedded into the thermal mass.

[0023] FIG. **20** shows details of the solar thermal collector cabinet, in cross-section.

[0024] FIG. **21** shows an alternative of the solar collector thermal cabinet where fluid reservoirs are embedded in the thermal mass to collect heat.

[0025] FIG. **22** shows the orientation of beverage cans in combination with the fluid pipes.

[0026] FIG. **23** shows a different style of window (**210**).

[0027] FIG. **24** shows an alternative design for the transparent window (**220**). It also includes an alternative design for the air pipe that brings hot air from the oven.

DETAILED DESCRIPTION OF THE INVENTION

[0028] The invention is best described with reference to the drawings. FIG. **1** shows the solar thermal collector cabinet (**1**) of the instant invention in its most basic form, in side view. Air is circulated within the solar thermal collector cabinet (**1**). Solar thermal energy is transmitted to the air through transparent window (**2**). Heat is also absorbed by a thermal mass (**9**). The solar thermal collector cabinet is supported on footer (**3**), and includes a lifting frame (**6**) for moving the solar collector cabinet (**1**). Frame (**6**) is fastened to footer (**3**) securing the solar thermal collector cabinet to the footer (**3**). Radiant solar heat absorbed by the solar thermal collector cabinet is transported by forced convection via fluid pipes (**4**), as well as air pipes (**5**). An outside wall or shell (**16***a*) encloses insulation layer (**7**) and a reflective rigid insulation layer (**15**), which includes an inner shell (**16***b*). Corrugated black body sheet (**8**) is attached to the thermal mass (**9**) with bolts (**11**). Solar oven (**10**) is located between transparent window (**2**) and corrugated black body sheet (**8**), where air is heated by solar radiation. In operation, air enters the solar oven (**10**) through air pipe (**5**). The air pipes are embedded within thermal mass (**9**). When air passes through the thermal mass, the air is heated before the air exits through the insulation. Exhaust vent (**12**) is an exhaust vent to release excess hot air. A damper (**108**), best seen in FIG. **5**, can also be included with the air exhaust. Hinge and anchor assembly (**14**) is located at the bottom of the solar collector cabinet, enabling the transparent window (**2**) to be opened for cleaning or other maintenance. Latch/lock assembly (**13**) is located at the top of the cabinet to hold the transparent window (**2**) in a closed position.

[0029] Black metallic corrugated plate (**8**) contacts thermal mass (**9**). It is understood that the thermal mass (**9**) could be any suitable material with a high thermal conductivity and suitable specific heat. Aggregates with or without a suitable binder for use as thermal mass (**9**) are contemplated. Examples of binders include low temperature wax, natural or synthetic resin, asphalt, concrete, cement, polymers, acrylics, pozzolanic additives such as fly ash, other additives to create optimal formulas, or combinations thereof. Additionally, water/fluid reservoirs may be installed inside the thermal mass (**9**) to serve as additional thermal storage within the thermal mass, as best seen as element (**105**) in FIG. **21**. Containers of a water and anti-freeze fluid mix or oil (**105**) for instance could be located inside the thermal mass, which may serve as a thermal sink inside the thermal mass, in reference to FIG. **21**. Solar energy radiates through the transparent window (**2**), by black-body radiation, to the black metal corrugated plate (**8**). The metal corrugated plate (**8**) could be coated with an asphalt, tar or similar coating on either or both surfaces to better absorb radiant heat from black-body radiation. It is understood that the window (**2**) could be made from single or multiple panes. Multiple panes could include suitable air spaces between the panes for thermal insulation purposes. The window (**2**) could be glass, plastic, or composites. An insulated thermal cover is contemplated, overlying the transparent window (**2**). The purpose of this thermal cover is to prevent back radiation to the ambient during the night or whenever the ambient temperature is cold, and sunlight is minimal. The thermal cover (**102**) may be activated by manual or mechanical means well known in the art. Single or multiple sections are contemplated for the thermal cover. The thermal cover could be rigid or flexible, paneled or louvered. Radiant energy in turn is transported by heat conduction into the thermal mass (**9**), which serves as a heat sink to store heat. Bolts and nuts (**11**) increase the surface area for heat conduction into the thermal mass (**9**). Preferably the bolts and nuts (**11**) are made from a metal that is very high in heat conduction, such as aluminum or copper, or other metals that possess the proper mechanical and thermal properties. It is understood that the bolts and nuts (**11**) can be supplied in as many numbers as is economical, even though only two are shown in FIG. **1**. In this manner, a large area for thermal diffusion is available to conduct heat into the thermal mass (**9**). Insulation (**7**) surrounds the thermal mass (**9**) to minimize heat transfer losses by radiation, conduction and convection to the atmosphere. Exhaust vent (**12**) may release excess air utilizing a thermostat. A damper, as seen as element (**108**) in FIG. **5** controls exhaust venting. Computer control (**86**), as seen in FIG. **16**, is configured to control damper (**108**), in addition to other automatic control functions.

[0030] FIG. **2** shows details of the metal lifting frame (**6**) embedded in the thermal mass (**9**), underlying transparent window (**2**). Insulation layer (**7**) has an inner shell (**16*b***) and an outer shell (**16*a***)

[0031] FIG. **3** shows the same solar thermal collector cabinet of FIG. **2**, as seen in section from the end position. A rigid top rim (**17**) is seen, contacting the top of transparent window (**2**). Insulation layers (**15**), (**16*a***) and (**16*b***) are seen surrounding the thermal mass (**9**). It is understood that the entire solar thermal collector cabinet is portable, and can be moved to any position desired, or may be secured to a permanent structure, whereby it cannot be easily removed without authorization. Preferably the solar thermal collector cabinet is placed on the support footer (**3**).

[0032] FIG. **4** shows of the solar thermal collector cabinet (**1**) as seen from the top, looking below the corrugated black body sheet (**8**). Fluid pipe (**4**) is connected to the corrugated sheet (**8**) with brackets (**20**). The fluid pipe can take any convenient path, such as the serpentine shown here. It is expressly understood that any pattern is contemplated within the scope of the invention. Bracket (**20**) aids in conducting heat to the fluid pipe (**4**). Metallic conductor (**92**) is coaxially located within fluid pipe (**4**) to aid in heat transfer longitudinally along fluid pipe (**4**) in a manner described below. Element (**18**) is a fluid pump, and element (**19**) is a temperature sensor.

[0033] The fluid pipe (**4**) is embedded in the thermal mass in a systematic serpentine configuration that is spaced and positioned in the thermal mass (**9**) to allow for a balanced and uniform exposure of heat to equal areas of the thermal mass (**9**), creating thermal equilibrium throughout the thermal mass (**9**). Where the thermal mass (**9**) is cooler than the temperature of the heat transfer fluid, the thermal mass (**9**) is heated by the heat transfer fluid via forced convection through the fluid pipe (**4**). Conversely, where the thermal mass (**9**) is warmer than the heat transfer fluid, the heat transfer fluid is warmed by forced convection. In this way, the total thermal mass is kept close to the same temperature. In addition the thermal mass (**9**) will receive heat from the black metal corrugated plate (**8**), as it is heated by the solar radiation to the black metallic surface. Metal plate (**8**) also transfers heat by forced convection to the fluid interposed between the transparent window (**2**) and the black metallic corrugated surface (**8**). Note also the outgoing and return fluid pipes (**4**) extending through the rigid and reflective insulation (**15**). Pump (**18**), conveniently solar powered, moves the heat transfer fluid throughout the thermal mass (**9**). It is understood that any conventional pump, using any convenient energy source, is applicable to the invention. Most conveniently, solar energy is advantageous to power the pump. Temperature gauges (**19**) are located at both the inlet and outlet fluid pipes (**4**) to measure the fluid inlet and outlet temperatures. These temperature gauges (**19**) also provide feedback to computer control systems (**86**) seen in detail in FIGS. **7** and **16**.

[0034] FIG. **5** shows the thermal solar collector cabinet of FIG. **1** further including lateral extension and (**23**) and vertical extension (**24**), of metal lifting frame (**6**). Damper (**108**) regulates air exhaust.

[0035] Outside and inside metal cabinet wall (**16*a***) and (**16*b***) may comprise a metal mesh, covered with any suitable materials, including but not limited to fiberglass, cement, epoxy or resin coating. The outside wall or shell (**16*a***) or (**16*b***) may also be constructed using metal as a skin. The walls or shells will be secured with bolts (**97**), tied into the thermal mass and attached to the lifting frame extensions. A rigid and reflective insulation (**15**) is located interior of the outside wall. An air gap could be suitably located between the outside wall (**16*a***) and the insulation (**15**) as well as between insulation (**15**) and inner wall (**16***b*), or between insulation panels, to further insulate the solar thermal collector cabinet, as is conventional in the insulation art. The surfaces of insulation (**15**) are preferably reflective, to reflect heat back into the solar thermal collector cabinet. Insulation layer (**15**) could comprise one or more layers, with reflective coatings and air spaces.

[0036] The thermal mass (**9**) used includes an aggregate, or a mix including bonding agents and reinforcing fiber into the thermal mass (**9**). A preferred embodiment includes aluminum aggregate to maximize thermal diffusion within the solid and minimize weight. Compacted or granulated aluminum cans, or other convenient aluminum scrap shaped and sized to serve as the aggregate for a cement/concrete mix have been found to be ideal stock material for manufacturing aluminum aggregate, both because of their ready availability and cost. The compacted aluminum can be shaped and sized in the desired formulas to replace stone aggregate, offering several advantages over stone aggregate. First, the weight of the concrete mass is greatly reduced. Second, aluminum is a superior heat conductor and will therefore more easily transfer heat to the fluid pipe and ultimately to the fluid storage tank to aid with increasing the fluid temperature of the fluid in the fluid storage tank. The aluminum aggregate also aids greatly in diffusion of heat within the thermal mass (**9**). Although aluminum cans are contemplated because of their relative cost and availability, any metal scrap or stock material that possesses the requisite thermal conductivity is usable within the scope of the invention. In a very efficient embodiment, the aluminum stock can be installed as a heat fin attached to the bolts (**11**) to increase heat transfer from the bolts (**11**) to the thermal mass (**9**).

[0037] FIG. **6**) shows details of the air pipe (**5**), as seen from below the corrugated plate (**8**). Pipe (**5**) winds through thermal mass (**9**) in this view. Fan (**45**) forces the air through the circuit. Temperature sensors are located at (**21**).

[0038] Rigid and reflective insulation (**15**) is located inside the solar thermal collector cabinet. The rigid and reflective insulation (**15**) is positioned directly against the inside of the rigid wall of the cabinet, interposed between the rigid wall and the thermal mass (**9**). Thermal mass (**9**) could be any suitable material with a high thermal conductivity and suitable specific heat. Examples include cement, concrete, low temperature natural or synthetic wax, natural or synthetic resins, asphalt, thermal oils, aluminum scrap with or without bonding agents, granulated aluminum with or without bonding agents, or combinations thereof. In the Figures herein, cement mix can be the thermal mass (**9**) depicted. When cement mix is utilized, the rigid and reflective insulation (**15**) serves as the form and support for the pouring and installing of the wet cement mix, which will become the thermal mass (**9**). In the a highly preferred embodiment the thermal mass (**9**) is granular or compacted scrap aluminum with a bonding agent. Phase change materials are also particularly useful for the thermal mass (**9**), alone or as an addition to other materials. Phase change materials are also suitable for use as a fluid exchange medium, in the fluid pipes. The rigid and reflective insulation (**15**) occupies the floor and walls inside the solar thermal collector cabinet, and includes the wall areas around the solar oven (**10**) (see FIG. **5**). The rigid and reflective insulation (**15**) is omitted on the top side of the cement mass towards the transparent window (**2**). This surface is covered by the black metal corrugated plate (**8**). The arrangement of the rigid and reflective insulation (**15**) and hot air pipes is designed to prevent heat loss from the thermal mass (**9**), fluid pipes (**4**), heat transfer fluid, black metal corrugated plate (**8**) and solar oven (**10**). The insulation configuration may include air chambers, or insulation techniques or insulation products to minimize heat loss from the solar thermal collector cabinet.

[0039] Fluid pipe (**4**) travels along the underside of the black metallic corrugated plate (**8**) in a back and forth loop configuration in order to maximize the number of surface contacts between the fluid pipe (**4**) and the black metal corrugated plate (**8**). The fluid pipe (**4**) is affixed to the black metal corrugated plate (**8**) firmly so as to produce a unitary configuration, and maximize heat conduction, such as by welding. Fasteners or brackets (**20**) between the fluid pipe (**4**) and the corrugated metallic plate (**8**) that maximize heat transfer conductive area are usable. The important consideration is to maximize thermal conduction between the fluid pipe (**4**) and the metallic corrugated plate (**8**).

[0040] FIG. **7** shows the a bank of solar thermal collector cabinets (**25**) connected in parallel utilizing manifolds. Although FIG. **7** shows five solar thermal collector cabinets connected in parallel, it is understood that any number of thermal solar collector cabinets may be connected in either parallel, series, or some combination of parallel or series, as best optimizes the system for the particular individual conditions. IOCS computer control system (**86**) advantageously controls the system to optimize heat transfer parameters. The thermal solar collector cabinets can be installed in vertical, horizontal, or any combinations thereof.

[0041] FIG. **8** shows an insulated fluid storage tank (**27**). Storage tank (**27**) contains a large volume of heat transfer fluid to stabilize short-term fluctuations in the overall operating temperature of the system. Heat is also stored in the storage tank (**27**), which must be well insulated. The amount and type of insulation is determined by the economics of the system and is left to the designer to determine based on current energy costs and insulation costs, and best efficiencies. It is contemplated within the scope of the invention to utilize a heated jacket (**109**), seen in FIG. **16**, around storage tank (**27**), to prevent heat transfer from the storage tank (**27**). When in operation, such a heated jacket is kept at the same temperature as the bulk temperature of the fluid within storage tank (**27**), through an automatic control system. Such systems are well known in the art, as for instance in a Junkers calorimeter, and need not be described further herein. Hot heat transfer fluid from pipes (**4**) is pumped by pump (**32**) through out-going manifold (**34**) and in series through filter (**41**), then insulated fluid pipe (**30**). Fluid pipe (**30**) communicates with fluid storage tank (**27**). Heat transfer fluid from storage tank (**27**) is supplied to a radiant heat loop system (**40**) via manifold (**36**), by pump (**38**). Temperature gauges, and computer controlled valves, and flow gauges are supplied at (**28**). Return heat transfer fluid is distributed through manifold (**37**) by pump (**39**) to fluid storage tank (**27**). Pump (**33**) supplies return fluid, through insulated fluid pipe (**31**) to the return manifold (**35**) and pipes (**4**). It is understood that the pipes (**4**) represent input and output connections to solar thermal collector cabinets or batteries of cabinets. Alternatively, a single solar thermal collector cabinet could be utilized. Ultimately, a steady state can be attained in the building wherein the heat stored in the storage tank (**27**) will be sufficient to maintain the environmental conditions in the building at a constant temperature throughout the year, as well as during short-term fluctuations in the ambient temperatures.

[0042] FIG. 9 shows a combination system that replaces the radiant heat transfer loop with a heat exchanger loop. Otherwise, it is identical to the system of FIG. 8. Conventional water-to-water heat exchangers, and/or conventional water-to-air heat exchangers are shown as (42). Another aspect of this embodiment of the invention is the reduction in energy used by HVAC systems because of the preheated fluids supplied by the solar thermal collection cabinets.

[0043] FIG. 10 details the air manifolds in the air transfer circuit. Outgoing air is distributed through air out-going manifold duct (47), past flow and temperature sensors with computer controlled valves (shown in block as (46)), by fan (45), and through filter (44). The out-going air is distributed at (43) by any conventional means of air distribution. Return air is collected at (48), filtered at (49), and moved to air return manifold/duct (51) by fan (50). As shown the air out-going and return manifolds/ducts are separate, but it must be understood that they are in actuality the same thermal solar collector cabinet or battery of cabinets. A major difference in the air transfer system and the fluid transfer system, is that warm air is not stored or saved, therefore there is no storage tank with the air transfer system. The air transfer system can operate independently of the fluid transfer system, or in combination with each other, with suitable computer control to optimize the economics. Where the air transfer system is combined with the fluid transfer system, of course a fluid storage tank can be included.

[0044] FIG. 11 shows the juxtaposition of two heat pipes (4) surrounded by insulation (58). Metallic conductor (92) is coaxially located within heat pipes (4) to help eliminate hot spots within the pipes (4) via heat conduction. Sleeve (59) maintains pipes (4) in heat transfer contact.

[0045] FIG. 12 shows another embodiment of the invention where a geothermal heat exchange system is included with the solar thermal collector cabinets shown herein. HVAC heat exchanger (42) is supplied with input fluid from switch valve (72) where either heated water from the solar thermal collector cabinet (1) or water heated to the groundwater temperature through geothermal in ground horizontal loop system (63). Return fluid from the HVAC system feeds the geothermal heat exchangers through fluid pipe return (62). Valves (65) and (66) control the in ground system. Switch valve (72), located in the supply fluid pipe (73) is used to divert all or part of the fluid from the geothermal system or systems into the solar thermal collector cabinet (1). Fluid pipe (67) delivers fluid to the solar thermal collector cabinet; and fluid pipe (69) returns fluid from the solar thermal collector cabinet. Fluid further heated in the cabinet (1) is then conjoined with fluid in supply fluid pipe (73) at switch valve (72). In this manner, the HVAC system works with the advantage that the inlet fluid is preheated, thereby reducing the load on the HVAC system. All the control valves (65), (66), and (72) can be independently operated and are intended to be part of an overall computer controlled system. The control valves can be individually partially or completely opened at the most economical overall setting.

[0046] FIG. 13 shows yet another embodiment of the invention where a geothermal heat exchange system is included with the solar thermal collector cabinets shown herein. HVAC heat exchanger (42) is supplied with input fluid from switch valve (72) where either heated water via fluid supply pipe (69) from the solar thermal collector cabinet (1) or water heated to the groundwater temperature through geothermal in ground vertical loop system (64). Return fluid from the HVAC system feeds the geothermal heat exchangers through fluid pipe return (62). Valves (70) and (71) control the in ground system. Switch valve (72), located in the supply fluid pipe (73) is used to divert all or part of the fluid from the geothermal system or systems into the solar thermal collector cabinet (1), through fluid line (67). Fluid further heated in the cabinet (1) passes through fluid line (69) is conjoined with fluid in supply fluid pipe (73) at switch valve (72). In this manner, the HVAC system works with the advantage that the inlet fluid is preheated, thereby reducing the load on the HVAC system. All the control valves (70), (71), and (72) can be independently operated and are intended to be part of an overall computer controlled system. The control valves can be individually partially or completely opened at the most economical overall setting.

[0047] FIG. 14 shows the system as depicted in FIG. 8, including metallic conductor (92) coaxially located in pipes (30) and (31). The purpose of the metallic conductor (92) is to assist the forced conduction of heat through the pipes, to the heat storage reservoir (27), by adding a conductive component to the heat exchange.

[0048] FIG. 15 shows details of the hinge bracket assembly (14) around which transparent window (2) rotates. An anchor shaft is pivotally attached to transparent window (2) with a bracket as shown.

[0049] FIG. 16 shows the combination of solar thermal collector cabinet (1) combined with radiant heat loop system (40), HVAC system (42). Heated fluid from the cabinet (1) is distributed to the fluid storage tank (27), from which fluid can be sent to and returned from the HVAC units (42) through conduits (80). Fluid can also be sent from storage tank (27) to the radiant loop system (40), via conduits (76), and manifolds (77). Either the radiant loop system or the HVAC system, or any combination thereof, can be utilized. It is understood that IOCS (86) controls the overall system to optimize efficiency. Radiant loop system (40) is located on slab (78). The fluid storage tank (27) supplies heated fluid to both the radiant floor and wall heat loop system (40) embedded in concrete slab (78). Radiant loop system (40) delivers heated fluid through fluid pipes (76). Loop manifolds (77) distribute incoming and outgoing fluid from and to the storage tank (27). Incoming and outgoing fluid pipes (80) deliver incoming and outgoing fluid to HVAC units (42), which exchanges heat through a water to water system. Similarly, fluid pipes (80) could deliver heated water to a water-to-air HVAC system (42). In actual use, one or both of the HVAC systems could be incorporated in the combination. Hot air from solar thermal collector cabinet (1) is transported through air pipes (5) to be delivered through hot air distribution port (43) and return air collected through air collection port (48). Intelligent operating computer system (86) controls and optimizes the operation of the combined system. It is understood that flow sensors, temperature sensors, and valves responsible to the computer system (86) can be placed in any part of the fluid circuit where desired.

[0050] FIG. 17 is a portable battery of four solar thermal collector cabinets (1). It is expressly understood that any number of thermal collectors may be combined into a battery. Fluid heated within the solar thermal collector cabinets (1) is collected in the fluid storage tank, and transported to the site where desired. Alternatively, the portable battery could be moved to the site, for instance to replace a defective unit. It is understood that the solar thermal collector cabinets can be made entirely mobile. This is particularly advantageous for temporary installations, or where additional solar thermal collector cabinets are necessary because of unusual weather conditions, or where replacement units are necessary on a temporary basis. Also, it is advantageous to have the solar thermal collector cabinets rotatable to enable the window to face the solar radiation with an optimum angle, to maximize black body solar radiation. With this embodiment, the brackets are specifically designed to enable movement of the solar thermal collector cabinets.

[0051] FIG. **18** introduces yet another aspect of the invention. A plurality of radiant energy concentrating mechanisms, such as magnifying glasses (**52**) are operatively associated with transparent window (**2**). The magnifying glasses (**52**) are adjustable through adjustable mechanical linkages (**53**), such as threaded rods and holding brackets.

[0052] FIG. **19** shows the magnifying glasses (**52**) in their simplest embodiment. Here a threaded rod or bolt (**54**) is rotatably inserted in an opening in thermal mass (**9**). Threaded nuts or brackets (**55**) affix the threaded metal rod (**54**) to the thermal mass (**9**), passing through black metal corrugated metal surface (**8**). By suitable adjustment of the magnifying glasses (**52**), radiant energy can be concentrated in smaller areas, such as directly impinging onto bolts (**11**), thereby increasing the heat transported by conduction through bolts (**11**) to the thermal mass (**9**). Suitable pneumatic or other mechanical control systems can be utilized, whereby individual magnifying glasses (**52**) can be focused on cooler spots on the surface of the corrugated metal plate (**8**). Aluminum scrap (**29**) is seen attached to metal rods (**54**) and embedded into thermal mass (**9**) to enhance heat transfer to the thermal mass (**9**) by increasing the area of heat transfer.

[0053] It is understood that the lenses or sheets of lenses could equally be attached above or below transparent window (**2**). The magnifying lenses or sheets of lenses could be molded within the transparent sheet, or laminated between transparent sheets.

[0054] FIG. **20** shows detail of the solar thermal collector cabinet. From outside to inside, first the outer layer is metal lath (**93**). The metal lath outer layer (**93**) forms a rigid outer wall, using metal or a lath system covered with mortar stucco mix or an epoxy or a fiberglass formula. The coatings may be sprayed on or troweled on so as to bond with the metal lath. The lath is affixed to the outer wall or shell (**16***a*) to create a unitary construction. Suitable insulation (**94**) is the next layer, contiguous to the metal outer layer (**93**). An insulating air chamber (**95**) is interposed between the reflective insulation (**94**) and sheets or panels of rigid insulation (**15**). An inner wall or shell (**16***b*) can also be used, if desired. Spacers (**98**) are installed inside of the reflective insulation to create the air chamber to increase the efficiency of the reflective insulation. Transparent window (**2**) allows thermal radiation to pass through into the cabinet.

[0055] FIG. **21** is a side view of the solar thermal collector cabinet (**1**). Thermal window cover (**102**) is shown covering transparent window (**2**), to prevent back radiation at night, for instance. Brackets (**103**) secure the cabinet to footer (**3**). Fluid reservoirs (**105**) help store heat that is collected in thermal mass (**9**).

[0056] FIG. **22** shows the beverage cans connected in columns (**150**) that touch the black plate and fluid pipes (**4**) and internal air circulating pipe (**160**), best seen in FIG. **24**, to create a conduit from the black plate to the fluid pipes and transfers heat down into the thermal mass. The drawing also shows several columns bound together (**150**) to form a monolithic unit. The beverage cans are full of fluid which becomes heat sinks inside the thermal mass.

[0057] FIG. **23** shows a different style of window (**210**). The transparent window (**2**) as seen in FIG. **1** is a one piece and flat unit which sets on the walls of the solar oven area (**10**). With the flat window (**2**) of FIG. **1**, the walls of the solar oven produce shaded areas where solar radiation is shielded from the black corrugated surface. The transparent window (**210**) has clear sides to enable thermal radiation to penetrate the window regardless of the time of day. When the transparent window (**210**) is set in this manner, the walls of the solar oven do not produce shade in the oven area during periods of low sun (early morning and late afternoon). The prismatic shaped window has vertical transparent sides allows sun to enter additional hours of each day.

[0058] FIG. **24** shows a different style of window (**220**). This window can be described as a dome, round dome or a ellipse shaped transparent window. It may also be a round dome shaped window. As described above, this window has transparent sides to enable the window to absorb sunlight during more hours per day. Thermal window cover (**102**) will be designed to fit and compliment the windows (**210**) and (**220**).

[0059] FIG. **24** also shows an air pipe that brings hotter air from the oven, circulates through the thermal mass and returns back into the oven at the other end of the solar oven (**160**). Also shown is a fan (**200**) and a thermostat (**205**) to assist the hot air circulation. In this embodiment, no solid insulated wall surrounds the solar oven. Removal of the solid insulating wall allows the transparent window to seat at the black plate (**8**) location.

1. A cabinet for collecting solar radiant energy, storing the solar energy as thermal energy, and further for distributing the thermal energy to at least one heat transfer fluid, comprising a cabinet including front and back opposing wall members, and two pairs of opposing side wall members, each pair of side wall members comprising a pair of vertical substantially parallel side wall members, the front wall member being transparent to solar thermal radiation, and where the front wall member includes transparent sides, the wall members being connected along their perimeters in a fluid impervious fashion forming a sealed box, a thermal mass embedded within the space defined by the wall members, the thermal mass covered by a corrugated black surface interposed between the transparent front wall member and the thermal mass, whereby the black corrugated surface is exposed to solar radiation that passes through the transparent front wall member, wherein the thermal mass and corrugated black surface are recessed behind the front transparent wall member, creating an empty space between the transparent front wall member and the corrugated black surface, the solar cabinet further including ports to enable fluid to enter and exit the empty space between the transparent front wall member and the corrugated black surface, for the purpose of heating the fluid by solar thermal radiation and heat transfer from the corrugated black surface and thermal mass, and where the thermal mass further includes channels for fluid transportation within the thermal mass, for the purpose of transferring heat from the thermal mass to a circulating fluid, the solar cabinet including fluid ports in fluid communication with the channels within the thermal mass.

2. The solar cabinet of claim **1** wherein the corrugated black surface is bolted to the underlying thermal mass with black metallic bolts, the black metallic bolts having a large surface area for heat conduction to the thermal mass and a large surface area for radiant solar heat exchange.

3. The solar cabinet of claim **1** wherein the thermal mass is a concrete mix with aluminum pieces uniformly distributed within the concrete mix, wherein the concrete mix is both lighter and more heat conductive than the concrete mix without the aluminum pieces.

4. The solar cabinet of claim **4** wherein the concrete mix is Portland cement.

5. The solar cabinet of claim **1** further including handle means enabling the solar cabinet to be lifted for transportation to an alternate location and rotated to maximize the exposure of the transparent window member to solar radiation.

6. The solar cabinet of claim **1** further including hinge means to open the transparent front wall member for cleaning and inspection of the solar thermal cabinet and its components.

7. The solar cabinet of claim **1** further including insulation between the back wall member, side wall members, and the thermal mass for the purpose of minimizing thermal loss through the wall members.

8. The solar collector cabinet of claim **7** wherein the insulation comprises several layers.

9. The solar collector cabinet of claim **7** wherein one insulation layer is a hollow layer defining a gas or evacuated space.

10. The solar cabinet of claim **5** wherein the handle means comprises metallic rods embedded through the vertical walls and through the thermal mass.

11. The solar cabinet of claim **1** wherein the fluid channels within the thermal mass are serpentine.

12. The solar cabinet of claim **3** wherein the aluminum pieces are crushed and compacted recycled aluminum cans.

13. The solar cabinet of claim **1** wherein aluminum cans filled with fluid transfer fluid extend through thermal mass to the corrugated black surface.

14. The solar cabinet of claim **13** wherein the aluminum cans are stacked vertically.

15. The solar cabinet of claim **14** where a plurality of aluminum can stacks are contiguously aligned, whereby the stacks are in heat transfer orientation between the stacks.

16. The solar cabinet of claim **1** wherein fluid circulated through the hollow space between the corrugated black surface and the transparent front wall member is in fluid communication with a thermal storage reservoir, whereby radiant energy is transferred and stored by the thermal storage reservoir.

17. The solar cabinet of claim **1** wherein the transparent window is domed shaped.

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