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(54) GEOTHERMAL COOLING DEVICE

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(57) **ABSTRACT**

A geothermal cooling device is couplable to a ground coil formed from a thermal superconductor material. The device includes a thermal superconductor heat exchange coil, and a thermostat controller and a blower. The device uses a high thermal transfer superconductor to efficiently move heat to the earth source for the purpose of cooling. The device operates by controlling the blower operation in response to the difference between a set point and a measured temperature. Optionally cooling device is enclosed in a housing mounted in standard structural spaces. Alternative simplified versions, without a thermostat, operate manually with a switch or power connection.

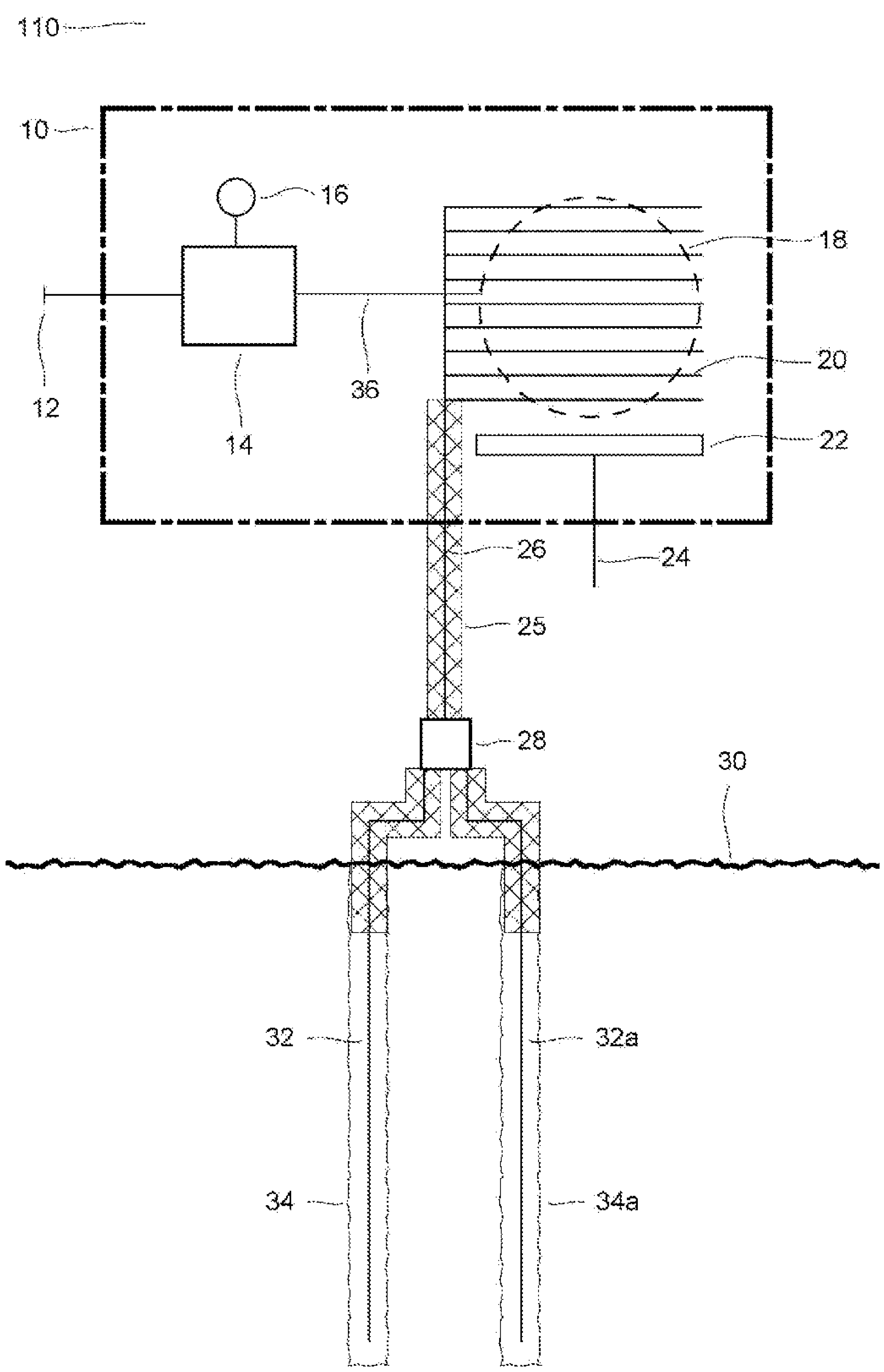


Figure 1A

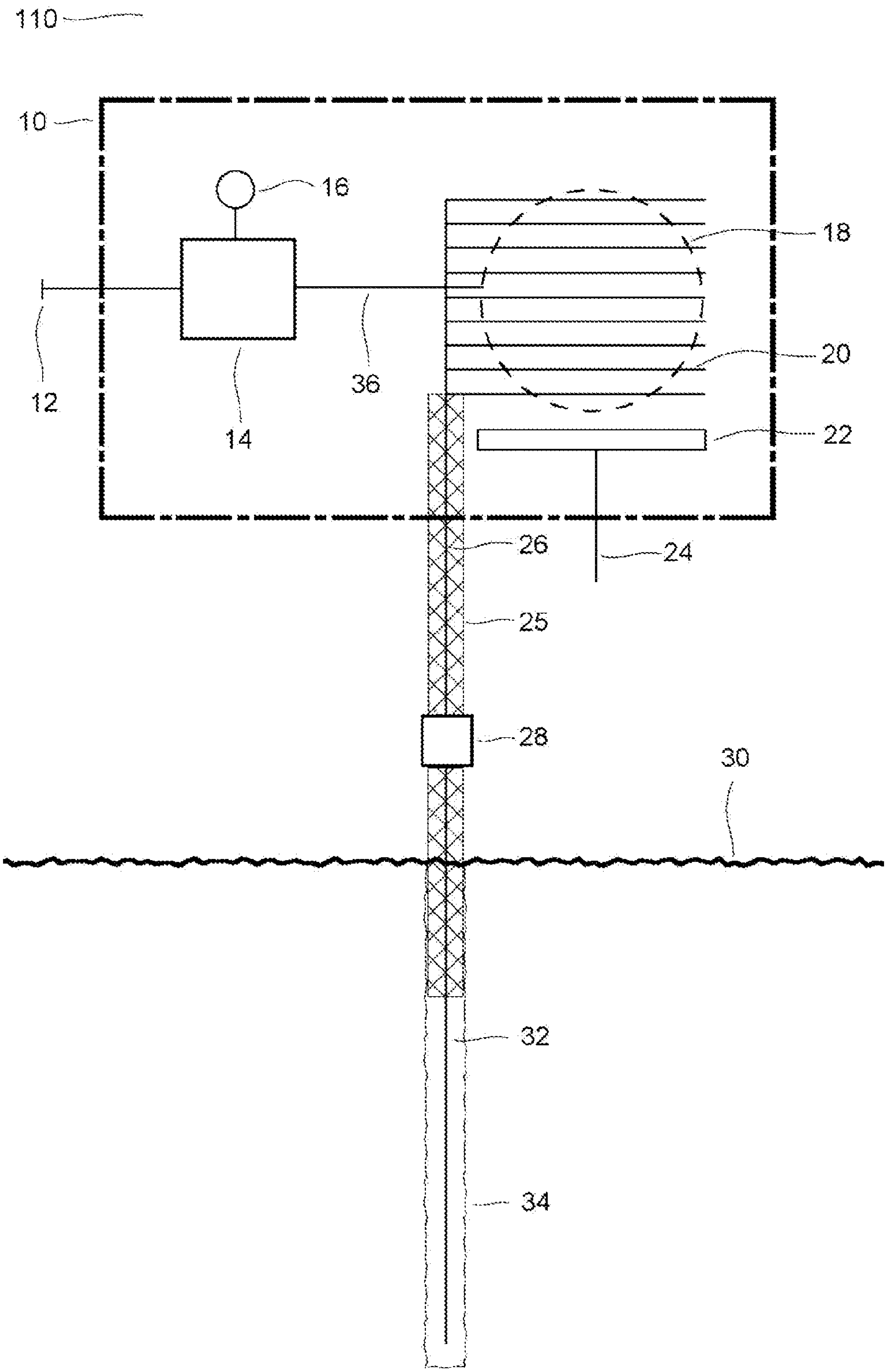


Figure 1B

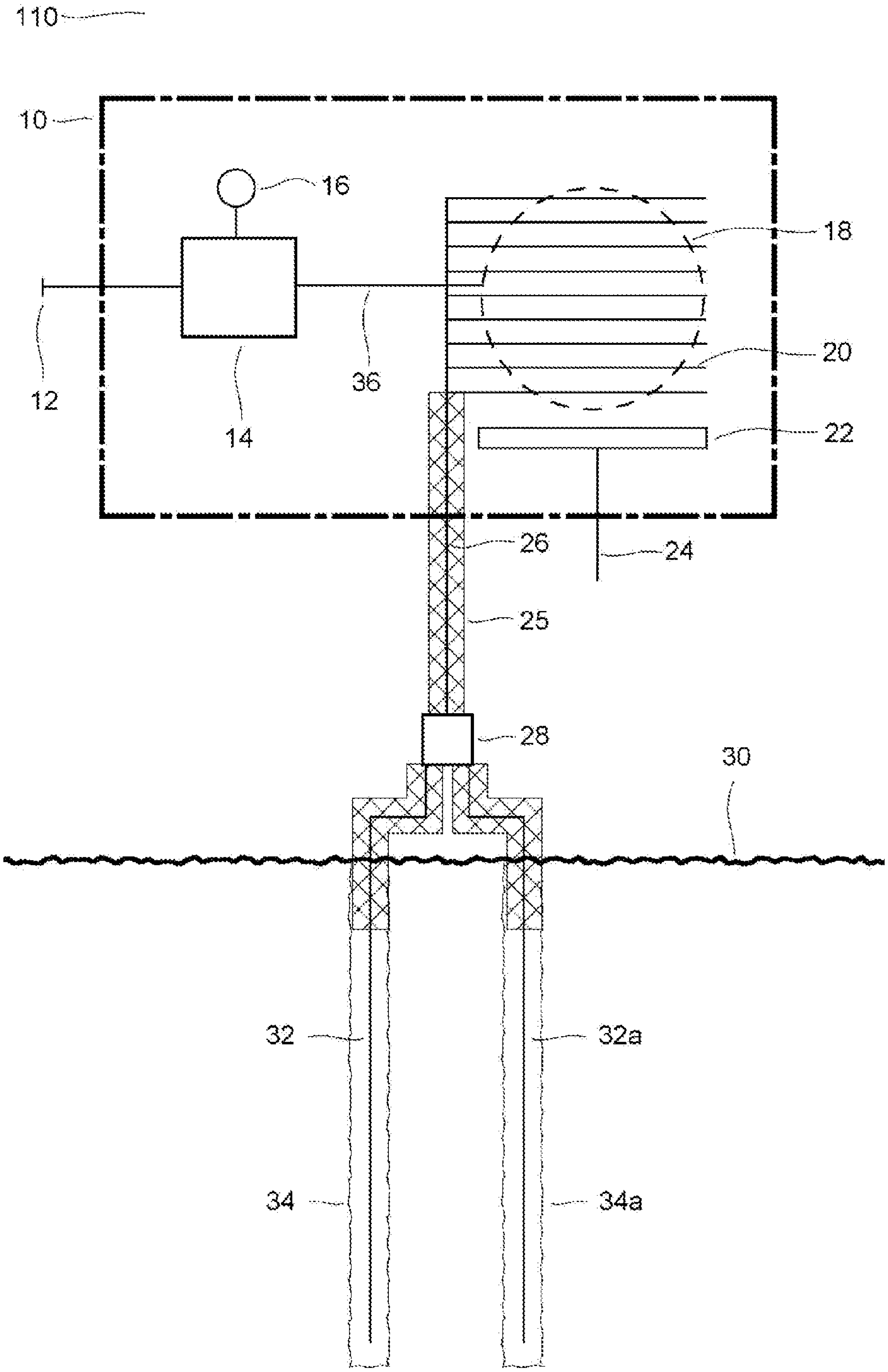
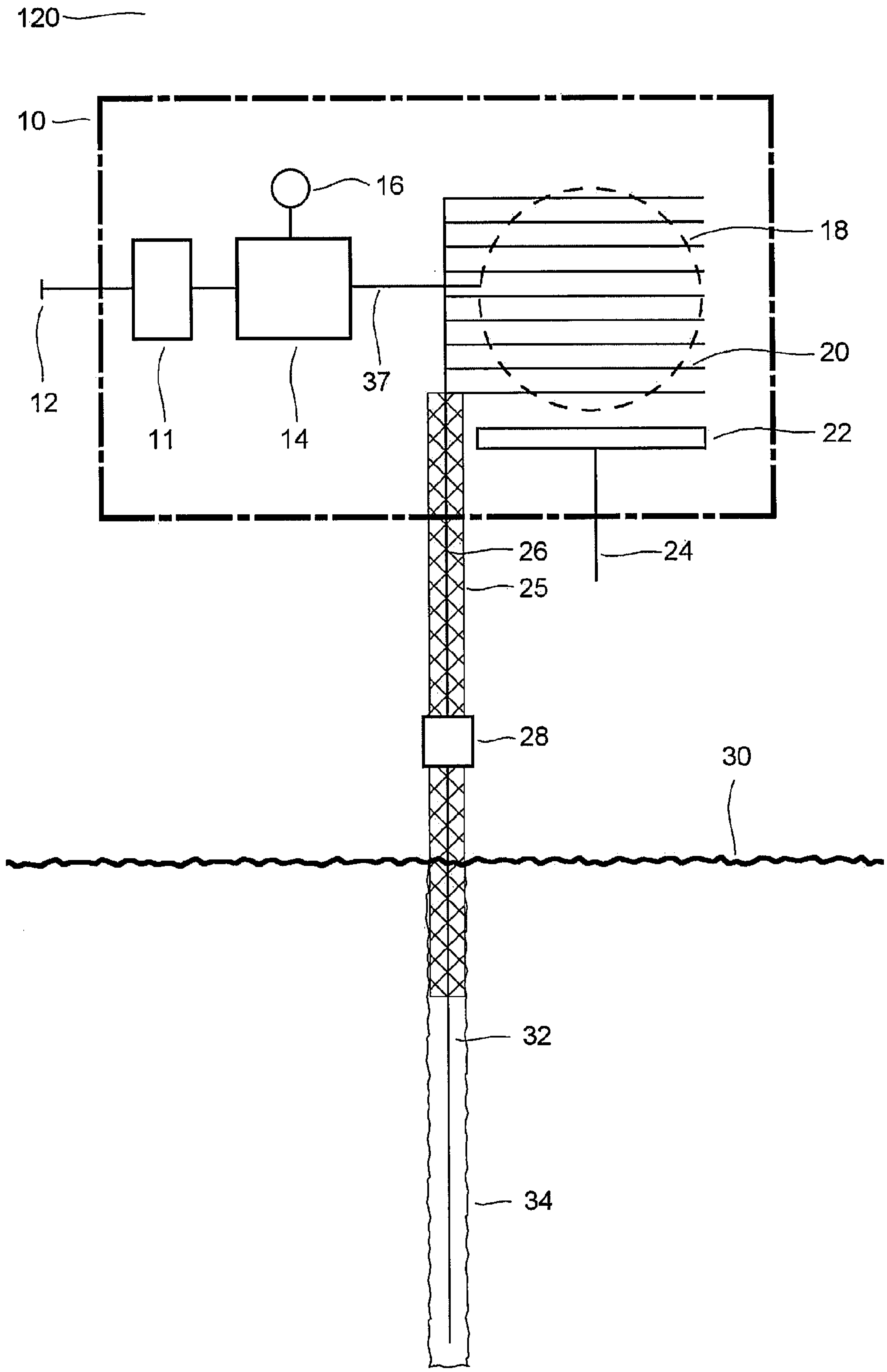


Figure 2



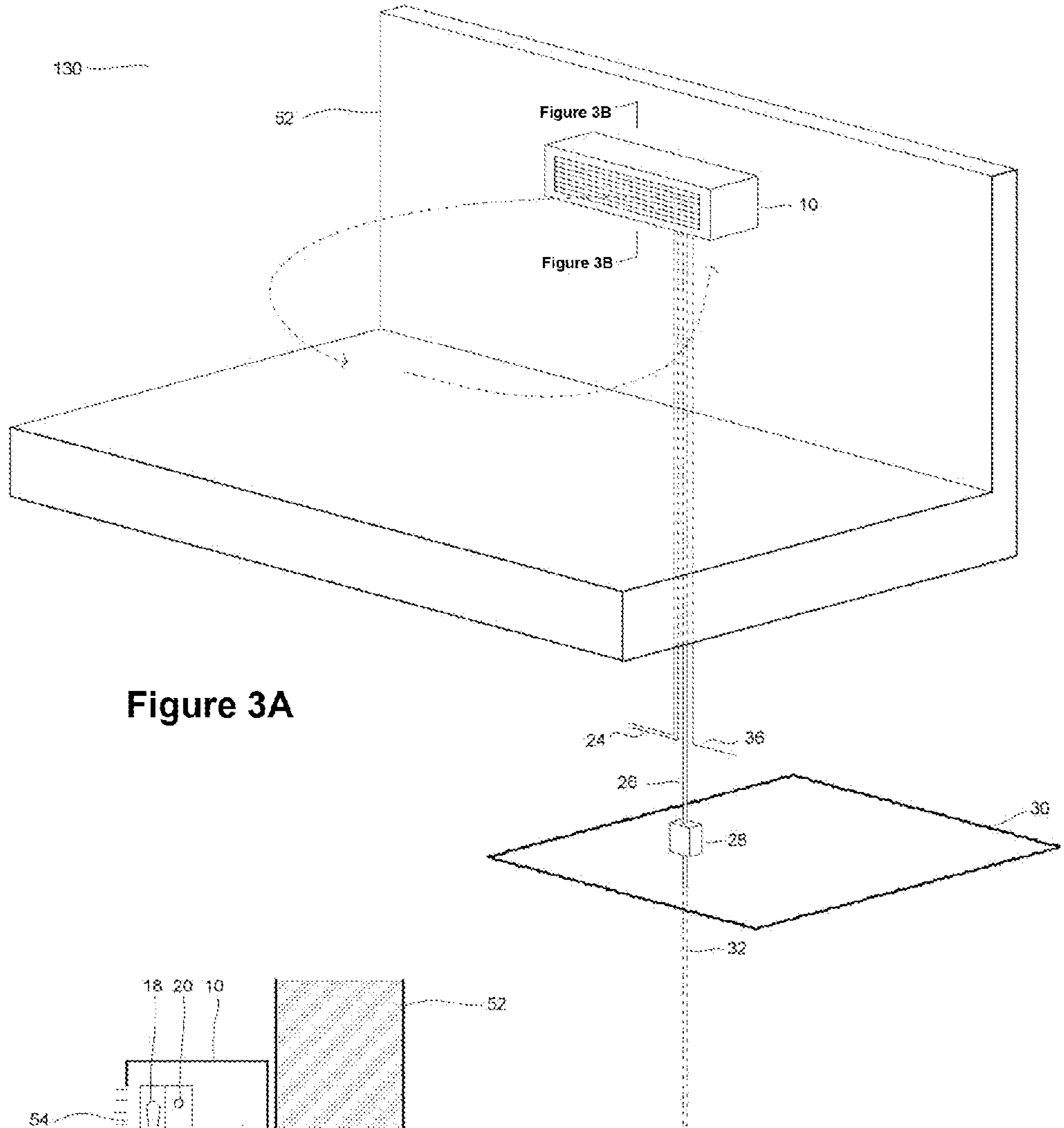


Figure 3A

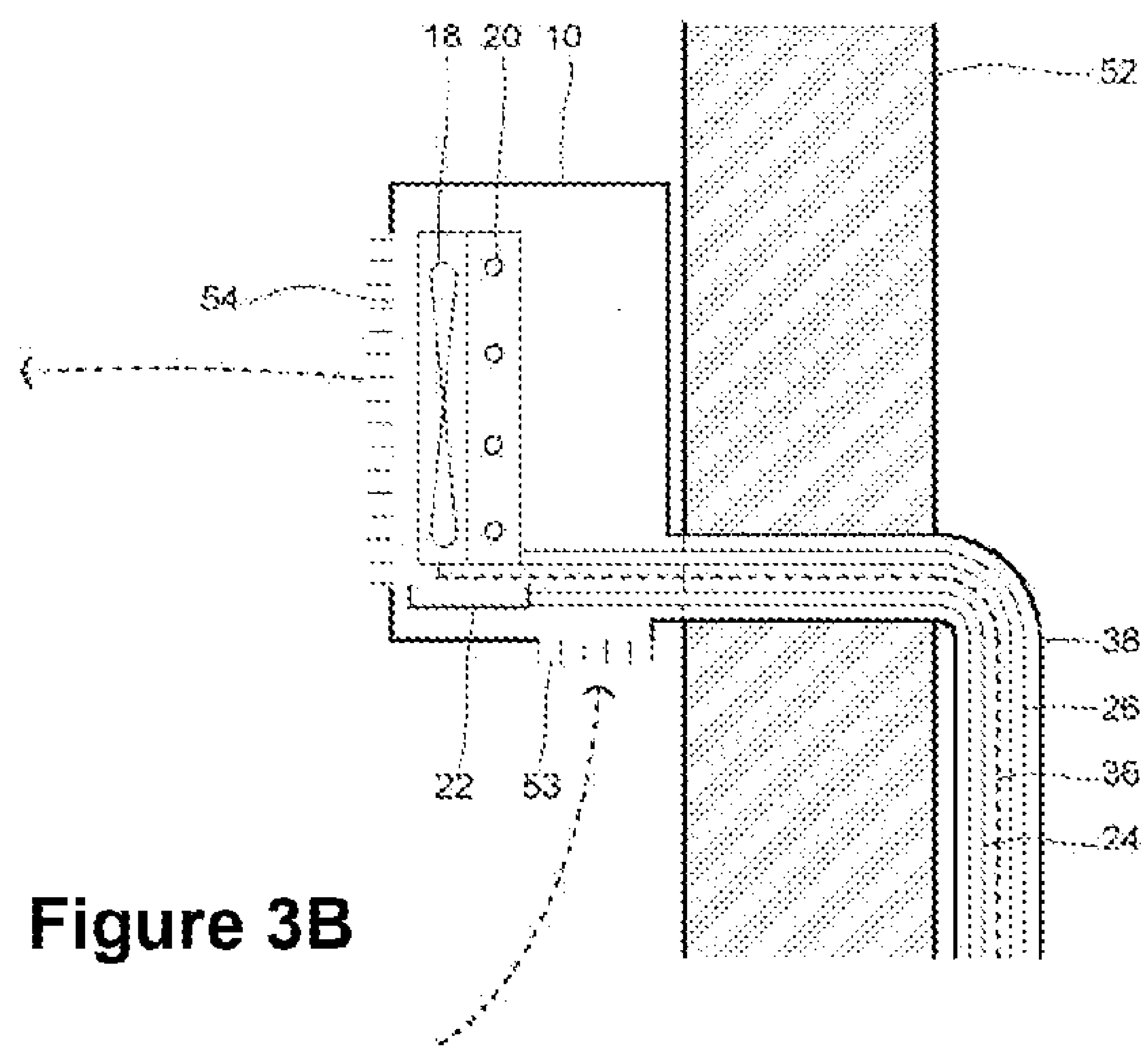


Figure 3B

Figure 4

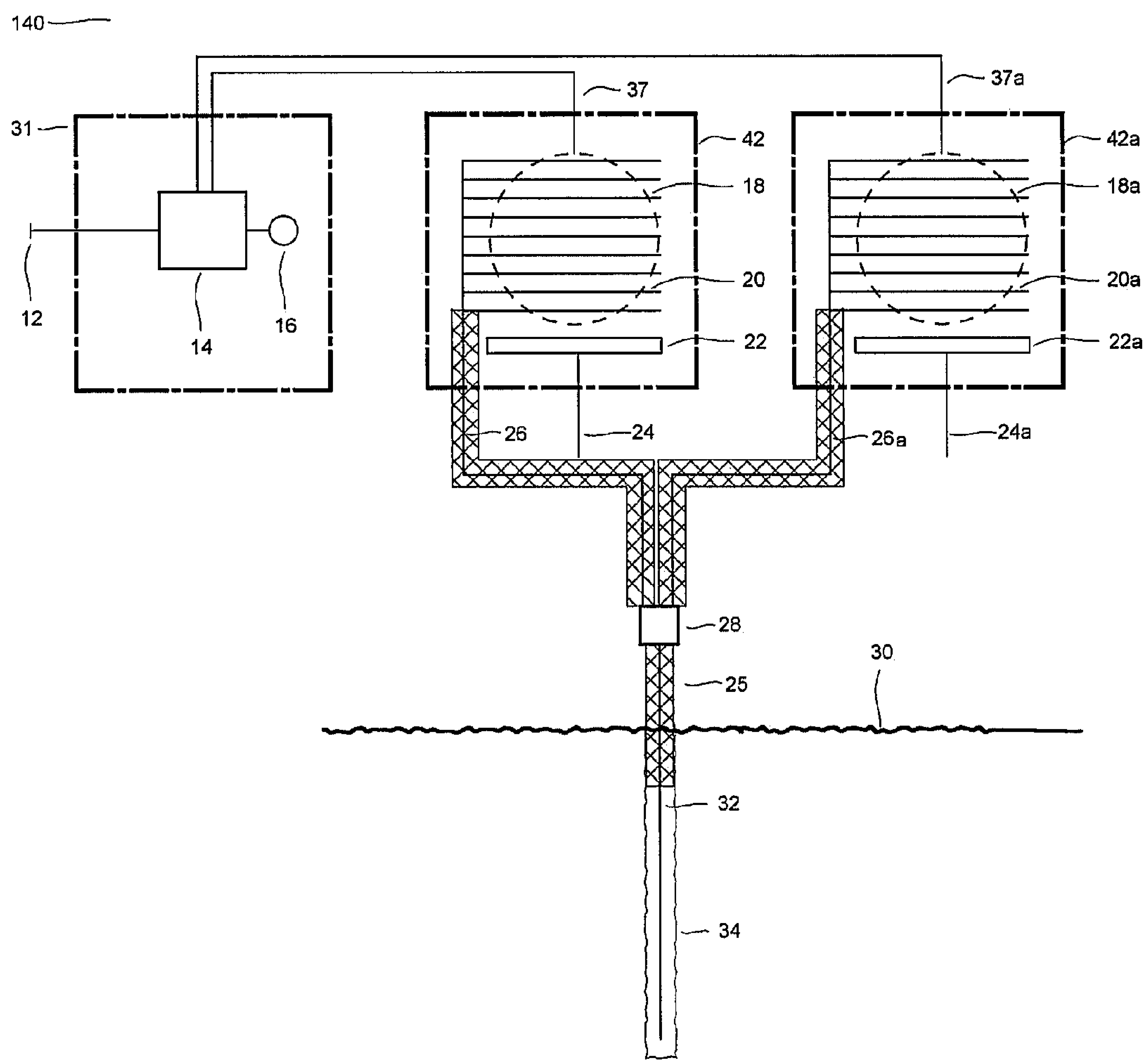

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Figure 5

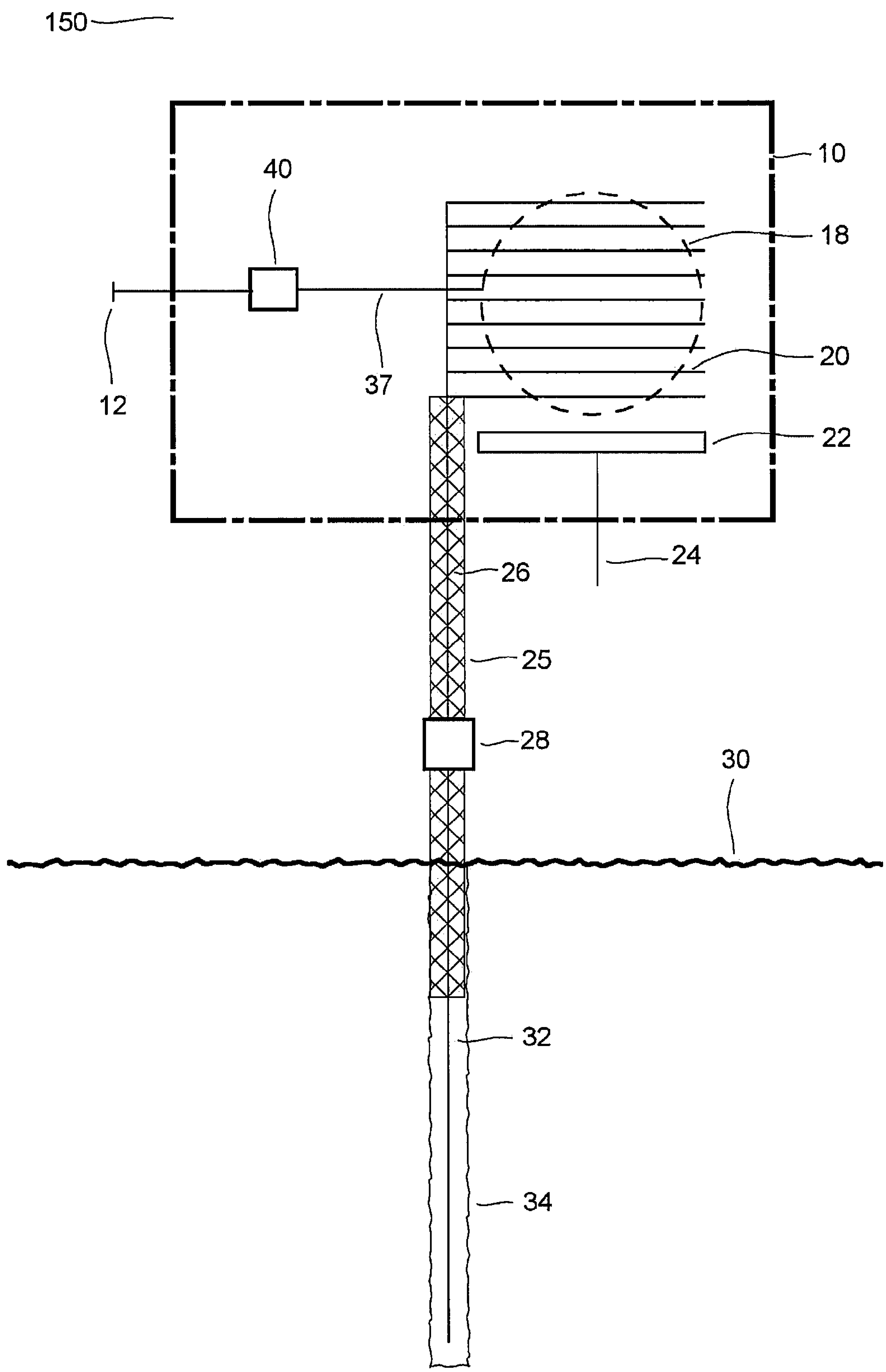
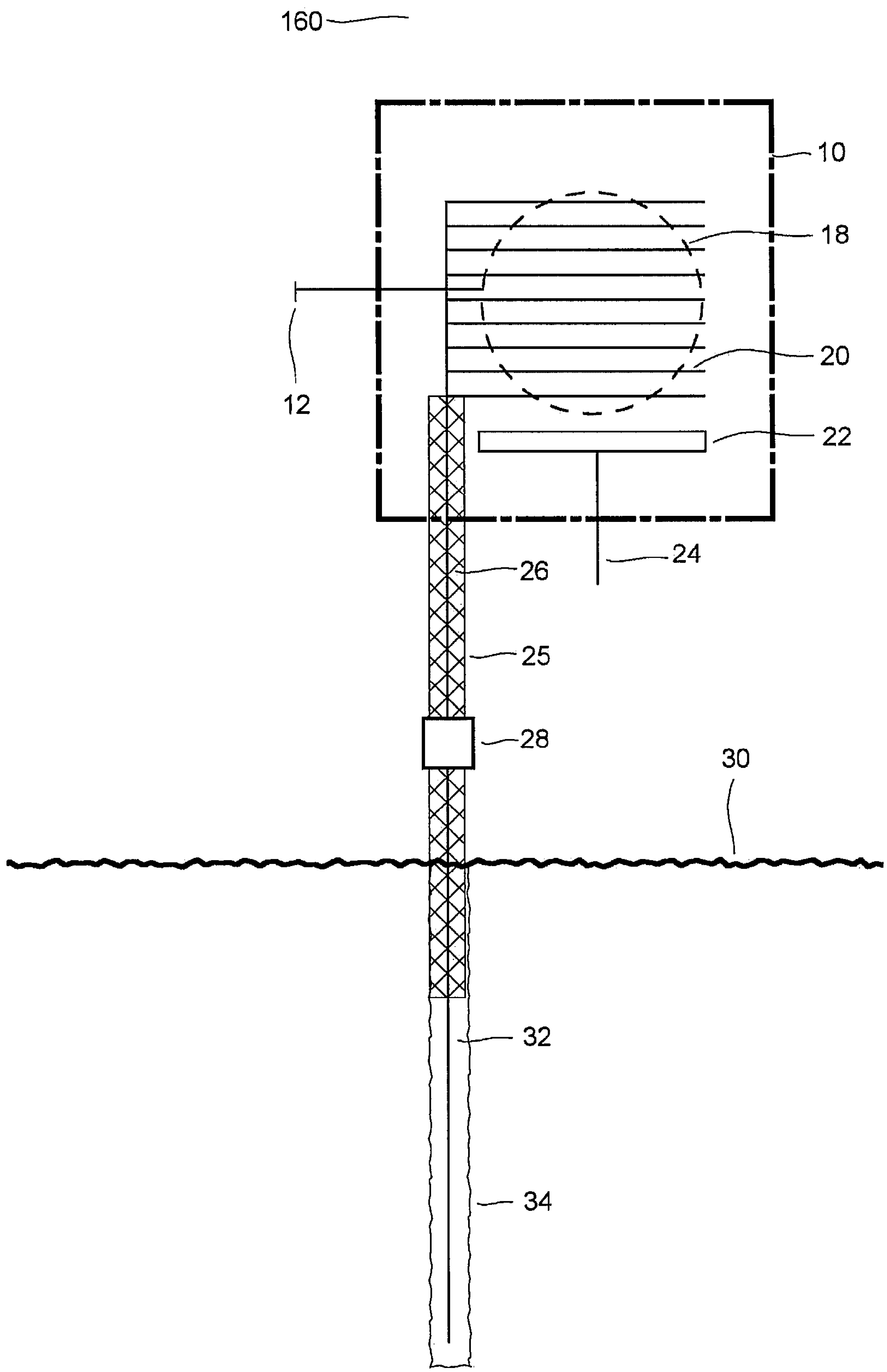


Figure 6



GEOTHERMAL COOLING DEVICE

FIELD OF THE INVENTION

[0001] The present invention relates generally to geothermal cooling systems, and more particularly to a geothermal cooling device coupled with a superconducting heat transfer element for use as an air conditioner.

BACKGROUND OF THE INVENTION

[0002] Ground source heat pump systems, also known as geothermal or geoexchange systems, have been used for cooling and heating homes for more than half a century. In 1993, the Environmental Protection Agency evaluated all commercially available technologies and concluded that ground source heat pumps were the most energy efficient systems available to the consumer.

[0003] Conventional ground source heat pump systems operate on a simple principle. In the cooling mode, heat from the building is collected at a heat exchanger and transferred to the heat pump, which concentrates the heat and transfers it to a ground source loop, which transfers the heat to the ground. In the heating mode, heat energy is absorbed from the ground and transferred to a heat pump which concentrates the heat and transfers it to the building's heat distribution system which in turn heats the building. In both modes, only a small amount of the heat energy comes from the electricity that runs the compressor; most of the energy comes from the air (in the cooling mode) and the ground (in the heating mode). This allows ground source heat pump systems to achieve more than 100% efficiency: every unit of energy consumed by the heat pump produces more than a unit of useful energy in the form of heat.

[0004] Even though ground source heat pump systems achieve efficiencies of up to 350% compared to less than 100% for most conventional systems, they have achieved a very low level of adoption in the commercial marketplace because their capital costs and installation costs have been much higher than conventional systems.

[0005] These high capital and installation costs have largely been due to fundamental inefficiencies in the ground loop subsystem. In a typical installation, the ground loop consists of hundreds or thousands of feet of looped plastic piping buried in deep trenches or deep holes drilled into the ground. An antifreeze solution such as glycol is pumped through this loop to transfer heat energy to the ground (in the cooling mode) or to absorb heat energy from the ground (in the heating mode). Few installations have sufficient available land for trenching so loops are most commonly installed in deep holes and this makes them relatively expensive for several reasons.

[0006] First, each loop consists of a supply and return line, which should fit down the same hole. With an outer diameter of an inch or more for each pipe and a tendency for these pipes to bow away from each other due to the plastic material's memory of being coiled for shipment, the hole should typically have a diameter of 4 to 6 inches to allow the loop to be installed. Holes of this size are relatively expensive to drill and require heavy equipment that disrupts landscaping, making it expensive to retrofit existing homes. Holes of this size also leave large voids around the loop that should be filled with materials such as bentonite clay in order for heat to transfer from the ground to the loop, which adds significantly to the cost of installation.

[0007] Second, having both supply and return lines in the same hole results in thermal "short circuiting" which reduces the efficiency of the loop. In the cooling mode, for example, heat absorbed by the building's cooling system is transferred to the fluid in the ground loop system and pumped down a supply line into a bore hole. As it goes down the hole it loses heat to the cool ground, causing the ground to warm up—more at the top of the hole because the fluid in the pipe is hottest as it enters the top of the hole. As the fluid goes down the tube it cools. When the cooled fluid comes back up the hole in the return line, it passes through the ground that was just heated, so the fluid in the pipe reabsorbs some of the heat it lost on the way down. This lowers the efficiency of the loop so the loop should be made longer to compensate, adding to the cost of drilling and piping.

[0008] Third, for the ground loop to function, the antifreeze solution should be pumped through hundreds or thousands of feet of small diameter piping. This consumes a significant amount of electric energy, lowering the overall efficiency of the system.

[0009] In recent years, a new ground source heat pump technology has evolved to overcome some of the inefficiencies of conventional systems. This technology, called "direct geoexchange," replaces the conventional plastic ground loop with a small-diameter copper loop. Instead of an antifreeze solution, direct geoexchange systems pump a refrigerant through the loop to pick up heat from the ground or give off heat to the ground in the same way that conventional ground loops function.

[0010] Direct geoexchange has some significant advantages over conventional systems. First, the direct geoexchange loop runs directly to and from the heat pump's compressor, eliminating the heat exchanger that required by conventional systems to transfer heat from the loop to the heat pump. Second, the small diameter of the direct exchange loop makes it possible for loops to be installed in smaller diameter holes in the ground; this reduces the cost of drilling and backfilling the holes and reduces the size of the drill rig required to drill the holes, decreasing damage to landscaping in retrofit applications. Third, the copper pipes used in direct geoexchange transfer heat more efficiently to and from the ground so the total length of loop required is typically less than conventional systems. Because of these improvements, direct geoexchange systems can be cheaper to install than conventional ground source systems and more energy efficient.

[0011] In spite of these inherent advantages, direct geoexchange also has some significant disadvantages. First, both supply and return pipes run in the same hole, so the thermal short circuit problems of conventional systems remain. Second, the loop system pumps much more refrigerant through many more feet of piping past many more connections than conventional systems, so the potential for refrigerant leaks is increased.

[0012] Both direct geoexchange and conventional ground source heat pump systems have additional limitations that affect their usefulness. First, they are designed to heat and cool whole buildings, so neither can efficiently be installed on the incremental room-by-room basis on which most of the world—particularly the developing world—installs air conditioning. Second, they require significant amounts of electrical energy to operate pumps and compressors; this power is not often available or reliable in many parts of the world.

[0013] Most of the world either does without air conditioning (where money and electricity are in short supply), or uses refrigerant-based room air conditioners to cool individual rooms. Like geothermal systems (in the cooling mode), room air conditioners use a refrigeration circuit to absorb heat from room air and intensify it so it can be dissipated outside the building. Unlike geothermal systems, room air conditioners dissipate this heat into the outside air instead of the ground. Because air conditioning is usually used when the outside air is hot—often more than 40 degrees Fahrenheit hotter than the ground in a geothermal installation—the process of dissipating heat to the air requires air conditioners to work much harder and use much more energy than geothermal heat pumps to produce the same amount of cooling.

[0014] In spite of their high electrical power consumption, room air conditioners have dominated world markets because they are inexpensive to buy and simple to install. Rising demand for energy, however, is changing these markets. Rising demand is causing the cost of electricity to rise, making inefficient systems such as room air conditioners much less attractive to consumers. Rising demand is also causing shortages of power. Metropolitan areas such as Shanghai are finding that room air conditioners are consuming as much as two thirds of the capacity of the entire electrical grid on hot summer days, destabilizing the grid and leaving too little power for the manufacturing sector to operate during the day.

[0015] There is a need, therefore, for a cooling device that consumes significantly less power than conventional air conditioners and is cheaper to buy, easier to install and has fewer moving parts than ground source heat pump systems.

SUMMARY OF THE INVENTION

[0016] Cooling devices are provided that use a thermal superconducting transfer medium to absorb heat from a room and transfer that heat to the ground where it can be dissipated. The thermal superconducting transfer medium in these devices allows heat to move between building and ground without the assistance of a compressor or refrigeration circuit, and without the assistance of a ground loop and associated pumps, valves and circulating fluids. This reduces the power required to operate these cooling systems, and also eliminates or reduces refrigerant leaks and reduces cost and system complexity.

[0017] In one embodiment, a cooling device is suitable for coupling to a thermal superconductor geothermal ground coil extending below a ground level allowing passive thermal conduction to an earth source. The cooling device includes a thermal superconductor having a first end couplable to said thermal superconductor geothermal ground coil and a second opposing end configured as a thermal superconductor exchange segment, and a blower positioned in the region of said thermal superconducting exchange segment, and a thermostat controller associated with an indoor space and programmable to a desired temperature set point and for measuring temperature of said indoor space and further having a blower controller connected to said blower. The blower controller operates the blower in response to the difference between the set point and the measured temperature, for the purpose of operating in a cooling mode to efficiently cool an indoor space.

[0018] In another embodiment, a cooling device is operable without a thermostat and suitable for coupling to a thermal superconductor geothermal ground coil extending below a ground level allowing passive thermal conduction to an earth source. The cooling device includes a thermal superconductor having a first end couplable to said thermal superconductor geothermal ground coil and a second opposing end configured as a thermal superconductor exchange segment, and a blower positioned in the region of said thermal superconducting exchange segment, and a power connection for providing operating power to said blower when connected, and a switch connected to the power connection and the blower for controlling the blower. The blower may be manually controlled for the purpose of operating in a cooling mode to efficiently cool an indoor space.

[0019] In another embodiment, a simple cooling device not requiring a thermostat or switch is suitable for coupling to a thermal superconductor geothermal ground coil extending below a ground level allowing passive thermal conduction to an earth source and for connecting to a power source. The cooling device includes a thermal superconductor having a first end couplable to said thermal superconductor geothermal ground coil and a second opposing end configured as a thermal superconductor exchange segment, and a blower positioned in the region of said thermal superconducting exchange segment, and a power connection for providing operating power to said blower when connected. The blower may be powered by connecting the external power connector to the power source, for the purpose of operating in a cooling mode to efficiently cool an indoor space.

BRIEF DESCRIPTION OF THE DRAWING(S)

[0020] FIG. **1** is a schematic diagram of an efficient geothermal cooling device couplable to a ground source. FIG. **1***a* shows an alternate embodiment with multiple ground source loops.

[0021] FIG. **2** is a schematic diagram of an embodiment of an efficient geothermal cooling device powered by an alternative energy source and having a power conditioner.

[0022] FIG. **3***a* and FIG. **3***b* are perspective and sectional views, respectively, of an embodiment of an efficient geothermal cooling device formed of a thermal superconductor extending to the ground source.

[0023] FIG. **4** is a schematic diagram of multiplexed cooling segments couplable to a single ground loop and connected to a power and sensor control box.

[0024] FIG. **5** is schematic diagram of a geothermal cooling device with a power switch for operating the blower for additional air heat transfer.

[0025] FIG. **6** is schematic diagram of a geothermal cooling device with a power connector for manually powering the blower for additional air heat transfer.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT(S)

[0026] With reference to the drawings, new and improved cooling devices and systems for improved cooling embodying the principles and concepts of the present invention will be described. In particular, the devices and systems are operable in the conditions where an earth source temperature is lower than an above ground temperature associated with an interior space to be cooled. The earth source may alternatively be a ground source or a body of water effectively below ground level.

[0027] Recent advances in thermal superconducting materials can now be considered for use in novel energy transfer applications. For example, U.S. Pat. No. 6,132,823 and continuations thereof, discloses an example of a heat transfer medium with extremely high thermal conductivity, and is included herein by reference. Specifically the following disclosure indicates the orders of magnitude improvement in thermal conduction; "Experimentation has shown that a steel conduit **4** with medium **6** properly disposed therein has a thermal conductivity that is generally 20,000 times higher than the thermal conductivity of silver, and can reach under laboratory conditions a thermal conductivity that is 30,000 times higher that the thermal conductivity of silver." Such a medium is thermally superconducting. In this disclosure, the term superconductor shall interchangeably mean thermal superconductor or thermal superconductor heat pipe. The available product sold by Qu Energy International Corporation is an inorganic heat transfer medium provided in a vacuum sealed heat conducting tube.

[0028] Alternate thermal superconductors may be equivalently substituted, such as thermally superconducting heat pipes. Heat pipes typically include a sealed container(pipe), working fluid and a wicking or capillary structure inside the container. Heat is transported by an evaporation-condensation cycle when a thermal differential is present between opposing ends. Working fluids can be selected with high surface tension to generate a high capillary driving force such that the condensate can migrate back to the evaporator portion, even against gravity. Some working fluids useful for the geothermal operating temperature range include ammonia, acetone, methanol and ethanol. Inside the tube, the liquid enters and wets the internal surfaces of the capillary structure. Applying heat at one segment of the pipe, causes the liquid at that point to vaporize picking up latent heat of vaporization. The gas moves to a colder location where it condenses, giving up latent heat of vaporization. The heat transfer capacity of a heat pipe is proportional to the axial power rating, the energy moving axially along the pipe. For maximum energy transfer the heat pipe diameter should be increased and the length shortened, making it operable but less preferred than a non-liquid superconductor such as the Qu product. In particular with respect to the ground loop, scaled-up heat pipe designs have been disclosed for geothermal heating applications, such as in PCT Publication No. WO 86/00124 ("Improvements in earth heat recovery systems"). These designs partially overcome the length to diameter ratio problem but preferably require a recirculation pump for the fluid. A two-way heat pipe design for ventilation heat-exchanger is disclosed in U.S. Pat. No. 4,896,716, and could be used for non-ground loop transfer as a two-way thermal superconductor.

[0029] When suitably configured for geothermal cooling, thermal superconductors of this kind result in many significant advantages. In particular, because they transfer heat at a very high rate, they are able to absorb heat in a building, transfer it quickly and efficiently out of the building over relatively long distances of hundreds of feet with little loss of energy, and then dissipate this energy into the cool ground, without the mechanical pumping of circulating fluids required to move heat in conventional geothermal systems.

[0030] FIG. **1** illustrates an embodiment of the present geothermal cooling device **110**. Device **110** is positioned above ground level **30** and couplable to a geothermal heat exchange element **32** formed from thermal superconductor and positioned in a ground loop hole **34**. The thermal superconductor **32** extends above ground level where it is covered by insulation and terminated in a coupler **28**. For illustrative purposes, this superconductor may be in the form of a sealed metal tube as currently available from Qu Corporation and will be considered to be in tube form. Alternatively other available thermal superconductors could be similarly substituted that may have various forms and cross sections such as flexible conduits, thin laminate, thin film coated metal etc. Optionally, the superconducting transfer segments maybe formed from discontinuous discrete sections of superconducting material separated by small gaps of a non-superconducting material.

[0031] In the preferred case, the depth of hole **34** is selected in combination with the transfer properties of geothermal heat exchange element **32**, the heat absorbing properties of the ground at the hole and the quantity of heat required by the system to be dissipated into the ground. As per conventional geoexchange systems, the depth of hole **34** may be greater than is practicable for a single hole, so a plurality of holes may be substituted to receive a plurality of geothermal heat exchange elements **32** and **32***a* with an aggregate depth equal to or greater than the required depth of a single hole. As shown in FIG. **1***a*, this plurality of geothermal heat exchange elements **32** and **32***a* can be joined at or below coupler **28** in such a manner that they are equally able to transfer heat to the ground. Due to the superior thermal transfer properties of the thermal superconductor element and the fact that the element is not looped so thermal "short-circuiting" is avoided, the hole size and depth can be considerably less than conventional geoexchange loops, saving installation costs and enabling installation in places where the large holes required by conventional geoexchange are not practical. In the example of a body of water being the earth source, the superconducting ground coil can be either suspended in the body of water, or in indirect thermal contact with the body of water. The latter example is specifically useful for marine applications.

[0032] The coupler **28** couples between the ground loop superconductor **32** and a cooling device superconductor segment **26**, providing for ease of installation and conduit routing into an interior location prior to connection. The cooling device superconductor segment **26** extends inside a housing **10**. Persons familiar with the technology involved here will appreciate that coupler **28** could equivalently be alternatively positioned under the ground, above ground outside a building, inside the building but outside the housing **10**, or even inside the housing **10**, as selected for best ease of installation. Housing **10** includes two vented regions (not shown), an inlet region to draw hot air in, and an outlet region to push cool air out. Positioned within housing **10** and between the two vented regions is a thermally superconducting air exchanger **20** connected to or integral with the cooling device superconductor segment **26**, which is further insulated by insulation **25** up to the air exchanger **20**, and further includes power line **36**. A blower **18** is positioned in proximity to the superconducting air exchanger to pull or push air through the exchanger for cooling, the preferred position being near the outlet vent region such that air is pulled over the air exchanger **20**. Due to the superior heat transfer properties of the exchanger, the fan can be a low power, low throughput fan to conserve energy, or alternatively a variable speed fan. The fan is powered by powerline **36** coupled through controller **14** to external power line **12**. The preferred fan has operating noise less than 45 dB and the external power line **12** can be DC powered by an alternative energy source (not shown). Superconducting air exchanger **20** may be configured in many possible designs provided sufficient net surface area is exposed to the air flow through cooling device **110**, the illustrated design of an array of bars substantially corresponding to the fan diameter is a preferred example. Blower **18** is connected to controller **14** and power line **12** for control of fan operation. In some atmospheric conditions, condensate will form on the superconductor heat exchanger **20**, and an optional drip tray **22** is shown positioned below to catch condensate and an optional water drain line **24** is shown connected to drip tray for runoff disposal.

[0033] The controlled operation of the geothermal cooling device **110** provides user comfort and control of cooling. Controller **14** may be programmed as a thermostat controller responding to a temperature sensor **16** (such as a thermocouple) associated with the space to be cooled, or as a cooling device controller that receives input from a remote thermostat and sensor associated with the space (not shown). The controller is shown within the housing **10**, but may alternatively be in any suitable location provided it is in communication with the blower and temperature sensor. While the simplest implementation is one temperature measurement, multiple temperature measurements could also be weighted or averaged for the purpose of feedback set points in the controller **14**. In the case of a multi-speed fan, alternatively a second temperature sensor could be positioned on or near the air exchanger **20** to determine the initial fan speed for faster cooling. Unlike conventional central geothermal heat pumps, which are large, noisy and require greater power than available from a standard household outlet, the geothermal cooling device **110** can be operated from a standard outlet connected to power line **12**, anywhere in the house, very quietly and in a small form factor housing. The housing **10** for geothermal cooling device **110**, may be positioned anywhere within the interior room to be cooled; it does not have to be near or in a window region. Preferably the housing is positioned to provide optimum or adequate air mixing and cooling for the room.

[0034] With the controller **14** set to a desired room temperature T**1** via a manual input (not shown), or a remote control input or a second remote thermostat (not shown) in communication with the controller **14**, the controller senses existing room temperature T**2** and if higher than T**1**, operates the blower **18** to circulate air until the temperature reaches T**1**. Alternatively, as common in the art, various thresholding or smoothing processes can be programmed to avoid jitter and to determine when to switch the blower **18** on or off. In the example of a multi-speed blower, the blower speed can be programmed to change proportional to the rate of change of existing temperature T**2**, in addition to on or off. The geothermal cooling device **110** can be programmed to operate for inputs that act as related proxies for associated interior temperature and that have known characterized relationships to temperature.

[0035] The geothermal cooling device **110** of FIG. **1** has many advantages that solve the problems described in the background, due to the substantial efficiency increase relative to existing cooling solutions. First, the geothermal earth source element is not looped so it is not subject to thermal short-circuiting, so hole depth can be less than conventional ground loop depth, reducing costs and increasing qualifying sites. Second, by eliminating a compressor and heat intensifying circuit or circulating pumps, the power requirements of the geothermal cooling device are an order of magnitude less than conventional geothermal exchange units, whether central or for a single room, and permit the installation and operation on low power electrical systems such as conventional 15 Ampere residential circuits. Third, the generated noise is orders of magnitude better than compressor driven geothermal exchange units. Fourth, the lightweight and small size of the geothermal cooling device **110** relative to existing solutions, permits easy installation in a wide range of locations and even installations of individual geothermal cooling devices **110** in multiple rooms of a residence interior. Fifth, eliminating or reducing refrigerant and reducing moving parts extends system lifetimes and reduces system maintenance.

[0036] The geothermal cooling device may operate from an alternative energy power source for even more economical sustainable operation, as shown in FIG. **2**. This embodiment is similar to FIG. **1** with the addition of a power converter **11** inside the enclosure and connected to power line **12**, for the purpose of processing alternative energy from an alternative power source (not shown), such as a hydrogen fuel cell, a solar cell array, or a wind turbine and the like, resulting in DC power requiring conditioning by power converter **11** to supply controller and fan power. Due to the efficient thermal transfer of the configuration, low voltage components (12V) can be used in an embodiment, permitting alternate energy sources to be used without conditioning. Preferably the alternative power source would supply continuous power, but controller **14** may be adapted to use intermittent power operation.

[0037] Alternatively, for reducing potential thermal losses through coupler **28** shown in FIGS. **1** and **2**, a geothermal cooling system can be designed where the thermal superconductor is formed as one integral loop from earth source segment **32** through to superconductor air exchanger **20**, by eliminating coupler **28**. In this example, installation is done differently. The housing **10** is installed in position in the interior space, and both the above ground insulated thermal superconductor segment **26** and uninsulated segment **32** are routed through openings from the interior to the ground **30**, and uninsulated segment **32** is seated in the ground loop hole. The interior openings may be either through a sidewall and out to an uncovered hole, or in the case of new building may be positioned in the foundation of the building and fed into ground loop holes underneath the building.

[0038] Due to the advantages of lightness and compactness, interior mounting can be considered for geothermal cooling devices that was previously not feasible. In FIGS. **3** and **3***a*, an example is shown for a wall-integrated geothermal cooling device **130** mounted on interior wall **52**, in perspective view to show air circulation and in sectional view to show installation assembly. In FIG. **3***a*, connections are shown as coming up from below the interior wall **52** for illustration. Thermal superconductor earth source loop **32** extends into the ground **30** and terminates in coupler **28** above ground. The three connections to the cooling device **130** include a water drain line **24**, a cooling device thermal superconductor segment **26** couplable to coupler **28**, and power line **36** couplable to a controller (not shown) or power supply/mains (not shown); the three are shown supported in conduit **38** that serves for protection when exteriorly mounted, and fastening through wall opening **55**. Thermal superconductor **26** may have insulation (not shown for clarity). Optionally controller (not shown) may be housed in housing **10** and powerline **36** is replaced by external powerline **12** (not shown). The conduit **38** is terminated at housing **10** and delivers the 3 services to the internal components. Persons familiar with construction techniques will recognize that the conduit could be routed or positioned at various points on the wall or routed partially on the interior side of the wall, or interior to the wall within the scope of the embodiments, or alternatively, that the services contained in the conduit could be separately routed within or outside the structure. It will also be noted from this disclosure that water drain line **24** could be eliminated in installations where environmental conditions do not result in condensation sufficient to require collection and drainage. Housing **10** is secured to the wall, either by conduit **38** or by separate fasteners such as wall-anchors not shown, in a manner that meets building codes.

[0039] Housing **10** has inlet vents **53** underneath and outlet vents **54** at the room facing side, such that cooled air is circulated as shown by the arrows in FIG. **3***a*. The fan **18** and thermal superconductor air exchanger **20** are positioned preferably at the outlet vent **54** and operated to pull the air from the inlet. Arrangements of inlet and outlet can be configured on the exposed sides of the housing, but the preferred arrangement is shown. Additionally the controller **14** (not shown) and thermostat (not shown) can be enclosed in housing **10** and connected to power line **36** for operation, and as discussed previously various user controls may be provided on the housing exterior or by way of a remote control. Alternate versions may have the coupler **28** moved inside the housing **10**, or along the conduit path between the ground **30** and housing **10**. Alternatively, for ease of installation the conduit may have a conduit coupler (not shown) such that the geothermal cooling device **130** can be installed in stages. The integrated cooling device provides safety in that wires and supply lines are less accessible and reduces installation costs as normal power wiring can be used, and the housing can be safely and quickly wall-mounted with common mechanical fasteners, without requiring reinforced supports or cutaways in the wall.

[0040] FIG. **4** demonstrates a multiplexed version of the geothermal cooling device **140**. A thermal superconductor ground loop **32** is coupled to two or more superconductor air exchangers **20** and **20***a* though two or more cooling device superconductor segments **26** and **26***a* with insulation **25** (as shown generally on above-grade superconductor transfer segments). Housings **42** and **42***a* respectively enclose the air exchangers **20**, **20***a*, associated blowers **18**, **18***a* and optional drip trays **22**, **22***a* and optional drain lines **24**,**24***a*, and have inlet and outlet vents (not shown in schematic view). The controller **14**, temperature sensor **16** and power line **12**, while shown externally, can alternatively be housed in either of the housings **42**, **42***a*, and connects to both blowers **18**, **18***a* through power lines **37**, **37***a*. The configuration as described allows for distributed cooling through a single thermostat, for example in a large interior space where one cooling device is inadequate. The operation would be as described previously. Alternate embodiments could have separate thermostat in each enclosure with separate set points for controlling each blower individually, or separate thermostat controller and sensor for each blower integrated into housings **42** and **42***a*.

[0041] In the examples of geothermal cooling devices thus far, a thermostat has been used to control operation. The superconducting air exchanger can be effectively "cool" with no power and doesn't have to be "disconnected" from the ground loop. Therefore, for further parts reduction it may be desired to remove the thermostat and provide manual controls only, as shown in FIGS. **5** and **6**. In FIG. **5**, a geothermal cooling device **150** consists of enclosure **10**, cooling device superconductor segment **26** with insulation **25**, superconductor air exchanger **20**, blower **18**, power line **12** to exterior power supply (not shown) and user operable switch **40** in series with power line **12** and power line **37** to switch fan off or on. When cooling device superconductor segment is coupled to thermal superconductor ground loop at coupler **28**, heat is transferred from air exchanger **20** to earth **30** through the thermal superconductor, at a rate determined by blower operation and temperature differential. It will be appreciated in an alternate arrangement that blower **18** could be a multi-speed blower and switch **40** could be a variable control switch such that the user could control various speed settings.

[0042] FIG. **6** varies from FIG. **5** in that the switch **40** has been removed. External power line **12** is terminated in an electrical connection such as a plug, so that user operates the geothermal cooling device **160** by plugging or unplugging direct power to the blower of the geothermal cooling device **160**.

[0043] In these examples and embodiments described, insulation has been shown on superconductor segments designed for low thermal loss transfer (that is, not the ends of the superconductor segments), and is the preferred example, whether or not explicitly stated in figure descriptions or numbered on drawings. However, as noted previously, the cooling device described will operate with no insulation or with some transfer lines insulated or combinations of insulated or uninsulated portions of the superconductors thereof.

[0044] In these examples housing has been described as split housing in a preferred case, however it will be appreciated that the various embodiments can be integrated into existing structures or enclosed in a single housing.

[0045] Although particular embodiments of the invention have been described by way of example, it will be appreciated that additions, modifications and alternatives thereto may be envisaged. The scope of the present disclosure includes any novel feature or combination of features disclosed therein either explicitly or implicitly or any generalization thereof irrespective of whether or not it relates to the claimed invention or mitigates any or all of the problems addressed by the present invention. The applicant hereby gives notice that new claims may be formulated to such features during the prosecution of this application or of any such further application derived therefrom. In particular, with reference to the appended claims, features from dependent claims may be combined with those of the independent claims and features from respective independent claims may be combined in any appropriate manner and not merely in the specific combinations enumerated in the claims.

What is claimed is:

1. A cooling device suitable for coupling to a thermal superconductor geothermal ground coil extending below a ground level allowing passive thermal conduction to an earth source, the device comprising:

(a) a thermal superconductor having a first end couplable to said thermal superconductor geothermal ground coil and a second opposing end configured as a thermal superconductor exchange segment;

(b) a blower positioned in the region of said thermal superconducting exchange segment;

(c) a thermostat controller associated with an indoor space, programmable to a desired temperature set point and for measuring temperature of said indoor space and further having a blower controller connected to said blower;

wherein said blower controller operate said blower in response to the difference between said set point and said measured temperature, for the purpose of operating in a cooling mode to efficiently cool an indoor space.

2. The cooling device of claim 1, further comprising at least one geothermal ground coil formed from a thermal superconductor material and extending below ground level allowing passive thermal conduction to the earth source and thermally coupled to said above ground thermal superconductor segment.

3. The cooling device of claim 1, wherein said thermal superconductor material is an inorganic high heat transfer medium.

4. The cooling device of claim 1, wherein said high heat transfer medium is applied in a sealed heat transfer pipe.

5. The Cooling device of claim 4, wherein said thermal superconductors are heat transfer pipes containing said high heat transfer medium, and insulated along at least a portion of heat transfer segment, said heat transfer pipes having thermal conductivity greater than 100 times the thermal conductivity of silver and substantially negligible heat loss along said heat transfer segment.

6. The cooling device of claim 1, further comprising a power conditioner connected to said blower and said thermostat controller.

7. The cooling device of claim 6, wherein said power conditioner is a power converter couplable to an alternative energy source, one selected from the group of photovoltaic arrays, wind generators and fuel cells.

8. The cooling device of claim 7, wherein said power conditioner is a power converter couplable to 110V AC power and converting AC to DC supply for operating said cooling device.

9. The cooling device of claim 7, wherein said power converter includes a power conditioning circuit for converting low grade alternative power from an alternative energy source to conditioned power suitable to operate said blower.

10. The cooling device of claim 1, wherein said blower operates in one of a variable or multispeed mode as controlled by said blower controller.

11. The cooling device of claim 1, wherein at least a portion of said thermal superconductors are formed in discrete segments joined by substantially short thermally conducting joiners.

12. The cooling device of claim 1, wherein said first thermal superconductor exchange segment is arranged as a condenser array with area substantially corresponding to said blower area for increased air heat exchange.

13. The cooling device of claim 1, further comprising a receiver connected to said thermostat controller and a remote control in communication with said receiver such that thermostat set points and operations are wirelessly controllable.

14. The cooling device of claim 1, wherein a segment of said heat exchange coil is arranged as a thermal conductor bus with a plurality of said first thermal superconductor segments.

15. The cooling device of claim 14, further comprising a plurality of blowers positioned proximal to each of said first thermal superconductor exchange segments and connected to said blower controller, such that said cooling device provides a plurality of exchanges associated with a plurality of locations within a structure.

16. The cooling device of claim 15, further comprising multiple thermal sensors associated with said plurality of locations and connected to said thermostat controller to provide temperature measurements associated with each location.

17. The cooling device of claim 1, further comprising an enclosure which houses said controller, said heat exchanger, said thermal superconductor exchange segment, a blower positioned proximal to said segment, said enclosure having venting near said blower.

18. The cooling device of claim 2, wherein said earth source is a body of water.

19. The cooling device of claim 18, wherein said geothermal ground coil is suspended in said body of water.

20. The cooling device of claim 18, wherein said geothermal ground coil is in indirect thermal contact with said source water.

21. The cooling device of claim 15, wherein said thermostat controller is programmable to independently vary the speed or operation of individual blowers.

22. A cooling device suitable for coupling to a thermal superconductor geothermal ground coil extending below a ground level allowing passive thermal conduction to an earth source, the device comprising;

(a) a thermal superconductor having a first end couplable to said thermal superconductor geothermal ground coil and a second opposing end configured as a thermal superconductor exchange segment,

(b) a blower positioned in the region of said thermal superconducting exchange segment;

(c) a power connection for providing operating power to said blower when connected; and

(d) a switch connected to said power connection and said blower for controlling said blower;

wherein said blower may be manually controlled for the purpose of operating in a cooling mode to efficiently cool an indoor space.

23. The cooling device of claim 22, wherein said blower operates in one of an off or on mode.

24. The cooling device of claim 23, wherein said blower operates in a variable speed mode and said switch is a variable switch.

25. The cooling device of claim 22, further comprising a receiver connected to said switch and a remote control in communication with said receiver such that blower operation is wirelessly controllable.

26. The cooling device of claim 22, further comprising at least one geothermal ground coil formed from a thermal superconductor material and extending below ground level allowing passive thermal conduction to the earth source and thermally coupled to said above ground thermal superconductor segment.

27. The cooling device of claim 22, wherein said thermal superconductor material is an inorganic high heat transfer medium.

28. The cooling device of claim 22, wherein said high heat transfer medium is applied in a sealed heat transfer pipe.

29. The cooling device of claim 28, wherein said thermal superconductors are heat transfer pipes containing said high heat transfer medium, and insulated along at least a portion of heat transfer segment, said heat transfer pipes having thermal conductivity greater than 100 times the thermal conductivity of silver and substantially negligible heat loss along said heat transfer segment.

30. The cooling device of claim 22, further comprising a power conditioner connected to said blower.

31. The cooling device of claim 30, wherein said power conditioner is a power converter couplable to an alternative energy source, one selected from the group of photovoltaic arrays, wind generators and fuel cells.

32. The cooling device of claim 31, wherein said power conditioner is a power converter couplable to 110V AC power and converting AC to DC supply for operating said cooling device.

33. The cooling device of claim 31, wherein said power converter includes a power conditioning circuit for converting low grade alternative power from an alternative energy source to conditioned power suitable to operate said blower.

34. The cooling device of claim 22, wherein at least a portion of said thermal superconductors are formed in discrete segments joined by substantially short thermally conducting joiners.

35. The cooling device of claim 22, wherein said first thermal superconductor exchange segment is arranged as a condenser array with area substantially corresponding to said blower area for increased air heat exchange.

36. The cooling device of claim 22, wherein a segment of said heat exchange coil is arranged as a thermal conductor bus with a plurality of said first thermal superconductor segments.

37. The cooling device of claim 36, further comprising a plurality of blowers positioned proximal to each of said first thermal superconductor exchange segments and connected to said switch and power connection, such that said cooling device provides a plurality of exchanges associated with a plurality of locations within a structure.

38. The cooling device of claim 22, further comprising an enclosure which houses said switch, said heat exchanger and said thermal superconductor exchange segment, a blower positioned proximal to said segment, said enclosure having venting near said blower.

39. The cooling device of claim 26, wherein said earth source is a body of water.

40. The cooling device of claim 39, wherein said geothermal ground coil is suspended in said body of water.

41. The cooling device of claim 38, wherein said geothermal ground coil is in indirect thermal contact with said source water.

42. A cooling device suitable for coupling to a thermal superconductor geothermal ground coil extending below a ground level allowing passive thermal conduction to an earth source and for connecting to a power source, the device comprising;

(a) a thermal superconductor having a first end couplable to said thermal superconductor geothermal ground coil and a second opposing end configured as a thermal superconductor exchange segment;

(b) a blower positioned in the region of said thermal superconducting exchange segment;

(c) a power connection for providing operating power to said blower when connected;

wherein said blower is capable of being powered by connecting said external power connector to said power source, for the purpose of operating in a cooling mode to efficiently cool an indoor space.

43. The cooling device of claim 42, further comprising an enclosure which houses said thermal superconductor exchange segment, a blower positioned proximal to said segment, and a power connection, said enclosure having venting near said blower and wherein said power connection has at least one connector disposed external to said housing for connecting to an external power supply.

44. The cooling device of claim 42, further comprising at least one geothermal ground coil formed from a thermal superconductor material and extending below ground level allowing passive thermal conduction to the earth source and thermally coupled to said above ground thermal superconductor segment.

45. The cooling device of claim 42, wherein said thermal superconductor material is an inorganic high heat transfer medium.

46. The cooling device of claim 45, wherein said high heat transfer medium is applied in a sealed heat transfer pipe.

47. The cooling device of claim 46, wherein said thermal superconductors are heat transfer pipes containing said high heat transfer medium, and insulated along at least a portion of heat transfer segment, said heat transfer pipes having thermal conductivity greater than 100 times the thermal conductivity of silver and substantially negligible heat loss along said heat transfer segment.

48. The cooling device of claim 42, further comprising a power conditioner connected to said blower.

49. The cooling device of claim 48, wherein said power conditioner is a power converter couplable to an alternative energy source, one selected from the group of photovoltaic arrays, wind generators and fuel cells.

50. The cooling device of claim 49, wherein said power conditioner is a power converter couplable to 110V AC power and converting AC to DC supply for operating said cooling device.

51. The cooling device of claim 49, wherein said power converter includes a power conditioning circuit for converting low grade alternative power from an alternative energy source to conditioned power suitable to operate said blower.

52. The cooling device of claim 42, wherein at least a portion of said thermal superconductors are formed in discrete segments joined by substantially short thermally conducting joiners.

53. The cooling device of claim 42, wherein said first thermal superconductor exchange segment is arranged as a condenser array with area substantially corresponding to said blower area for increased air heat exchange.

54. The cooling device of claim 42, wherein a segment of said heat exchange coil is arranged as a thermal conductor bus with a plurality of said first thermal superconductor segments.

55. The cooling device of claim 54, further comprising a plurality of blowers positioned proximal to each of said first thermal superconductor exchange segments and connectable to said power connection, such that said cooling device provides a plurality of exchanges associated with a plurality of locations within a structure.

56. The cooling device of claim 42, further comprising an enclosure which houses said heat exchanger, said thermal superconductor exchange segment, a blower positioned proximal to said segment, said enclosure having venting near said blower.

57. The cooling device of claim 44, wherein said earth source is a body of water.

58. The cooling device of claim 57, wherein said geothermal ground coil is suspended in said body of water.

59. The cooling device of claim 58, wherein said geothermal ground coil is in indirect thermal contact with said source water.

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