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(72) Inventors:

- **Pesics, Endré Feranc**
Wootton Bassett, Wiltshire SN4 7EQ (GB)
- **Pesics, Suzanne Cathleen**
Wootton Bassett, Wiltshire SN4 7EQ (GB)

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(71) Applicant: **Sunflow Limited**
Wiltshire SN4 7EQ (GB)

(74) Representative: **Ford, James et al**
Abel & Imray
20 Red Lion Street
London
WC1R 4PQ (GB)

(54) **A low surface temperature (LST) heating apparatus**

(57) A low surface temperature (LST) heating apparatus comprising a heat source (1); a multiplicity of upwardly extending conduits (9) in front of, and spaced apart from, the heat source (1) but arranged such that the conduits (9) are heated by the heat source; and a cover (5), the cover (5) being arranged to substantially enclose the conduits (9) and the heat source (1). The conduits (9) are arranged such that, when they are heated by the heat source (1) a natural convection current is created.

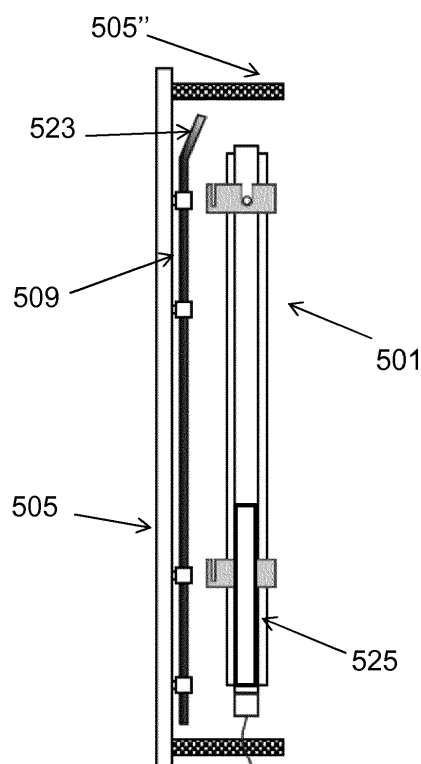


Figure 11

Description

Technical Field

[0001] The present invention relates to heating apparatus, and more particularly to low surface temperature (LST) heating apparatus having convection-improving apparatus.

Background of the Invention

[0002] Many types of heating apparatus are arranged to heat rooms at least partly by radiation. For example, radiators in domestic wet central heating systems typically comprise a fluid-filled panel which, when the fluid is heated, both radiates heat into the room and locally warms some of the air in the vicinity of the radiator. Such an arrangement has been found to create relatively large temperature gradients in the room, with the warmest air collecting at the top of the room, and a layer of cooler air near the floor. For example, if a thermostat is set at a setpoint temperature of 20 degrees Celsius (C), the room may, in practice have air at 26 degrees C near the ceiling and air at around 17 degrees C near the floor. Other heating apparatus such as under-floor heating, or skirting board heaters may also create large temperature gradients.

[0003] Some attempts have been made to improve the uniformity of the temperature distribution from radiators, by increasing the amount of convection generated. This has typically been achieved in more modern radiator designs by manufacturing the radiator with fins welded to the back and/or in the middle of the radiator. Whilst this may improve the effectiveness of the radiator to some extent, undesirable temperature gradients may still exist.

[0004] Another problem with some known heating apparatus is that they tend to have a relatively high surface temperature. In the UK, Health and Safety guidelines and National Health Service (NHS) guidelines specify that the surface temperature of heating apparatus (i.e. the temperature of an exposed surface of the heating apparatus that a person could contact) should not exceed 43 degrees C because prolonged contact with surfaces above 43 degrees has been found to cause partial thickness burns or full thickness burns, particularly in vulnerable people such as the elderly or small children. Many known heating apparatus are only be able to provide a satisfactory heating effect, if they simultaneously have a high surface temperature that is above 43 degrees. They therefore present a potential safety concern.

Summary of the Invention

[0005] The present invention seeks to address at least some of the above-mentioned disadvantages. More specifically, but not exclusively, it is desirable to provide an effective heating apparatus that maintains a relatively low surface temperature.

[0006] According to a first aspect of the invention, there is provided a low surface temperature (LST) heating apparatus for installing in a room, the heating apparatus comprising: (i) a heat source having a front, a back, sides, and a top; (ii) a convection-improving apparatus, the convection-improving apparatus comprising a multiplicity of upwardly extending conduits, each having an inlet located at its lower end and an outlet at its upper end, the conduits being in front of, and spaced apart from, the heat source but arranged such that the conduits are heated by the heat source; and (iii) a cover, the cover being arranged to substantially enclose the convection-improving apparatus and the front, back and sides of the heat source, wherein the conduits are arranged such that, when they are heated by the heat source, cold air from the room is drawn in through the inlets, heated by the respective conduits, and the heated air is released from the outlets, thereby creating a natural convection current.

[0007] The invention makes use of the so-called 'chimney effect' (also known as the 'stack effect'). More specifically, by providing a heated, upwardly extending, conduit, air in the conduit is heated, and thus rises, thereby drawing in cooler air at the base and setting up a natural convection current, preferably around the perimeter of the room. The present invention recognises that by having a convection-improving apparatus comprising a multiplicity of conduits between the front of the heat source and the cover, not only is the effectiveness of the heating apparatus increased (by way of improving convection), the cover also has a relatively low surface temperature. For example, the surface temperature of the cover may be significantly less than the surface temperature of the heat source.

[0008] The cover and the convection-improving apparatus may be retro-fitted with the heat source. The heat source may have been pre-installed in the room. It will be appreciated that although the convection-improving apparatus may be retro-fitted, it need not necessarily be fitted, or otherwise connected to the heating apparatus. In some embodiments the convection-improving device may be connected (more preferably detachably connected) to the heat source, whereas in other embodiments the convection-improving apparatus may merely be arranged such that the conduit is heated by the heat source (for example it may be free-standing in front of the heat source).

[0009] The heat source may be adjacent a wall of the room and arranged to convey heat outwards into the room. The multiplicity of conduits are preferably positioned in front of the heating apparatus such that the conduits are heated as the heat is conveyed outwards into the room. Such an arrangement enables straightforward retrofitting because it tends not to need any structural modification of the heat source; instead the conduits can be simply located in front of the heat source.

[0010] The cover may be arranged to at least partially shield the conduits from sight. The cover is preferably arranged to substantially shield the conduits from sight.

Alternatively or additionally, the cover may be arranged to at least partially shield the heat source from sight. The cover is preferably arranged to substantially shield the heat source from sight.

[0011] The cover may comprise attachment means for attaching the cover to the heat source. The cover may comprise attachment means for attaching the cover to a wall structure, for example a wall structure adjacent the heat source.

[0012] The conduits are preferably spaced apart from the inner surface of the cover. The conduits preferably do not contact the cover. It will be appreciated that the conduits may, nevertheless, be coupled to the cover (for example the conduits may be coupled to the rear face of the cover by a support bracket).

[0013] The cover itself may be arranged to allow, and more preferably to facilitate, convection. The cover is preferably arranged to allow airflow from outside the cover to behind the cover through an inlet, and is preferably arranged to allow airflow from behind the cover to outside the cover through an outlet, the outlet being higher than the inlet. The inlet is preferably substantially at floor level.

[0014] The cover may be a unitary structure. The cover may comprise a plurality of modular cover elements, the modular cover elements being detachably connected to form the cover. A modular arrangement may be beneficial since it may enable the size of the cover to be tailored to different heating apparatus, depending on how many modules are detachably connected.

[0015] The heat source is suitable for heating a room. The heat source may, in some embodiments, be a radiator. The radiator is preferably a fluid-filled radiator forming part of a wet central heating system. In preferred embodiments, the heat source comprises a heated thermal mass for heating air within the heat source, the heated air being released through the top of the heat source. The heated thermal mass may comprise an electric heater element embedded in a solid core. The solid core may be a baked kiln clay core. The present invention has been found to be especially beneficial with such a heat source because whilst said heat sources tend to be very efficient it tends to have a relatively high surface temperature and cannot therefore be used (in isolation) in scenarios requiring an LST heater. The heat source may be arranged release heated air through the top of the heat source. In addition, the heat source may also be arranged such that the front, and preferably the sides and/or top, of the heat source are heated (by the thermal mass). The front, sides and/or top of the heat source may therefore warm the surrounding environment by heat transfer (e.g. comprising radiation) to the surrounding air.

[0016] The conduits are arranged such that, when heated, cold air from the room is drawn in through the inlet, heated by the conduit, and the heated air is released from the outlet, thereby creating a natural convection current. The conduits may, in principle, be any shape that achieves this function. For example the conduits may be a circular, or non-circular, cylinder. The conduits are ther-

mally conductive. For example the conduit may be made from a thermally conductive material such as a metallic material.

[0017] The convection-improving apparatus improves natural convection. The heating apparatus preferably does not comprise means for providing forced convection. For example, the heating apparatus preferably does not comprise a fan, pump or other means for actively creating an air flow.

[0018] The multiplicity of conduits may be positioned laterally adjacent each other. The conduits may be substantially parallel to one another.

[0019] The conduits are sufficiently upwardly extending to enable convection. The conduits may be inclined at over 45 degrees to the horizontal. The conduits may be inclined at 60 degrees or over to the horizontal. The conduits may be substantially vertical. In some embodiments of the invention, the inclination of the conduit is fixed. In other embodiments of the invention, the inclination of the conduit may be adjustable.

[0020] The heat source may be such that the heated air, released through the top of the heat source, is released at a first temperature. The convection-improving apparatus may be arranged such that the heated air from the outlets, is released at a second temperature. The second temperature is preferably lower than the first temperature. The conduits are preferably arranged such that the heated air from the outlets blends with the heated air released through the top of the heat source. Such an arrangement has been found to be especially effective in ensuring the cover has a low surface temperature, because it can act to cool the temperature of the air coming directly from the heat source (whilst still ensuring a convective current is created). The upper end of each conduit preferably comprises an angled portion for directing heated air from the outlets, into the path of the heated air released through the top of the heat source.

[0021] The convection-improving apparatus has preferably been designed to ensure the region of the cover heated by the blended air, has a surface temperature that is below a predetermined threshold temperature. In principle there may be a variety of factors that can be adjusted to achieve this. Most preferably, at least one of the size, number and/or spacing of the multiplicity of conduits is selected such the surface temperature is below the predetermined threshold temperature.

[0022] By providing the conduits between the front of the heat source and cover, the present invention both improves the convective heating effect, and also ensures there is an at least partial barrier (i.e. the conduits) between the front of the heat source and rear of the cover. This may be used to ensure the surface temperature of the cover is kept relatively low. At least one of the size, number and/or spacing of the multiplicity of conduits may be selected to restrict thermal heat transfer from the front of the heat source to the front of the cover, such that the surface temperature of the front of the cover is below a predetermined threshold temperature.

[0023] The predetermined threshold temperature is preferably 43 degrees Celsius.

[0024] According to another aspect of the invention, there is provided a method of designing the low surface temperature (LST) heating apparatus as described herein. The method may comprise the steps of: tailoring at least one of the size, number and/or spacing of the multiplicity of conduits to ensure the cover has a surface temperature that is below a predetermined threshold temperature.

[0025] According to yet another aspect of the invention, there is provided a convection-improving apparatus for use as the convection-improving apparatus described herein, the convection-improving apparatus comprising a multiplicity of conduits, each having an inlet located at its lower end and an outlet at its upper end, the conduits being positionable in front of the heat source such that the conduits are heated by the heat source, and wherein the conduits are arranged such that, when heated, cold air is drawn in through the inlet, heated by the conduit, and heated air is released from the outlet, thereby creating a convection current.

[0026] The convection-improving apparatus may be in combination with a cover, which, when the convection-improving apparatus is retro-fitted with a heat source, is arranged to substantially enclose the convection-improving apparatus and the front, back, top and sides of the heat source.

[0027] It will be appreciated that any reference to operating temperatures, or other operating characteristics, are for when the relevant device is operating a maximum output in an environment in which the air is at standard temperature and pressure.

[0028] Any features described with reference to one aspect of the invention are equally applicable to any other aspect of the invention, and *vice versa*.

Description of the Drawings

[0029] Various embodiments of the invention will now be described, by way of example only, with reference to the accompanying schematic drawings of which:

Figure 1 is a perspective view of a heating apparatus, according to a first embodiment of the invention;
Figure 2 is a view of the rear side of part of the cover in Figure 1;

Figures 3a and 3b are views of the side of part of the cover in Figure 1;

Figure 4 is a view of the rear side of part of a cover and convection-improving apparatus in a second embodiment of the invention;

Figure 5 is a perspective view of a cover in a third embodiment of the invention;

Figure 6 is a view of the rear side of the cover in Figure 5;

Figure 7 is a view of the side of the cover in Figure 5;
Figure 8 is a side view of a heating apparatus ac-

cording to a fourth embodiment of the invention;

Figure 9 is a view of the rear of a cover and convection-improving apparatus in yet another embodiment;

Figure 10 is part of the cover in the embodiment in Figure 9; and

Figures 11, 12 and 13 are side, rear and front views respectively, of a heating apparatus according to yet another embodiment of the invention.

Detailed Description

[0030] Figure 1 is a perspective view of a first embodiment of the invention. A conventional radiator 1 is pre-installed in a room and is connected to a wet central heating system (not shown). As is well known, the radiator comprises a fluid-filled panel 3, on the rear of which are welded a series of corrugated fins (not shown). The radiator 1 in isolation was found to create relatively large temperature gradients in the room, with air towards the top of the room being warmed to above a setpoint temperature, and air towards the bottom of the room remaining relatively cold (below the setpoint temperature). This is thought to be due to the component of the heating from radiation being relatively large, and there being relatively little convection (especially around the perimeter of the room). During use, the surface temperature of the radiator is also relatively high. Indeed, at maximum output, it is well above the 43 degrees C limit recommended by the UK Department of Health and in isolation it cannot be classified as a low-surface temperature (LST) heater.

[0031] In an attempt to address these problems, a cover and a convection-improving apparatus was retro-fitted to the radiator.

[0032] The cover 5 comprises a series of modular sections 7 (only three modular sections of which are shown in Figure 1). Each modular section comprises a front panel 7a and a top panel 7b. Along their vertical edges the modular sections have fasteners (not shown), enabling the modular sections 7 to be joined together, thereby forming an elongate cover 5 which is arranged to enclose and shield the radiator 1 from view (some of the radiator is visible in Figure 1 only because not all the cover sections 7 are shown).

[0033] The cover 5 has decoration (not shown) on the front panel which has been tailored according to the users' tastes. Thus, the cover 5 mitigates any aesthetic problems that might have been thought to exist with the radiator.

[0034] Radiator covers *per se* are known and are typically made with little consideration of their effect on heating efficiency (for example they may be made from a thermal insulator such as MDF, and/or have few ventilation holes). Thus, installation of a cover *per se* could have exacerbated the above-mentioned problems of the heat distribution in the room. However, in the first embodiment, a convection-improving apparatus is provided as will now be described with reference to Figures 2 to 3b.

[0035] Figure 2 is a view of the rear of two modular sections 7 of the cover 5. Attached to the rear surface of each section are three upwardly extending pipes 9. The pipes are in the form of thin-walled aluminium tubes having a circular cross-section. At the upper end of each pipe 9 is an outlet 11 and at the base of each pipe 9 is an inlet 13, such that air may freely pass through the pipe 9.

[0036] The pipes 9 are parallel to one another, and are positioned laterally adjacent to each other to form a strip of pipes 9 along the width of the cover 5. Figures 3a and 3b are side views of one of the pipes 9. Each pipe is pivotably held, at its lower end, by a mounting on the rear face of the modular section 7 of the cover 5. A perforated bracket 15 is attached to the rear face of the modular section 7. The bracket protrudes perpendicularly from that rear face such that it extends to one side of the mid-section of the pipe 9. Holding pins (not shown) are inserted through the perforations in the bracket 15 and engage corresponding recesses (not shown) in the sides of the pipe 9. Accordingly, the inclination of each pipe 9 can be altered from a vertical position (Figure 3a) to an inclined position (Figure 3b).

[0037] In all positions, the pipes remain sufficiently upright to facilitate creation of a convection current, as will now be described: When the radiator is hot, it radiates heat outwardly, primarily from its front face, and onto the pipes 9 between the radiator and the rear face of the cover 5. Since the pipes 9 are thermally conductive, they heat up and in turn, heat the air inside the pipe. As the air in the pipe is warmed it becomes less dense and rises up the pipe. Air starting at the base of each pipe is continuously warmed as it rises up the pipes, and is eventually released at the outlet 11. This upwards movement of air in turn draws in new cooler air at the inlet (this is often referred to as the chimney effect (or stack effect)). Movement of the air into the inlet is facilitated by the rectangular cut-ways 17 at the base of each modular section 7 of the cover 5, and movement of warm air into the room is facilitated by the grill 19 on the upper surface of the cover 5. This movement is shown by the large arrows in Figure 1

[0038] By providing the pipes 9, spaced apart from the radiator but such that they can be heated by the radiator 1, and allowing air flow into and out of the pipes 9, a natural convection current is established. The convection current has been found to improve the uniformity of the temperature distribution in the room. Thus, the first embodiment of the invention improves temperature distribution in the room. Furthermore, the multiplicity of pipes 9 have been found to act as a barrier to restrict heat transfer from the front of the radiator to the rear surface of the front cover 5. In fact, in the first embodiment of the invention, the size, number and spacing of the conduits has been selected to ensure that (at maximum output of the radiator) the temperature of the front cover does not exceed 43 degrees C. The heating apparatus (i.e. radiator, pipes and cover in combination) is thus an LST heater. This makes the heating apparatus especially attrac-

tive for use in buildings such as schools, care homes, hospitals.

[0039] Figure 4 is a view of two modular sections of a cover in a second embodiment of the invention. Features in the second embodiment of the invention that correspond to similar features in the first embodiment of the invention, are shown with the same reference numerals as in the first embodiment, but with the addition of the prefix '1' (or '10' where appropriate). The second embodiment is identical to the first embodiment except that each modular section 107 has only one pipe 109 attached thereto, and in that each pipe is made from copper. This arrangement is for use with a radiator having a lower thermal output than the first embodiment, so the number of pipes may be reduced to achieve the same surface temperature. In other embodiments, the pipes may be made from other thermally conductive materials such as brass or another metallic alloy, a thermally conductive composite or a thermally conductive plastic.

[0040] Figure 5 is a front perspective view of a third embodiment of the invention. Features in the third embodiment of the invention that correspond to similar features in the first embodiment of the invention, are shown with the same reference numerals as in the first embodiment, but with the addition of the prefix '2' (or '20' where appropriate). In the third embodiment of the invention, the cover 205 is a prefabricated structure that has been sized to enclose the radiator 203 it covers (the radiator 203 not being visible in Figure 5). The cover includes a decorative pattern (illustrated with asterisks in Figure 5). In common with the first embodiment, the cover 205 includes four rectangular inlets 217 at its base and a series of circular openings 219 at its top to enable circulation of air through the convection-improving apparatus. In the third embodiment, the cover 205 also includes a series of perforations 221 on the side to allow air circulation in the vicinity of the thermostatic radiator valve (TRV) (not shown).

[0041] Figure 6 is a view of the rear of the cover 205 and shows four upwardly extending pipes 209 mounted on the rear of the cover 205. The radiator is in a larger room than that of the first embodiment, thus the pipes 209 are each of larger diameter, and are each longer, than the pipes of the first embodiment, to allow a greater mass flow of air through the pipes. As shown in Figure 7, each pipe is held on the rear of the cover 5 by a similar mounting arrangement to the first embodiment. The pipes are all in front of, but spaced apart from, the radiator.

[0042] Figure 8 is a side view of yet another embodiment of the invention. This is identical to the above-described embodiments except that each pipe 309 includes a curved upper end 323 that is arranged to extend above the top of the radiator 301. The pipe 309 is shaped and positioned such that it always maintains a constant distance from the radiator 301 along almost its entire length. Having the upper-curved section ensures that the pipe is heated along as large a length as possible.

[0043] The curved upper section is also useful in ensuring the temperature on the top of the cover does not exceed the 43 degree threshold, as will now be explained in detail: The front of the radiator 301 primarily radiates heat to the surrounding environment (including the pipes 309). The radiator also draws air through it, which is heated and released through the top of the radiator. This heated air tends to be above 43 degrees. The pipes are designed such that the air released at the outlet is around 30 degrees. The curve, and the design of the pipes (e.g. their size, spacing, mass flow-rate etc.) has been chosen such that when the air from the pipe outlets mixes with the heated air from the radiator, the mixed air is at a temperature such that the temperature at the top of the cover, does not exceed this 43 degree threshold.

[0044] Figures 9 and 10 show features in a convection-improving device and cover according to a further embodiment of the invention. In Figure 9, the convection-improving apparatus comprises two rows of pipes 409, arranged in two adjacent layers. Furthermore, the pipes are somewhat shorter than those in the preceding embodiments and do not extend as close to the floor. Figure 10 shows a lid 407b for forming the top of a cover. The lid 407b includes perforations 419 arranged across the upper surface to allow warm air out of the cover. The lid 407b is attachable to side faces of a cover (not shown).

[0045] Figures 11, 12 and 13 are side, rear and front views respectively, of a heating apparatus according to yet another embodiment of the invention. In this embodiment, the heat source 501 is a clay core heater rated to 1500Watts. The heater comprises a baked kiln clay core 525 in which an electric heater element (not shown) is inserted. This type of heat source is known, and is, for example manufactured by the applicant (see for example <http://www.sunflowltd.co.uk/>). The kiln clay core 525 is heated to around 130 degrees C, which in turn heats the air within the heat source 501. The heated air rises upwardly through the heat source. During this process it transfers some heat into the front face, and other parts of the heat source, such that it is released through an opening (not shown) in the top of the heat source at around 90 degrees.

[0046] The cover 505 has a solid front face 505' (Figure 13) and perforated sides and top faces 505" and 505''' (Figures 11 and 12) to allow airflow from the room into the pipes 509 and heat source 501. As best seen in Figure 11, the cover 505 encloses the heat source.

[0047] The pipes 509 are held by brackets which locate them 15mm behind the rear of the cover 505 (but in front of the front of the heat source 501). The pipes are aluminium and have a 12.7mm outer diameter. The pipes 509 are 1500mm long and comprise a 90mm long angled portion 523 (angled at 24 degrees) for directing heated air from the outlets of the pipes, into the heated air that is released through the opening in the top of the heat source. The blending of the air from the pipes and from the heat source is such that the temperature of the top surface of the cover is below 43 degrees.

[0048] The pipes 509 are also laterally spaced apart (see Figure 12) such that they present a partial barrier to heat transfer, from the front of the heat source 501, into the rear of the front face of the cover 505. The spacing is such that the temperature of the front face of the cover 505 does not exceed 43 degrees.

[0049] Whilst the present invention has been described and illustrated with reference to particular embodiments, it will be appreciated by those of ordinary skill in the art that the invention lends itself to many different variations not specifically illustrated herein. For example, the pipes may be any shape that allows convection (for example they may be a non-circular cross-section).

[0050] Where in the foregoing description, integers or elements are mentioned which have known, obvious or foreseeable equivalents, then such equivalents are herein incorporated as if individually set forth. Reference should be made to the claims for determining the true scope of the present invention, which should be construed so as to encompass any such equivalents. It will also be appreciated by the reader that integers or features of the invention that are described as preferable, advantageous, convenient or the like are optional and do not limit the scope of the independent claims.

Claims

1. A low surface temperature (LST) heating apparatus for installing in a room, the heating apparatus comprising:

- (i) a heat source having a front, a back, sides, and a top;
- (ii) a convection-improving apparatus, the convection-improving apparatus comprising a multiplicity of upwardly extending conduits, each having an inlet located at its lower end and an outlet at its upper end, the conduits being in front of, and spaced apart from, the heat source but arranged such that the conduits are heated by the heat source; and
- (iii) a cover, the cover being arranged to substantially enclose the convection-improving apparatus and the front, back and sides of the heat source,

wherein the conduits are arranged such that, when they are heated by the heat source, cold air from the room is drawn in through the inlets, heated by the respective conduits, and the heated air is released from the outlets, thereby creating a natural convection current.

2. An apparatus according to claim 1, wherein the heat source comprises a heated thermal mass for heating air within the heat source, the heated air being released through the top of the heat source.

3. An apparatus according to claim 2, wherein the heated thermal mass comprises an electric heater element embedded in a solid core
4. An apparatus according to claim 3, wherein the solid core is a baked kiln clay core.
5. An apparatus according to any preceding claim, wherein the heat source is such that the heated air, released through the top of the heat source, is released at a first temperature, and the convection-improving apparatus is arranged such that the heated air from the outlets, is at a second temperature, the second temperature being lower than the first temperature.
6. An apparatus according to claim 5, wherein the conduits are arranged such that the heated air from the outlets blends with the heated air released through the top of the heat source.
7. An apparatus according to claim 6, wherein the upper end of each conduit comprises an angled portion for directing heated air from the outlets, into the path of the heated air released through the top of the heat source.
8. An apparatus according to claim 6 or claim 7, wherein the convection-improving apparatus has been designed to ensure the region of the cover heated by the blended air, has a surface temperature that is below a predetermined threshold temperature.
9. An apparatus according to claim 8, wherein the size, number and/or spacing of the conduits is selected such the surface temperature is below the predetermined threshold temperature.
10. An apparatus according to any preceding claim, wherein the size, number and/or spacing of the multiplicity of conduits is selected to restrict heat transfer from the front of the heat source to the front of the cover such that the surface temperature of the front of the cover is below a predetermined threshold temperature.
11. An apparatus according to any of claims 8 to 10, wherein the predetermined threshold temperature is 43 degrees Celsius.
12. An apparatus according to any preceding claim, wherein the cover and the convection-improving apparatus has been retro-fitted with the heat source.
13. An apparatus according to any preceding claim, wherein the multiplicity of conduits are positioned laterally adjacent, and substantially parallel, to each other.
14. An apparatus according to any preceding claim, wherein the inclination of the conduits to the vertical is adjustable.
15. A method of designing the low surface temperature (LST) heating apparatus according to any preceding claim, the method comprising the steps of:
 - tailoring at least one of the size, number and/or spacing of the multiplicity of conduits to ensure the cover has a surface temperature that is below a predetermined threshold temperature.

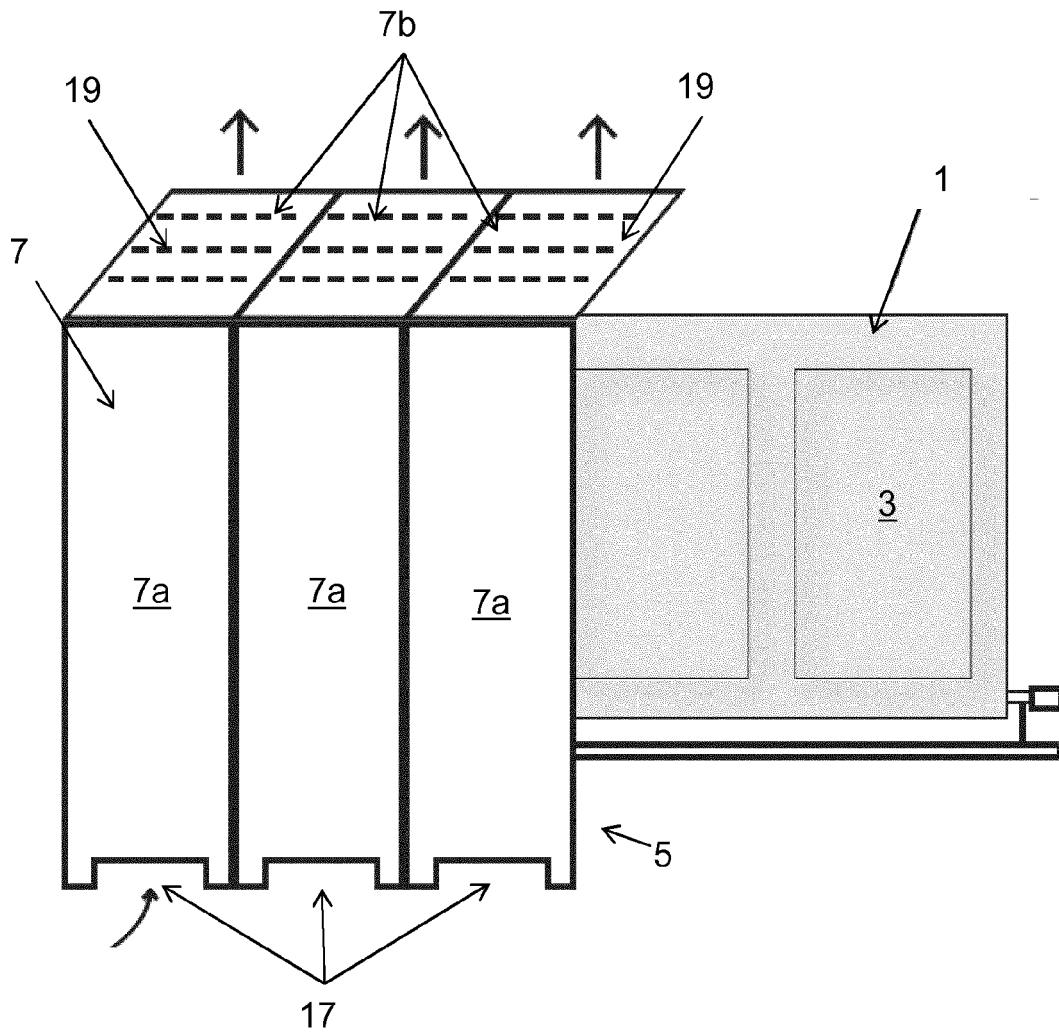


Figure 1

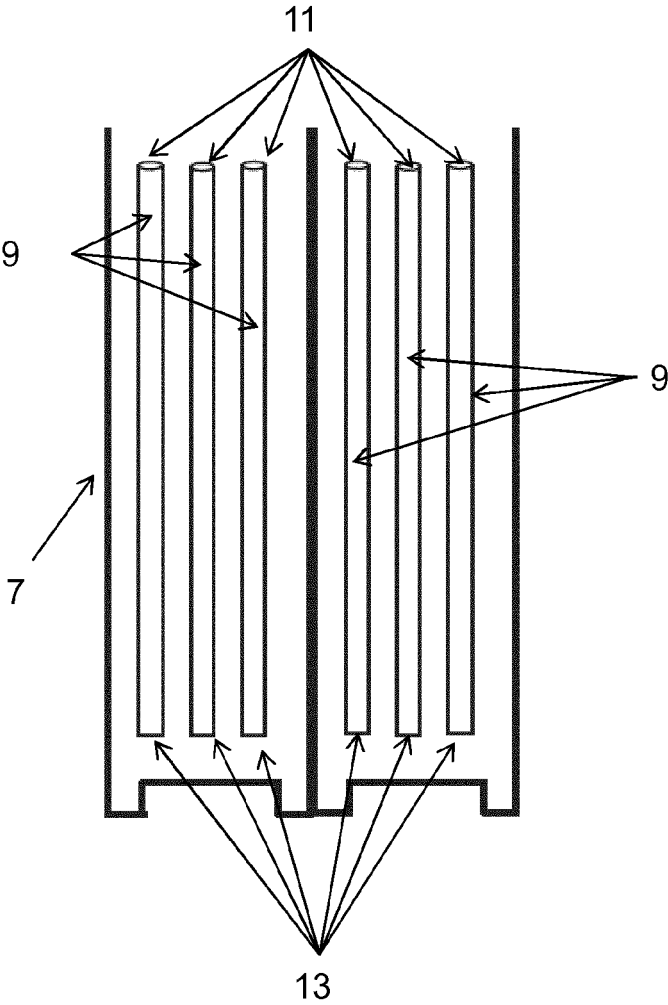
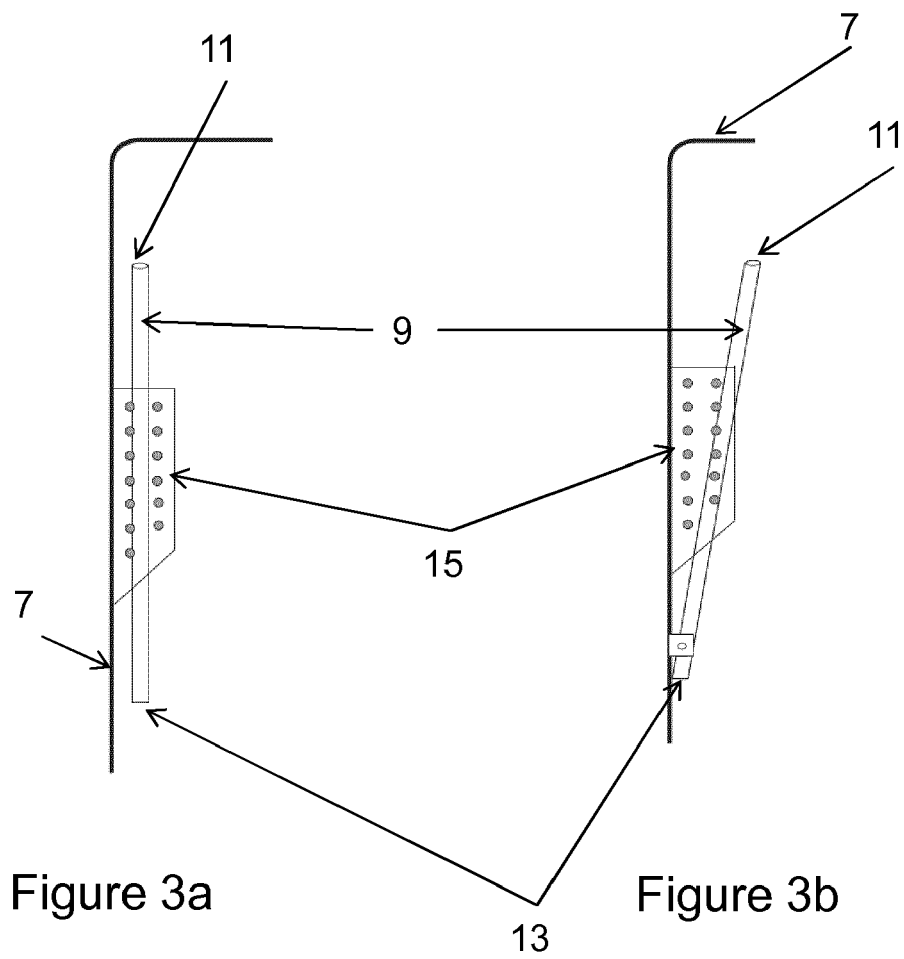


Figure 2



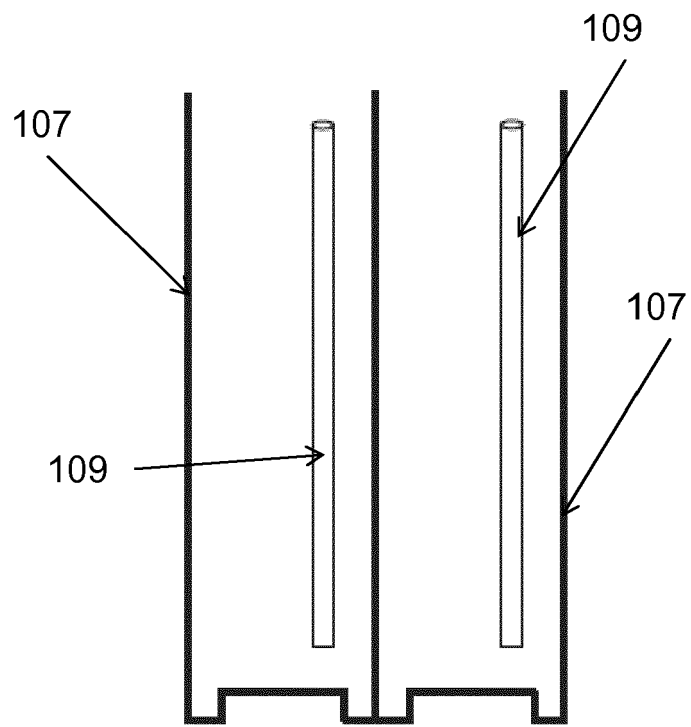


Figure 4

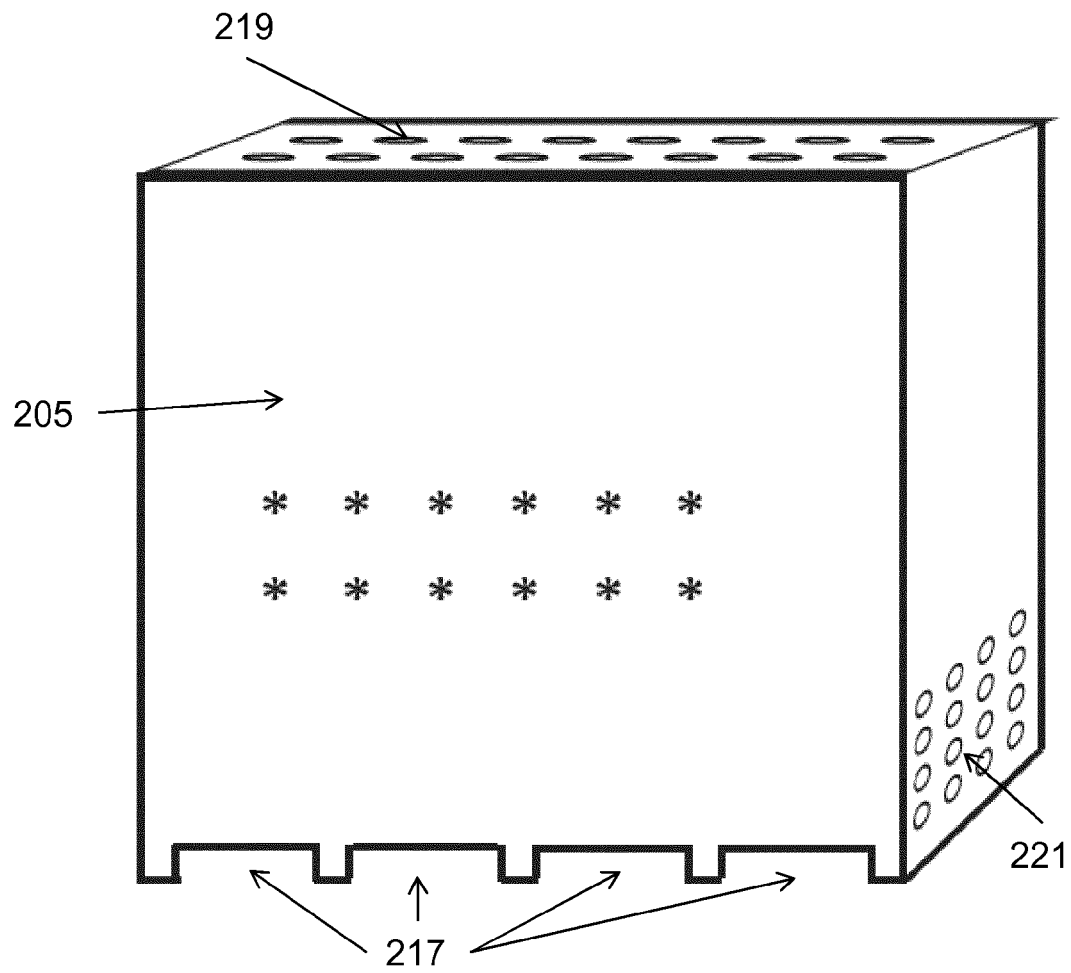


Figure 5

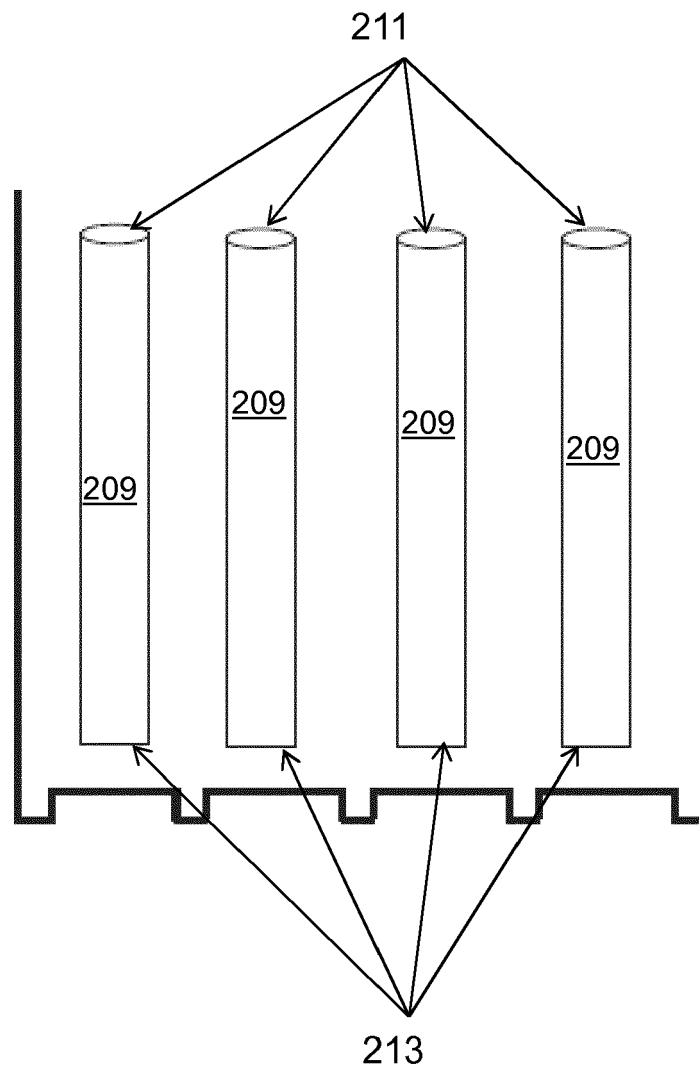


Figure 6

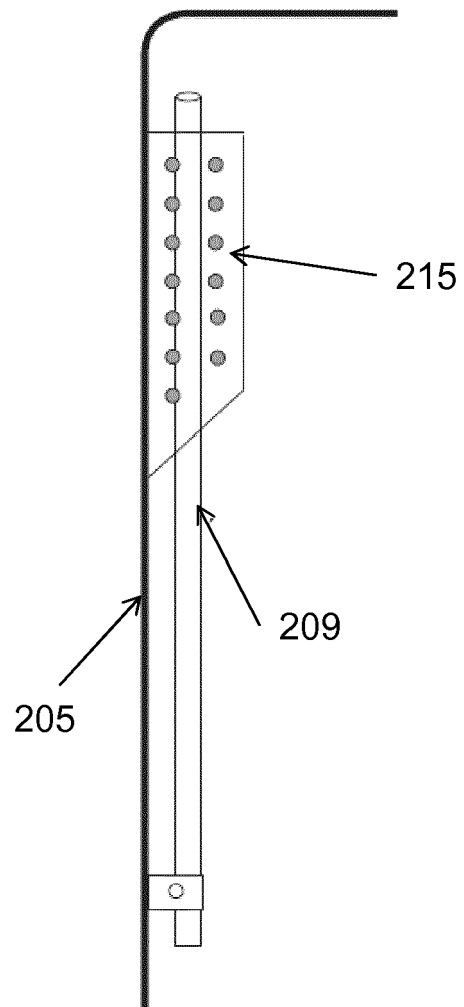


Figure 7

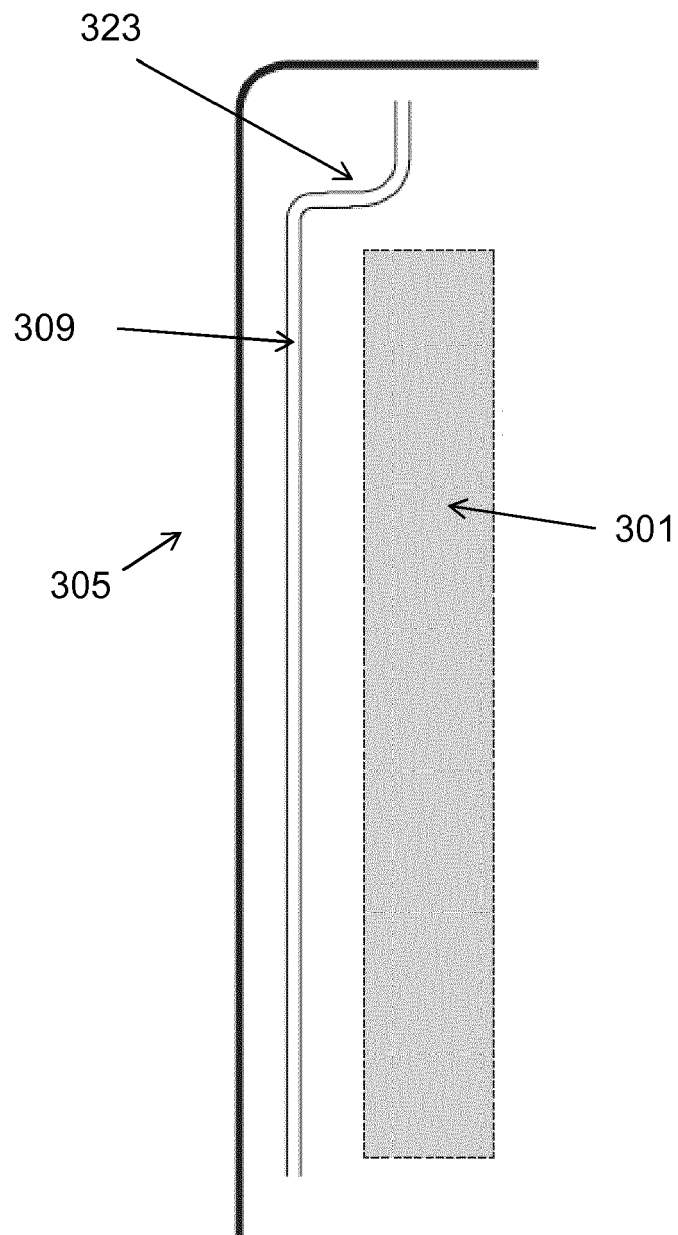


Figure 8

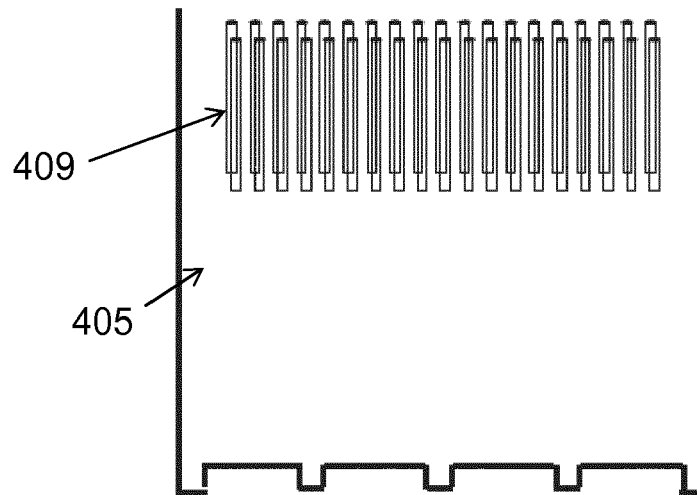


Figure 9

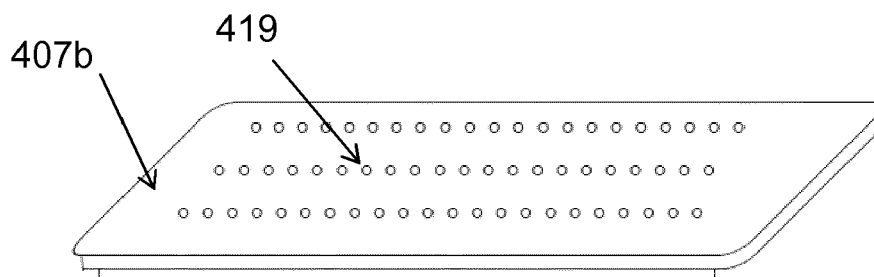


Figure 10

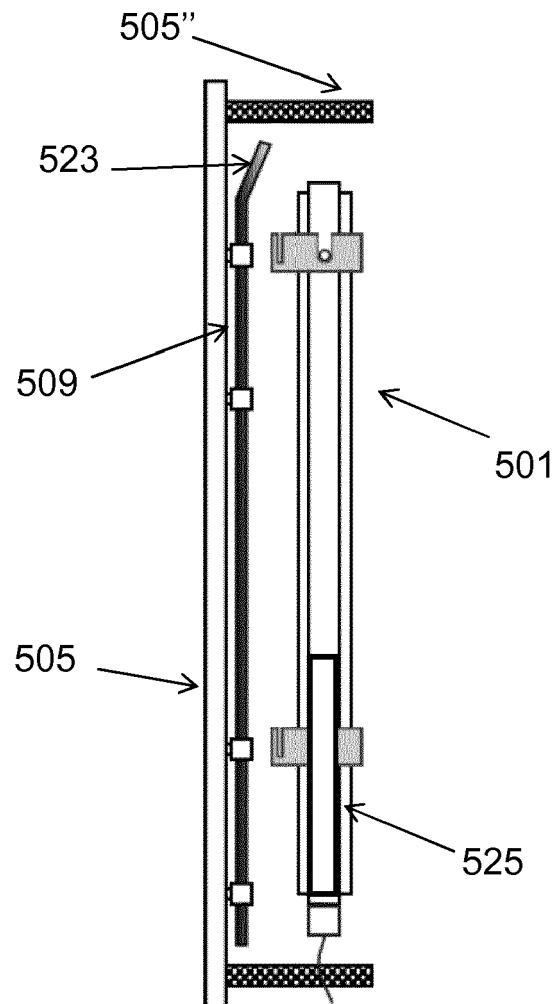


Figure 11

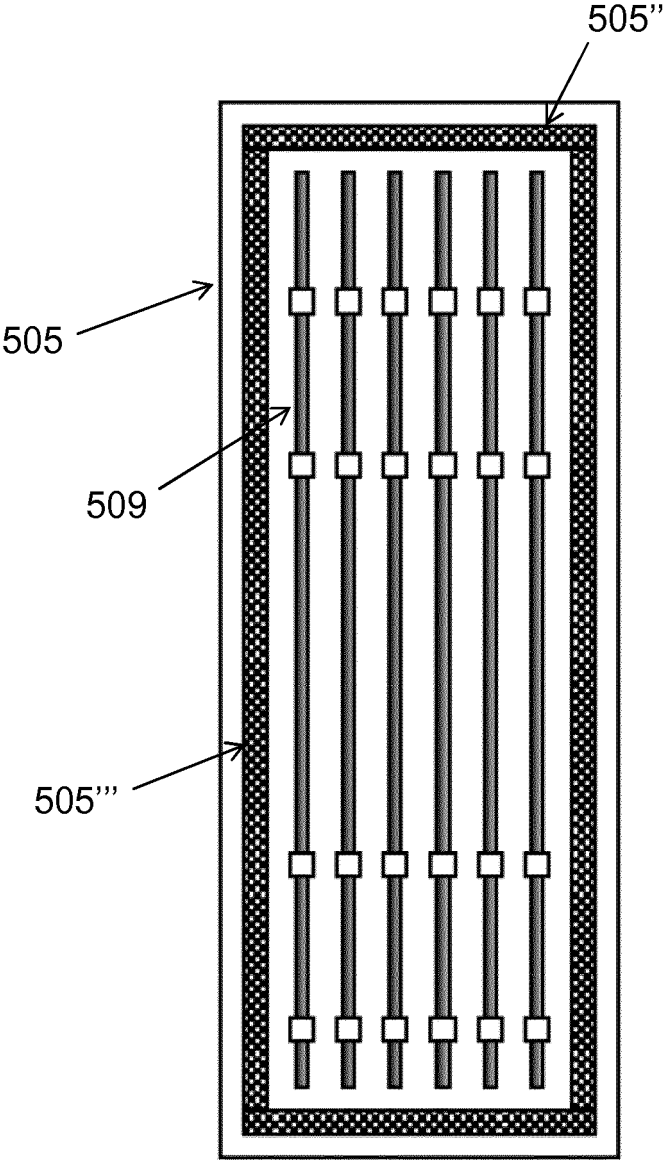


Figure 12

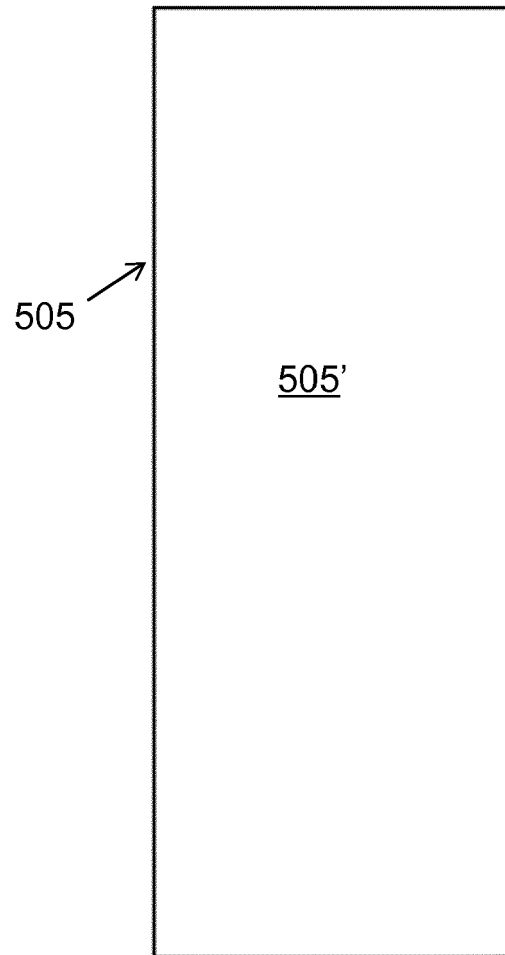


Figure 13



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 Application Number
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Place of search Munich		Date of completion of the search 30 June 2015	Examiner von Mittelstaedt, A
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The members are as contained in the European Patent Office EDP file on
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