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(54) THERMOACOUSTIC HEAT DISTRIBUTION SYSTEMS AND RELATED METHODS

(57) A thermoacoustic heat distribution system (100) is provided. The system includes a base (102) comprising a first surface (104) and a second opposite surface (106), a mounting structure (114C, 114D) for holding the base (102) to a supporting surface (116), a heating medium (108) applied on the base (102), an electrically conductive structure (110) arranged with the base (102), a power

supply unit (112) and a magnet unit (118). The power supply unit (112) is configured to increase the temperature of the heating medium (108) and to circulate a pulsating electric current through the electrically conductive structure (110). The magnet unit (118) is configured to generate a magnetic field which interacts with the pulsating electric current, causing the base (102) to vibrate.

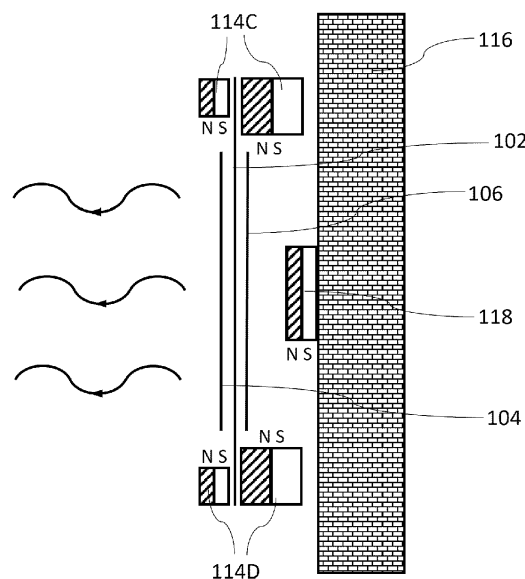


Fig. 3A

Description

TECHNICAL FIELD

[0001] The present disclosure relates generally to thermoacoustic technology and, more specifically, to thermoacoustic heat distribution systems and related methods for enhanced heating applications, for example for atmospheric and air heating applications. The thermoacoustic heat distribution systems and methods described herein may also be used in heat exchangers and heat pumps, as well as with other fluids or gases different from air.

BACKGROUND

[0002] Conventional heating systems often rely on mechanical components to distribute heat, which can be inefficient, noisy, and prone to wear and tear. A major challenge faced by conventional radiant and infrared heating applications is the low heat transfer rate to the surrounding medium, e.g. to the surrounding air. Also, distributing heat through a space, e.g. through a room, takes a relatively long time. In addition, the temperature distribution is usually non-homogenous throughout the room. Furthermore, conventional heating systems may offer limited rates of heating output.

[0003] To overcome at least some of the drawbacks of conventional heating systems, thermoacoustic systems may alternatively be used. A thermoacoustic device converts temperature modulation, i.e. thermal power, to pressure waves, i.e. acoustic power. However, the frequency response of existing thermoacoustic heating designs is generally insufficient at low frequencies and excessive at high frequencies.

[0004] Some other existing approaches attempt to utilize nano-scaled films for thermoacoustic sound generation, however sound generation achieved with these nano-scaled films is extremely weak because of the high thermal inertia. Hence, the existing design of thermoacoustic devices is not capable of achieving high acoustic impedance.

[0005] Therefore, there is a need to address the aforementioned technical drawbacks in existing technologies. Examples of thermoacoustic heat distribution system with increased efficiency, and well-suited for various applications and compatible with other technologies are herein provided.

SUMMARY

[0006] The present invention provides a thermoacoustic heat distribution system for enhanced heating applications. The thermoacoustic heat distribution system utilizes the thermoacoustic effect to convert and transfer thermal energy into and with acoustic waves for efficient heat distribution in the atmosphere, air, or any other suitable gas or fluid medium which surrounds the heat distribution system. The thermoacoustic heat distribution

system may be employed in various applications including space (rooms, building) heating, industrial processes, and waste heat recovery.

[0007] A first aspect of the present disclosure relates to a thermoacoustic heat distribution system. The system comprises a base having a first surface and a second surface opposite the first surface. The system further comprising a mounting structure configured to mount the base to a supporting surface such that the second surface of the base faces the supporting surface and such that the base can vibrate. A heating medium is applied on the first surface and/or the second surface of the base. The system further comprises an electrically conductive structure on the base and at least one power supply unit configured to supply an electric field to the heating medium to increase its temperature and to circulate a pulsating electric current through the electrically conductive structure (e.g. by apply a pulsating voltage or an electric field). The system further comprises a magnet unit comprising one or more magnets configured to be arranged on the supporting surface and facing the second surface of the base, the magnet unit being configured to generate a magnetic field which interacts with the electric current circulating through the electrically conductive structure for causing the base to vibrate.

[0008] Accordingly, the interaction between the pulsating current circulating through the electrically conductive structure and the magnetic field created by the magnet unit is able to cause a force on the electrically conductive structure. As the electrically conductive structure is connected to the base, the force is transmitted to the base. And as the current circulating through the electrically conductive structure changes direction, the base can be vibrated depending for example on the frequency of the applied pulsating voltage. The vibration of the base can therefore be transmitted to adjacent molecules of the surrounding fluid, helping to transfer and to distribute the heat released by the heating medium. In this manner, heat may be efficiently radiated to the surroundings of the heat distribution system.

[0009] The present disclosure provides an effective and rapid thermoacoustic heat distribution system for heating spaces such as living spaces. The thermoacoustic heat distribution system utilizes the thermoacoustic effect to convert and distribute thermal energy into and with acoustic waves for efficient heat distribution. The acoustic waves caused by the vibration of the base help to transfer and distribute the heat to the surrounding medium. In addition, the collision/friction between adjacent molecules of the surrounding medium may also help to increase the temperature.

[0010] A more uniform temperature distribution across the space surrounding the heat distribution system may be achieved. I.e., rather than having a rapid decrease of temperature with an increasing distance away from the heat distribution system, a more homogeneous temperature across the space may be obtained. A temperature may be similar near the heat distribution system as well

as far away from it.

[0011] The thermoacoustic heat distribution system may help to heat a space, e.g. a room, at a same time that adjacent spaces, e.g. other rooms, can be maintained at other desired temperatures. For example, the applied pulsating voltage, the applied magnetic field and the composition of the heating medium can be adjusted such that a specific temperature is achieved at the borders of the space what is heated with the heat distribution system.

[0012] Acoustic resonance may also help to increase heating and to distribute heat. If the base is vibrated at a resonance frequency of the surrounding fluid, the surrounding fluid may be vibrated more easily and higher amplitudes of the waves transferring heat may be achieved. The shape and dimensions of the base and the extension and shape of the applied heating medium and the electrically conductive structure may for example help to achieve a resonance frequency.

[0013] Also, if waves transferring heat rebound against e.g. a wall, they may interfere constructively with other waves going towards the wall, further increasing temperature. In addition, the reflected thermoacoustic waves may increase the internal energy of a fluid present in the chamber or room when interacting with it, also leading to an increase of temperature. One or more surfaces configured to enhance reflection of the thermoacoustic waves may be placed on the walls.

[0014] Another possibility to increase thermoacoustic performance may include using more than one heat distribution system, e.g. two bases may be arranged facing each other. This may also help to limit heat distribution between the base, without heating e.g. adjacent rooms.

[0015] The efficiency and performance of the thermoacoustic heat distribution system may be adjusted and improved by optimizing the design, materials, and operational parameters. The thermoacoustic heat distribution system may be employed in various applications, including space heating, industrial processes, and waste heat recovery. The system is compatible with other technologies, such as solar thermal collectors, heat pumps, and energy storage systems including for example compressed gas or other fluid, wherein compression is caused by acoustic resonance in a closed container with one or more membranes.

[0016] In another aspect of the disclosure, a method for thermoacoustic heat distribution is provided. The method comprises arranging a magnet unit comprising one or more magnets on a supporting surface; holding a base (102) comprising a heating medium (108) applied on a first surface (104) and/or a second surface (106) opposite the first surface (104) of the base to the supporting surface (116) such that the second surface (106) of the base (102) faces the magnet unit (118) on the supporting surface (116) and such that the base (102) can vibrate, wherein the base (102) comprises an electrically conductive structure (110) arranged with the base (102). The

method further comprises causing the heating medium to increase its temperature; circulating a pulsating electric current through the electrically conductive structure with a power supply unit; and generating a magnetic field, with the magnet unit, that interacts with the electric current circulating through the electrically conductive structure, therefore causing the base to vibrate.

[0017] Optionally, the method may further comprise applying the heating medium on a first surface and/or a second surface opposite the first surface of a base; and/or arranging the electrically conductive structure with the base, optionally with the second surface of the base.

[0018] The thermoacoustic heat distribution system described herein can be used to perform the method of this aspect. The following applies to the thermoacoustic heat distribution systems and the methods described throughout this disclosure.

[0019] The base may in general be a solid base configured to vibrate and withstand the vibrations. In some examples, the base comprises, or is made of, plastic, rubber aluminum, silicon, glass or iron. Other materials may also be suitable for the base. Also, the base may in general be configured to withstand the temperatures reached by the heating medium.

[0020] Optionally, the base is a sheet, e.g. a substantially flat sheet (when not vibrated and e.g. when stretched). The sheet may be flat when held by the mounting structure to the supporting surface, but if the sheet is flexible, it may fold if not in a stretched position. In some examples, the base may be made of a cellulose-based material. The base may have any suitable shape. For example, the base may have a cylindrical shape in some examples.

[0021] Optionally, the base is made of any other suitable material, e.g. a flexible material. The base may include one or more metals, plastics, silicon or rubbers. The base may include aluminum or iron.

[0022] The heating medium may be any sort of paint, coating, deposition or other distribution on the base. The heating medium may comprise nanoparticles. Optionally, the heating medium applied to the sheet, e.g. a cellulose sheet, comprises Si or SiO₂ nanoparticles dispersed in a solution comprising a binder capable of resisting high temperatures, e.g. temperatures above 300 °C, 1000 °C or 1800 °C. For example, the heating medium may comprise a mixture of SiO₂ nanoparticles dispersed in a Na₂SiO₃ solution. The Na₂SiO₃ helps the base to resist high temperatures. The SiO₂ nanoparticles may have a size between 2 and 50 nm, and they may be dispersed in a 30% Na₂SiO₃ solution in water with 5 g of nano SiO₂.

[0023] The base may be painted, e.g. impregnated with, the above solutions. The base may be more durable, have a better surface tension, strength, and elasticity in this manner. The base, e.g. a cellulose sheet, may operate effectively, without breaking or changing its dimensions.

[0024] Optionally, the heating medium applied to the base comprises a pH between 9 and 12 and comprises

carbon black nanoparticles and graphite nanoparticles. This may help to enhance the heating of the heating medium. The heating medium may be prepared e.g. by (i) dispersing 30% Na_2SiO_3 in water having a pH of 9, (ii), adding 5 g of carbon black nanoparticles, and (iii) combining the mixture with nano graphite (optionally having a particle between 2 and 60 nm) with additional water having a pH of 9. Na_2SiO_3 is used as a binder and the carbon black nanoparticles are added to increase electrical conductivity.

[0025] The heating medium may be prepared as an acid-based paint depending on the application surface. If the application surface has an alkaline pH, such as glass, the heating medium may dissolve portions of the application surface and the nanoparticles may be arranged in the created voids or channels.

[0026] Depending on the desired performance, various nanomaterials may be incorporated in the heating medium, e.g. for radiant or passive heating applications, including nano-silicon (Si), nano-silicon dioxide (SiO_2), nano-activated carbon, nano-tungsten (W), nano-aluminum (Al) flakes or powder, magnetite or iron, iron (II) oxide (FeO), and copper (Cu). For acoustic heating applications, nano-aluminum flakes may be used due to their excellent thermal conductivity, which facilitates heat transfer to the surrounding medium such as air. SiO_2 is a lightweight material with high-temperature resistance, incombustibility, and low thermal conductivity (less than 0.02 W/(m·K) at room temperature). SiO_2 has found application in the industrial energy conservation field, where it transforms into a glass structure at 1200°C. Furthermore, SiO_2 is considered a safe and non-hazardous material.

[0027] The heating medium may be an electrically conductive paint that operates through the combination of ultra-fine electrically conductive particles, such as metals or graphite, and a liquid medium. These particles are extremely small to maintain the wetting and binding properties of the nano heating medium. Electrical current may be conveyed through the nano heating medium by transferring from one nanoparticle to another. When the nano heating medium is applied as a thin layer on the first or second surface of the base, the inner resistance may increase due to the interaction of the electrically conductive nanoparticles with the binder, e.g. graphite nanoparticles with the heat insulating NaSiO_3 .

[0028] The NaSiO_3 arranges the graphite nanoparticles in a polymer chain-like structure, where the graphite's orientation is determined by its inherent polarity and its position within the substrate's voids. Upon drying and heating, the structure becomes glassy, and when heated up to 1200°C in an inert atmosphere, it transforms into an electrically conductive glass structure with enhanced heating performance. This conductive glass structure is suitable for passive heating and heat storage applications when mixed with quartz sand or cement, and can be molded into heating plates.

[0029] The thermal capabilities of the graphite-based

mixture can be improved by adding $\text{KNO}_3/\text{NaNO}_3$ (50 mol% NaNO_3) to achieve heat storage in materials such as concrete or stone plates painted with the nano heating medium, or aluminum plates painted with the nano heating medium for passive heating applications like radiators. With the incorporation of additional materials like amorphous SiO_2 and other molten salt combinations, the nano heating medium can withstand temperatures up to 500°C without degradation. This temperature range can be further extended to over 1000°C, making it essential for heat storage applications. The nano heating medium may in general be obtained as an ink, paste, or spray.

[0030] The mounting structure may be configured to mount the base to a support surface such as a wall or a ceiling in an elastic way and achieve limited friction between the base and the mounting structure. The base may therefore be connected to the support surface through the mounting structure, but the base may not directly contact the support surface at least in some examples. Vibration of the base and therefore heat radiation may be facilitated in this manner. In some examples, the mounting structure may comprise a plurality of magnets to hold the base to the supporting surface. In other examples, the mounting structure may comprise different elements. For example, the mounting structure may comprise one or more screws, adhesive, a damping element such as a spring, or others.

[0031] In examples where the mounting structure comprises a plurality of magnets, e.g. permanent magnets, the number of magnets may be adjusted depending e.g. on the shape and size of the base. In some of these examples, the mounting structure may include four permanent magnets positioned at each corner of the base to hold the base to the supporting surface.

[0032] The mounting structure may be constructed such that, in use, the base does not touch the supporting surface to avoid any loss caused by heat transfer to the supporting surface, e.g. to a wall surface. In some examples, the base does not touch the mounting structure. For example, the base may be positioned between two or more magnets such that the base levitates in between them without touching them. Magnetic bearings may be used to this end.

[0033] The magnets of the magnet unit and/or of the mounting structure may be permanent magnets or electromagnets. In some examples, the magnet unit may comprise a ring magnet.

[0034] Optionally, the plurality of (permanent) magnets of the mounting structure creates additional vibrations during the sound wave generation, i.e. during the vibration of the base. For example, depending on the arrangement of the electrically conductive structure and the mounting unit, additional vibrations may be created by the interaction between them.

[0035] Optionally, the magnets of the magnet unit, e.g. a plurality of permanent magnets or electromagnets of the magnet unit, may be arranged on the supporting surface, e.g. a wall surface, in one or more circular or

square patterns. The magnets would be opposite (facing) the second surface of the base.

[0036] The permanent or electromagnets may be circular-shaped, square-shaped, or of any other predefined shape. The permanent or electromagnets are positioned on the wall surface in various configurations to generate sound and vibrations by the interaction of applied current frequency and voltage in the conductive coil structure and the magnet field out of the positioned magnets.

[0037] In some embodiments, the electrically conductive structure and the heating medium are the same element. That is to say, the heating medium may increase its temperature such that heat can be distributed to the surroundings of the heat distribution system. Also, the heating medium may conduct electricity such that, when interacting with a magnetic field generated by the magnetic unit, the base is vibrated. In these examples, the heating medium may be applied to the second surface of the base. In some of these examples, the electrically conductive heating medium may be applied forming a spiral. The power supply unit may be configured to apply a pulsating current to the painted electrically conductive structure to generate heat. For example, an AC voltage may be used for generating heat and about 50 Hz vibrations.

[0038] The electrically conductive structure may be painted with any suitable electrically conductive paint. The paint may comprise or may be based on copper, carbon or silver. The painted electrically conductive structure may adopt different shapes or geometrical patterns.

[0039] In other examples, the electrically conductive structure and the heating medium are different elements. In some of these examples, the heating medium may be applied to the first surface of the base, whereas an electrically conductive structure such as a coil may be arranged with the second surface of the base. The coil may be a copper coil. The heating medium and the electrically conductive structure may have a same shape in some examples, e.g. a spiral shape. Both the coil and the heating medium are connected (through a wireless or wired connection) to a power source such that the amplitude and frequency of the waves generated by the vibration of the base can be controlled.

[0040] The electrically conductive structure may adopt different shapes or patterns, e.g. spiral, circular, squared, triangular, labyrinth-like or combinations thereof. It may be easier to have an electrically conductive structure with different shapes if the heating medium is used as the electrically conductive structure.

[0041] In some embodiments, a heat insulating layer may be applied to the first surface and/or to the second surface of the base before applying the heating medium for avoiding the release of heat beyond that heat insulating layer. In some examples, silicon nitride may be used as a primer, i.e. as a heat insulating layer below the heating medium. Silicon nitride may be prepared by heating powdered silicon between 1300 °C and 1400

°C in a nitrogen atmosphere according to the following chemical reaction: $3 \text{ Si} + 2 \text{ N}_2 \rightarrow \text{Si}_3\text{N}_4$.

[0042] The power supply unit may be configured to heat the heating medium and to apply a pulsating voltage to the electrically conductive structure. The power supply unit may comprise one or more power sources to this end. In some examples, a same power source may be used to cause the heating medium to raise its temperature and to circulate a current through the electrically conductive element. In other examples, the heating medium and the electrically conductive element may use different power sources and different power supply units.

[0043] Optionally, causing the heating medium to increase its temperature comprises applying an electric field to the heating medium. Electromagnetic waves such as radio waves or microwaves may be applied. The heating medium may be heated wirelessly. A free flow of electrons from any suitable power source may be used.

[0044] The power supply unit may be wirelessly connected to the heating medium and/or the electrically conductive structure in some examples. For example, the power supply unit may be configured to apply an electric field to the heating medium. In other examples, the power supply unit may be connected to the heating medium and/or the electrically conductive structure through wires. The wires may be made of different materials. Optionally, the wires connected to the base may be painted (coated) with the heating medium.

[0045] The power supply unit may be configured to provide a pulsating voltage, e.g. a DC pulsating voltage or an AC voltage. The power supply may be obtained through a wall socket of e.g. 1 to 50 V, 50 to 380 V, 380 V to 10000 V, e.g. 120 V or 220 V. The voltage may have different amperage. The applied voltage and amperage may for example vary depending on the desired temperature output.

[0046] The power supply unit, or a power source therein, may be a frequency driven power supply with different signals, e.g. squared, saw toothed, triangular, or sinusoidal signals, or a combination thereof. The frequency of a signal may start in 50 Hz and may reach the MHz range. Frequencies comprising harmonics and resonance frequencies for causing the heating medium and/or the electrically conductive structure to resonate may be used.

[0047] In some embodiments, a modular pulse and frequency controller is employed to provide a frequency depending on the medium surrounding the heat distribution system, e.g. depending on the fluid, liquid or gas, and/or on the dimension, volume and different shapes of the chamber(s) or room. By applying a previously decided signal (squared, etc.) resonance may be achieved to maximize the heating effect. To find out the harmonics and resonance frequencies required for the best possible effect, a spectrum analysis may be used to analyze the given conditions and optimize the behavior of the heat distribution system.

[0048] The sound waves generated may be audible or

sub-audible.

[0049] The power supply unit may comprise electrical heating elements, combustion, or solar energy in some examples.

[0050] A heating medium may be understood as any coating, deposition, impregnation or particularly a paint which can be applied to a surface, and which may heat e.g. if a current or an electric field is applied to it.

[0051] It should be noted that voltage and current are related, and therefore "applying a pulsating voltage" covers both selecting a voltage, e.g. the amplitude of a voltage signal, as well as selecting a current, e.g. the amplitude of a current signal throughout this disclosure. A pulsating voltage may include a pulsating DC voltage as well as an alternating (AC) voltage.

BRIEF DESCRIPTION OF THE FIGURES

[0052] The disclosure will be better understood and objects other than those set forth above will become apparent when consideration is given to the following detailed description. Such description refers to the annexed figures, wherein:

FIG. 1 is a schematic illustration of a thermoacoustic heat distribution system according to an embodiment of the present disclosure.

FIGS. 2A - 2B is a schematic illustration of the first surface and the second surface of the thermoacoustic heat distribution system of **FIG.1**.

FIG. 3 is a schematic illustration of a side view of the thermoacoustic heat distribution system of **FIG.1**.

FIG. 4 illustrates fluid such as air or gas circulation between the wall surface and the thermoacoustic heat distribution system of **FIG.1**.

DETAILED DESCRIPTION OF EXAMPLES

[0053] The description set forth below in connection with the appended drawings is intended as a description of presently preferred embodiments of the disclosure and is not intended to represent the only forms in which the present disclosure can be constructed and/or utilized. The description sets forth the functions and the sequence of steps for constructing and operating the disclosure in connection with the illustrated embodiments. It is to be understood, however, that the same or equivalent functions and sequences can be accomplished by different embodiments that are also intended to be encompassed within the scope of this disclosure.

[0054] The vibrations caused in the base can generate additional heat by the interaction with air or other fluid molecules with no needed of applied power. I.e., the energy of the molecules of fluid adjacent to the base increases, and therefore their temperature too.

[0055] **FIG. 1** is a schematic illustration of a thermoacoustic heat distribution system according to an embodiment of the present disclosure. The thermoacoustic heat distribution system **100** includes a base **102** comprising a first surface **104** and a second surface **106** opposite the first surface (Not shown in **FIG.1**). The second surface **106** comprises an electrically conductive structure **110** (see **FIG. 2B**), which in this example is an electrically conductive coil **110** which has been painted using a heating medium **108**.

[0056] A power supply unit **112** causes the temperature of the heating medium to increase and causes a pulsating current to circulate through the conductive coil **110**. For example, an electric field may be applied to the conductive coil with a certain frequency. In particular, a power supply unit may cause an alternating pulse through the conductive coil **110**. The current in the coil causes a magnetic field, and the alternating pulses cause a varying magnetic field.

[0057] A mounting structure **114 A-D** is used to mount the base to a supporting surface, e.g. to a wall surface. In this example, the mounting structure comprises a plurality of permanent magnets provided at corners of the base **102**. A magnet unit **118** (Not shown in **FIG.1**) comprising a plurality of permanent magnets or electromagnets is arranged on the wall surface **116**. A magnetic field created by the magnet unit **118** interacts with the pulsating electric current circulating through the electrically conductive coil, causing vibrations in the base **102**. The vibrations accelerate air or other gas or fluid molecules in a surrounding medium causing compression and rarefaction (i.e. reduction in the density of the air or gas or fluid) of the air or other gases or fluids to produce the sound waves to transfer heat in the surrounding medium.

[0058] The sound waves cause collision or friction between the air or other gas molecules to enhance the heating effect.

[0059] **FIG. 2A - 2B** is a schematic illustration of the first surface and the second surface of the thermoacoustic heat distribution system of **FIG.1**. **FIG.2A** illustrates the first surface **104** of the thermoacoustic heat distribution system **100**. **FIG.2A** includes the mounting structure comprising the plurality of permanent magnets **114A-D** provided at each corner of the base **102**. **FIG.2B** illustrates the second surface **106** of the thermoacoustic heat distribution system **100**. The second surface **106** comprises a conductive coil **110** painted using the nano-heat paint **108**. Optionally, the magnet unit **118** is a ring magnet. Middle convection occurs from the central portion of the conductive coil **110** and the side convection occurs from the side portion of the conductive coil **110**.

[0060] **FIG. 3** is a schematic illustration of a side view of the thermoacoustic heat distribution system of **FIG.1**. The side view of the thermoacoustic heat distribution system **100** includes the base **102** comprising the first surface **104** and the second surface **106**, the mounting structure comprising the permanent magnets **114 C-D**, and the magnet unit **118**. A magnetic field created by the

magnet unit **118** interacts with the pulsating electric current circulating through the electrically conductive structure **110** causing vibrations in the base **102**. The vibrations accelerate air or other gas molecules in a surrounding medium causing compression and rarefaction of the air or other gases to produce the sound waves to transfer heat in the surrounding medium. The sound waves may cause collision or friction between the air or other gas or fluid molecules to enhance the heating effect.

[0061] FIG. 4 illustrates air or gas or fluid circulation between the supporting surface, e.g. a wall surface, and the thermoacoustic heat distribution system of FIG. 1. FIG. 4 includes the base **102** comprising the first surface **104** and the second surface **106**, the mounting structure comprising the permanent magnets **114 C-D**, and the magnet unit **118**. Air or gas or fluid circulation is achieved between the wall surface **116** and the base **102** by the mounting structure comprising the plurality of permanent magnets **114 A-D**. The air circulation may be facilitated using an air heating pump with one-way valves where air or other media is pumped or transported between the wall and the heated second surface.

[0062] The foregoing description is provided to enable any person skilled in the relevant art to practice the various embodiments described herein. Various modifications to these embodiments will be readily apparent to those skilled in the relevant art, and generic principles defined herein can be applied to other embodiments.

Claims

1. A thermoacoustic heat distribution system (100), comprising:

a base (102) comprising a first surface (104) and a second surface (106) opposite the first surface (104);
 a mounting structure (114C, 114D) configured to mount the base (102) to a supporting surface (116) such that the second surface (106) of the base (102) faces the supporting surface (116) and such that the base (102) can vibrate;
 a heating medium (108) applied on the first surface (104) and/or the second surface (106) of the base (102);
 an electrically conductive structure (110) provided on the base (102);
 at least one power supply (112) configured to cause the heating medium (108) to increase its temperature and to circulate a pulsating electric current through the electrically conductive structure (110);
 a magnet unit (118) comprising one or more magnets configured to be arranged on the supporting surface (116) and facing the second surface (106) of the base (102), the magnet unit (118) being configured to generate a magnetic

field which interacts with the electric current circulating through the electrically conductive structure (110) to cause the base (102) to vibrate.

2. The system (100) according to claim 1, wherein the heating medium (108) is the electrically conductive structure (110).
3. The system (100) according to claim 1 or claim 2, wherein the base (102) is a sheet.
4. The system (100) according to any of claims 1-3, wherein the base (102) is made of a cellulose-based material.
5. The system (100) according to any of claims 1-4, wherein the base (102) comprises, and optionally is made of, plastic, metals, rubber, silicon or glass.
6. The system (100) according to any of claims 1 - 5, wherein the electrically conductive structure (110) comprises a spiral pattern, a circular pattern, a squared pattern, a triangular pattern, or combinations thereof.
7. The system (100) according to any of claims 1-6, wherein the heating medium comprises nanoparticles.
8. The system (100) according to claim 7, wherein the heating medium comprises Si or SiO₂ nanoparticles dispersed in a solution comprising a binder capable of resisting temperatures above 300 °C, optionally above 1000 °C, and optionally above 1800 °C.
9. The system (100) according to claim 8, wherein the heating medium (108) comprises SiO₂ nanoparticles dispersed in a Na₂SiO₃ solution.
10. The system (100) according to claim 7, wherein the heating medium (108) comprises a pH between 9 and 12 and further comprises carbon black nanoparticles and graphite nanoparticles.
11. The system (100) according to any of claims 1 - 10, wherein the mounting structure (114C, 114D) comprises a plurality of magnets to hold the base (102) to the supporting surface (116).
12. A method for thermoacoustic heat distribution, the method comprising:

arranging a magnet unit (118) comprising one or more magnets on a supporting surface (116);
 holding a base (102) comprising a heating medium (108) applied on a first surface (104) and/or a second surface (106) opposite the first surface

(104) of the base to the supporting surface (116) such that the second surface (106) of the base (102) faces the magnet unit (118) on the supporting surface (116) and such that the base (102) can vibrate, wherein the base (102) further comprises an electrically conductive structure (110) arranged with the base (102); causing the heating medium (108) to increase its temperature;
circulating a pulsating electric current through the electrically conductive structure (110) with a power supply unit (112);
generating a magnetic field, with the magnet unit (118), that interacts with the electric current circulating through the electrically conductive structure (110), therefore causing the base (102) to vibrate.

13. The method according to claim 12, wherein the magnetic unit (118) comprises a plurality of magnets, and the plurality of magnets is arranged on the wall surface (116) in one or more circular or square patterns.
14. The method according to claim 12 or claim 13, wherein causing the heating medium (108) to increase its temperature comprises applying an electric field to the heating medium.
15. The method according to any of claims 12 - 14, wherein the base is held to the supporting surface by a mounting structure which comprises a plurality of magnets (114 A-D) that creates additional vibrations during the vibration of the base.

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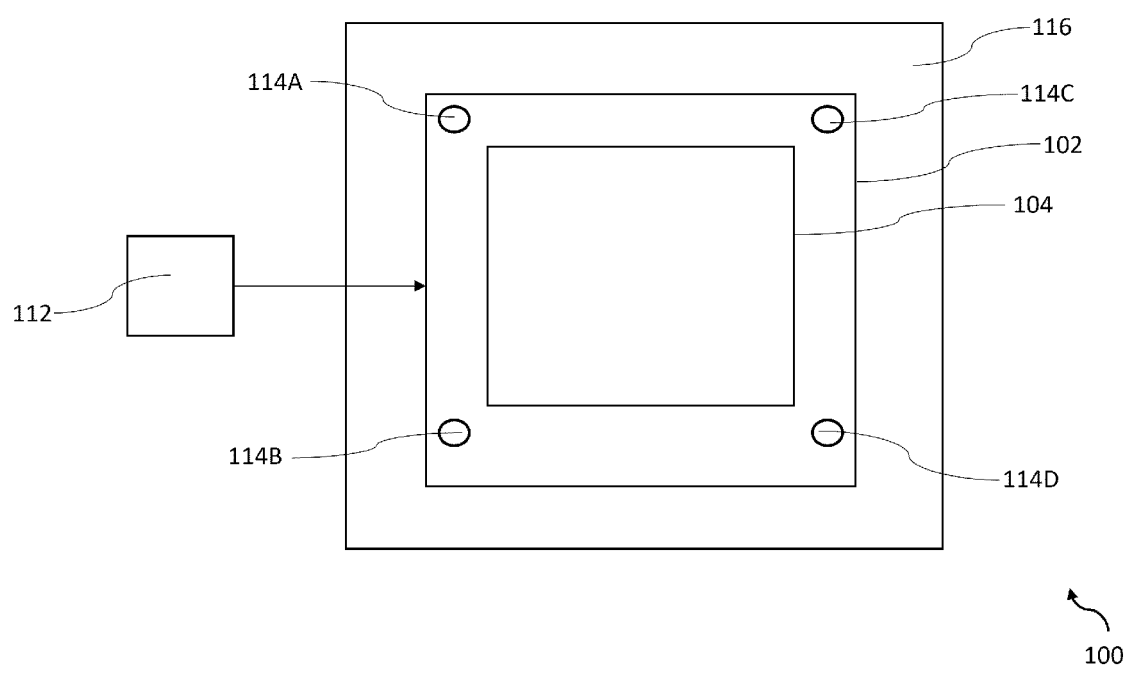


Fig. 1

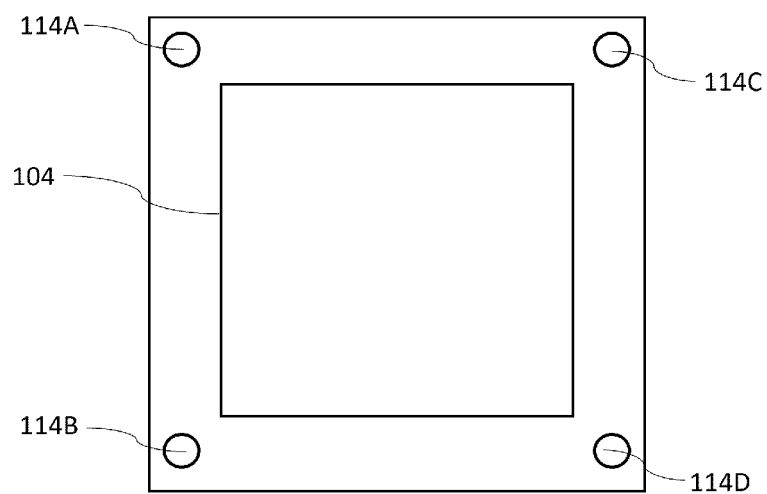


Fig. 2A

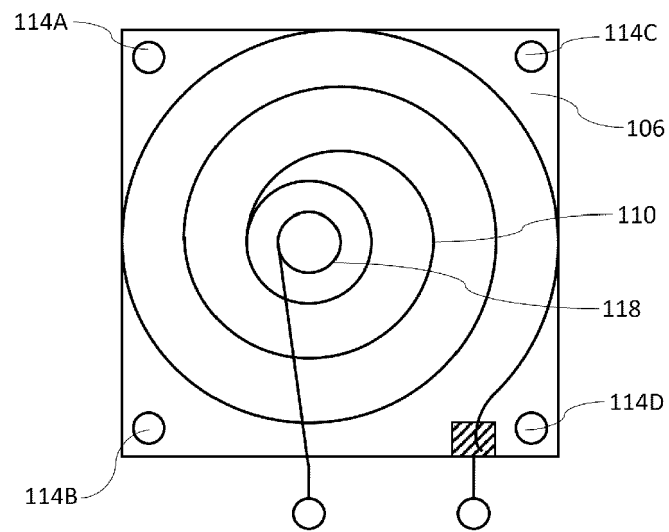


Fig. 2B

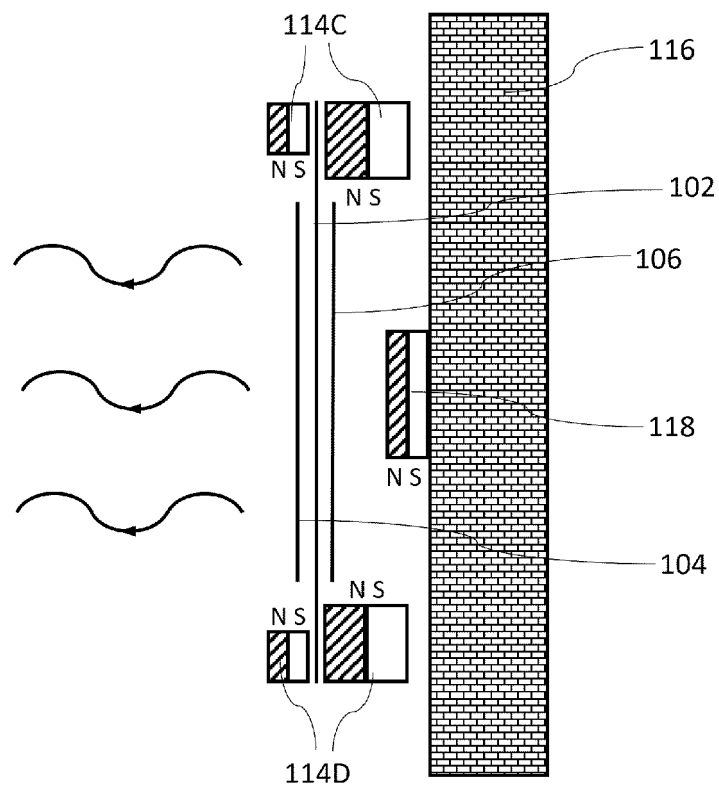


Fig. 3A

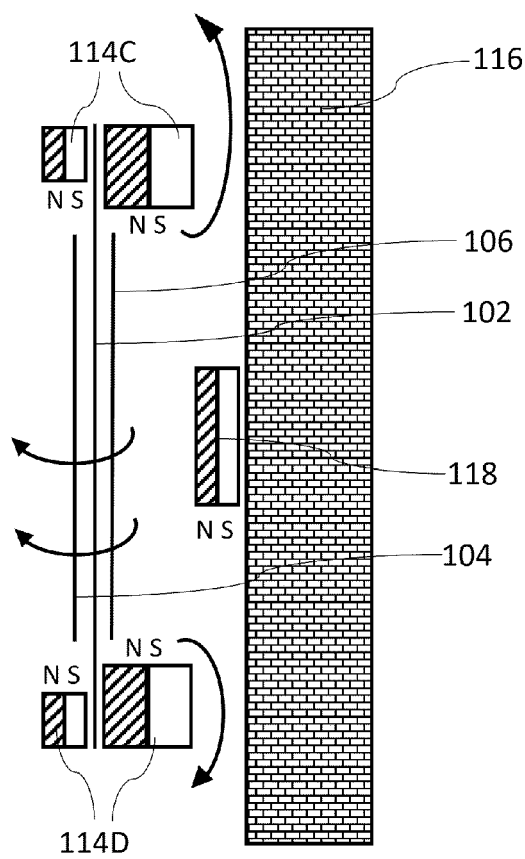


Fig. 3B



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Application Number

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Place of search		Date of completion of the search	Examiner
Munich		18 December 2023	Hoffmann, Stéphanie
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