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(54) ACOUSTIC TUBE ASPIRATOR APPARATUS

(57) The present invention refers to an acoustic tube aspirator apparatus for ventilating cooking environment comprises, at least one cylindrical tube (1), at least two sound transducers, at least one control unit and a plurality of amplifiers. Each of the sound transducers are attached to two ends of the cylindrical tube (1) for generating sound waves (6) inside the cylindrical tube (1) from both the ends of the cylindrical tube (1). The generated sound waves (6) from both the ends are in opposite direction to each other for creating standing wave inside the cylindrical tube (1). The cylindrical tube (1) is provided with plurality of holes (2, 3) for allowing air flow between the cylindrical tube (1) and the cooking environment. The holes are provided in the cylindrical tube (1) on locations of nodes (8) and antinodes (7) of the standing wave that pass through the cylindrical tube (1). The standing waves create precise pressure variations in specific volumes of the cylindrical tube (1) which in turn sucks unwanted gases and scattered fluids from the cooking environment thereby to create air flow in desired directions.

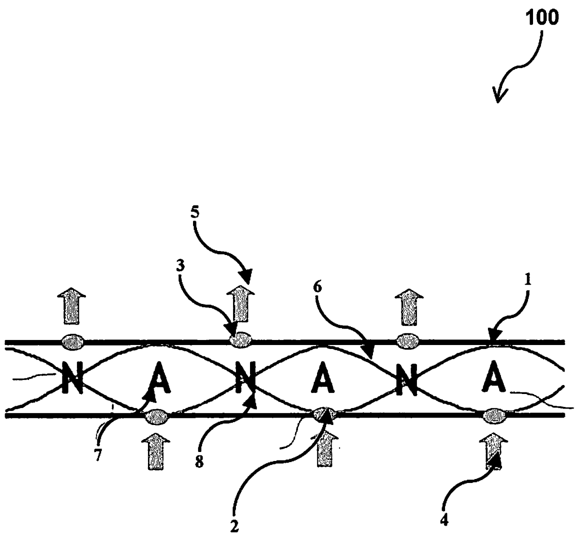

Fig. 1

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Description

[0001] This invention refers to an acoustic tube aspirator apparatus for ventilating cooking environment according to claim 1 and a method according to claim 10.

Background of the Invention

[0002] Ventilation systems such as aspirators are essential features that are implemented especially for cooking environments for creating an air flow in desired directions. Conventionally, in most of the cooking environments, exhausting systems such as propeller based systems are used. These systems introduce many drawbacks such as rotational noise, vortex noise, turbulence-induced noise, interaction, and distortion effects. There is an unmet need to reduce noise pollution due to the conventional exhausting systems. Another way to reduce noise pollution is to utilize scientific phenomenon such as standing waves and acoustic levitation. So far this phenomenon is not implemented in the ventilating systems. Thus there is a need of an aspirator apparatus for creating the air flow in the desired directions using standing sound waves.

[0003] Prior art document US4962330 A discloses an acoustic transducer apparatus with reduced thermal conduction. In that, a horn is described for transmitting sound from a transducer to a heated chamber containing an object which is levitated by acoustic energy while it is heated to a molten state, which minimizes heat transfer to thereby minimize heating of the transducer, minimize temperature variation in the chamber, and minimize loss of heat from the chamber. The forward portion of the horn, which is the portion closest to the chamber, has holes that reduce its cross-sectional area to minimize the conduction of heat along the length of the horn, with the entire front portion of the horn being rigid and having an even front face to efficiently transfer high frequency acoustic energy to fluid in the chamber. In one arrangement, the horn has numerous rows of holes extending perpendicular to the length of horn, with alternate rows extending perpendicular to one another to form a sinuous path for the conduction of heat along the length of the horn.

[0004] Another prior art US4393708 A discloses an acoustic system for material transport. The system described for acoustically moving an object within a chamber, by applying wavelengths of different modes to the chamber to move the object between pressure wells formed by the modes. In one system, the object is placed in a first end portion of the chamber while a resonant mode is applied along the length of the chamber that produces a pressure well at that location. The frequency is then switched to a second mode that produces a pressure well at the center of the chamber, to draw the object thereto. When the object reaches the second pressure well and is still travelling towards the second end of the chamber, the acoustic frequency is again shifted to a third mode (which may equal the first mode) that has a pressure well in the second end portion of the chamber, to draw the object thereto. A heat source may be located near the second end of the chamber to heat the sample, and after the sample is heated it can be cooled by moving it in a corresponding manner back to the first end portion of the chamber. The transducers for levitating and moving the object may be all located at the cool first end of the chamber.

[0005] Further, prior art US4218921A relates to a method and apparatus for shaping and enhancing acoustical levitation forces. The method and apparatus for enhancing and shaping acoustical levitation forces in a single-axis acoustic resonance system wherein specially shaped drivers and reflectors are utilized to enhance the levitation force and better contain fluid substances by means of field shaping.

[0006] Further, prior art US4688199A discloses transducers and control means. A standing wave is produced by interaction between the outputs of a pair of ultrasonic transducers driven by respective signal generating means. A phase interlock determines the phase difference between the signals and thus is progressively changed by a control signal regulated by a digital control means operated by a program so as to produce stepwise phase differences between the transducers in a cyclically varying manner. As a result, a sequence of momentary phase changes occur between the outputs of the signal generating means so that the standing wave is caused to move at a rate dependent upon the programmed operation of the digital control means.

[0007] The subject-matter of prior arts states the method of generating the standing waves and acoustic levitation. In some other prior art, the control of the standinng waves using transducers are available.

Object of the Invention

[0008] It is therefore the object of the present invention to provide an apparatus for creating air flow in desired directions using standing sound waves and a method thereof that reduces noise, increases air circulation and is simple in construction compared to the known systems and methods.

Description of the Invention

[0009] The before mentioned object is solved by an acoustic tube aspirator apparatus for ventilating cooking environment according to claim 1. The acoustic tube aspirator apparatus for ventilating cooking environment comprises, at least one cylindrical tube, at least two sound transducers, at least one control unit and a plurality of amplifiers. Each of the sound transducers are attached to two ends of the cylindrical tube for generating sound waves inside the cylindrical tube from both the ends of the cylindrical tube. The generated sound waves from both the ends are in opposite direction to each other for creating a standing wave inside the cylindrical tube. The cylindrical tube is provided with plurality of holes for allowing air flow between the cylindrical tube and the cooking environment. The holes are provided in the cylindrical tube on locations of nodes and antinodes of the standing wave that pass through the cylindrical tube. The standing waves create precise pressure variations in specific volumes of the cylindrical tube which in turn sucks unwanted gases and scattered fluids from the cooking environment thereby to create air flow in desired directions.

[0010] This solution is beneficial since such an apparatus highly reduces the noise pollution introduced by the ventilation systems and is also simple in construction which ultimately reduces the manufacturing cost. The present invention can be implemented in the fields of ventilation systems, aspirators, oven, cookers, cooktops, heaters, home appliances and for similar ventilation requirements.

[0011] Further preferred embodiments are subject-matter of dependent claims and/or of the following specification parts.

[0012] According to a preferred embodiment of the present invention the control unit is provided to control the generation of at least one sound wave from the sound transducer and also to control phase and amplitude of the sound wave.

[0013] This feature is beneficial since the control unit adjusts the phase and amplitude of the sound waves which in turn adjusts the pressure variation inside the cylindrical tube to increase the ventilation process.

[0014] According to another embodiment of the present invention, the plurality of amplifiers can boost the sound waves. The sound transducer generates standing waves in same frequency and phase. The frequency of the standing wave is related to the distance between the holes on the cylindrical tube, and wherein the distance between holes fits a wavelength of the standing wave. The phase of the standing wave is related to a position of the sound transducer from the holes in the cylindrical tube. A change in phase of the sound wave due to air flow generates resultant standing wave for sucking the unwanted gases and the scattered fluids from the cooking environment.

[0015] According to a further embodiment of the present invention, the holes are provided in the cylindrical tube on locations of nodes of the standing wave so that the air flow from the cylindrical tube is allowed to pass to the outside environment. The holes are provided in the cylindrical tube on locations of antinodes of the standing wave which allows the air flow from the outside environment to the cylindrical tube.

[0016] The before mentioned object is also solved by a method for ventilating cooking environment according to claim 10. Said method preferably comprises the steps: generating a standing wave inside a cylindrical tube using a sound transducer provided at each end of the cylindrical tube, generating the standing wave in a same frequency and phase, allowing air flow between the cylindrical tube and the cooking environment through a plurality of holes provided at the cylindrical tubes, allowing the standing wave to create a pressure gradient inside the cylindrical tube, and ventilating the cooking environment using the pressure gradient inside the cylindrical tube.

[0017] Further benefits, goals and features of the present invention will be described by the following specification of the attached figures, in which components of the invention are exemplarily illustrated. Components of the devices and method according to the invention, which match at least essentially with respect to their function can be marked with the same reference sign, wherein such components do not have to be marked or described in all figures.

[0018] The invention is just exemplarily described with respect to the attached figures in the following.

Brief Description of the Drawings

[0019]

Fig. 1 illustrates a standing wave generated in a cylindrical tube according to the present invention;

Fig. 2 illustrates an exemplary model of two sound waves traveling in a direction opposite to each other with a phase difference according to the present invention; and

Fig. 3 illustrates an exemplary model of a resultant standing wave generated for two sound waves with different phase, according to the present invention.

Detailed Description of the Drawings

[0020] Fig. 1 illustrates a standing wave generated in a cylindrical tube 100 according to the present invention. The acoustic tube aspirator apparatus for ventilating cooking environment comprises, at least one cylindrical tube 1, at least two sound transducers, at least one control unit and a plurality of amplifiers. Each of the sound transducers is attached to two ends of the cylindrical tube 1 for generating sound waves 6 inside the cylindrical tube 1 from both ends of the cylindrical tube 1. The generated sound waves 6 from both ends are in opposite direction to each other for creating a standing wave inside the cylindrical tube 1. The cylindrical tube 1 is provided with a plurality of holes for allowing air flow between the cylindrical tube 1 and the cooking environment. The holes (2, 3) are provided in the cylindrical tube 1 on locations of nodes 8 and antinodes 7 of the standing wave that pass through the cylindrical tube 1. The standing waves create precise pressure variations in specific volumes of the cylindrical tube 1 which in turn sucks unwanted gases and scattered fluids from the cooking environment thereby to create air flow in desired directions.

[0021] This solution is beneficial since such an apparatus highly reduces the noise pollution introduced by the ventilation systems and is also simple in construction which ultimately reduces the manufacturing cost. The present invention can be implemented in the fields of ventilation systems, aspirators, oven, cookers, cooktops, heaters, home appliances and for similar ventilation requirements.

[0022] According to a preferred embodiment of the present invention the control unit is provided to control the generation of the sound wave 6 from the sound transducer and also to control phase and amplitude of the sound wave.

[0023] This feature is beneficial since the control unit adjusts the phase and amplitude of the sound waves 6 which in turn adjust the pressure variation inside the cylindrical tube 1 to increase the ventilation process.

[0024] According to a further embodiment of the present invention, the plurality of amplifiers provided are able to boost the sound waves 6. The sound transducer generates the standing wave in same frequency and phase. The frequency of the standing wave is related to the distance between the holes (2, 3) on the cylindrical tube 1, and wherein the distance between holes fits a wavelength of the standing wave. The phase of the standing wave is related to a position of the sound transducer from the holes in the cylindrical tube 1.

[0025] According to another embodiment of the present invention, the apparatus may include an array of cylindrical tubes 1 to increase the ventilation. The holes (2, 3) are provided in the cylindrical tube 1 on locations of nodes 8 of the standing wave which allows the air flow 5 from the cylindrical tube 1 to outside environment. The holes 2 are provided in the cylindrical tube 1 on locations of antinodes 7 of the standing wave which allows the air flow 4 from the outside environment to the cylindrical tube 1. There are holes on the cylindrical tube 1 that allow air to flow in and out according to Bernoulli's equations as shown in Equation-1.

$$\frac{\rho V^2}{2} = P_0 - P_1 - - - - - - - - 1$$

$$V = \sqrt{P_0 - P_1}$$

[0026] Based on the Bernoulli's concept there is airflow between the cylindrical tube 1 and the surrounding or the environment. The standing wave creates a pressure gradient inside the tube. This pressure gradient allows the airflow.

[0027] Fig. 2 illustrates an exemplary model of two sound waves 200 traveling in a direction opposite to each other with a phase difference according to the present invention. Standing sound waves 6 are generated by sound sources (sound transducer) traveling in a direction opposite to each other (inverse direction) and have a specific frequency and phase. Inverse directional sound waves (9, 10) can be generated by using multiple sound sources or more commonly by a method of reflection, which is not preferred in this invention because of attenuation in the medium. An example of two inverse directional waves is shown in Figure 3 with the phase difference. The sound transducer generates the standing wave in the same frequency and with a different phase. The frequency of the standing wave is related to the distance between the holes on the cylindrical tube 1, and wherein the distance between holes (2, 3) fits a wavelength of the standing wave. The phase of the standing wave is related to a position of the sound transducer from the holes in the cylindrical tube 1.

[0028] Fig. 3 illustrates an exemplary model of a resultant standing wave 300 generated for two sound waves 6 with different phase according to the present invention. An example of resulting standing wave 11 is shown in Figure 3 due to the phase difference between two inverse directional sound waves 6 generated in the cylindrical tube 1. Thus, the change in phase of the sound wave due to air flow generates the resultant standing wave for sucking the unwanted gases and the scattered fluids from the cooking environment.

[0029] According to a further embodiment of the present invention, a method for ventilating cooking environment preferably comprises the steps: generating a standing wave inside a cylindrical tube 1 using a sound transducer provided at each end of the cylindrical tube 1, generating the standing wave in a same frequency and phase, allowing air flow between the cylindrical tube 1 and the cooking environment through a plurality of holes provided at the cylindrical tube 1s, allowing the standing wave to create a pressure gradient inside the cylindrical tube 1, and ventilating the cooking environment using the pressure gradient inside the cylindrical tube 1.

[0030] Thus, the present invention refers to an acoustic tube aspirator apparatus for ventilating cooking environment comprises, at least one cylindrical tube 1, at least two sound transducers, at least one control unit and a plurality of amplifiers. Each of the sound transducers are attached to two ends of the cylindrical tube 1 for generating sound waves 6 inside the cylindrical tube 1 from both the ends of the cylindrical tube 1. The generated sound waves 6 from both ends are in opposite direction to each other for creating a standing wave inside the cylindrical tube 1. The cylindrical tube 1 is provided with plurality of holes (2, 3) for allowing air flow between the cylindrical tube 1 and the cooking environment. The holes are provided in the cylindrical tube 1 on locations of nodes 8 and antinodes 7 of the standing wave that pass through the cylindrical tube 1. The standing waves create precise pressure variations in specific volumes of the cylindrical tube 1 which in turn sucks unwanted gases and scattered fluids from the cooking environment thereby to create air flow in desired directions.

List of reference numbers

[0031]

100	a standing wave generated in a cylindrical tube
1	cylindrical tube
2	holes for antinodes
3	holes for nodes
4	Air flow into the cylindrical tube through antinode side holes
5	Air flow out from the cylindrical tube through node side holes
6	sound wave
7	antinode formed by the sound wave
8	node formed by the sound wave
9	one sound wave travels towards left side end from the right side end
10	another sound wave travels towards right side end from the left side end
11	resulting standing wave
200	an exemplary model of two sound waves 6 traveling in a direction opposite to each other with a phase difference
300	exemplary model of a resultant standing wave generated for two sound waves 6 with different phase

Claims

1. An acoustic tube aspirator apparatus for ventilating cooking environment
comprises,
at least one cylindrical tube (1), at least two sound transducers, at least one control unit and a plurality of amplifiers;
characterized in that
each of the sound transducers are attached to two ends of the cylindrical tube (1) for generating sound waves (6) inside the cylindrical tube (1) from both ends of the cylindrical tube (1),
wherein the generated sound waves (6) from both ends are in opposite direction to each other for creating a standing wave inside the cylindrical tube (1),
wherein the cylindrical tube (1) is provided with a plurality of holes for allowing air flow between the cylindrical tube (1) and the cooking environment,
wherein the holes are provided in the cylindrical tube (1) on locations of nodes and antinodes of the standing wave that pass through the cylindrical tube (1), and
wherein the standing waves create precise pressure variations in specific volumes of the cylindrical tube (1) which in turn sucks unwanted gases and scattered fluids from the cooking environment thereby to create an air flow in desired directions.

2. The acoustic tube aspirator apparatus as claimed in claim 1, wherein the control unit is provided to control the generation of sound waves (6) from the sound transducer and also to control phase and amplitude of the sound waves (6).

3. The acoustic tube aspirator apparatus as claimed in claim 1, wherein the plurality of amplifiers is provided to boost the sound waves (6).

4. The acoustic tube aspirator apparatus as claimed in claim 1, wherein the sound transducer generates the standing wave in the same frequency and phase.

5. The acoustic tube aspirator apparatus as claimed in claim 4, wherein the frequency of the standing wave is related to the distance between the holes on the cylindrical tube (1), and wherein the distance between holes (2, 3) fits a wavelength of the standing wave.

6. The acoustic tube aspirator apparatus as claimed in claim 5, wherein the phase of the standing wave is related to a position of the sound transducer from the holes (2, 3) in the cylindrical tube (1).

7. The acoustic tube aspirator apparatus as claimed in claim 4, wherein a change in phase of the sound wave due to air flow generates the resultant standing wave (11) for sucking the unwanted gases and the scattered fluids from the cooking environment.

8. The acoustic tube aspirator apparatus as claimed in claim 1, wherein the holes (3) provided in the cylindrical tube (1) on locations of nodes (8) of the standing wave allows the air flow (5) from the cylindrical tube (1) to outside environment.

9. The acoustic tube aspirator apparatus as claimed in claim 1, wherein the holes (3) provided in the cylindrical tube (1) on locations of antinodes (7) of the standing wave allows the air flow (4) from the outside environment to the cylindrical tube (1).

10. A method for ventilating cooking environment comprising the step of,
generating a standing wave inside a cylindrical tube (1) using a sound transducer provided at each end of the cylindrical tube (1),
generating the standing wave in a same frequency and phase,
providing an air flow between the cylindrical tube (1) and the cooking environment through a plurality of holes (2, 3) provided at the cylindrical tube (1),
allowing the standing wave to create a pressure gradient inside the cylindrical tube (1), and
ventilating the cooking environment using the pressure gradient inside the cylindrical tube (1).

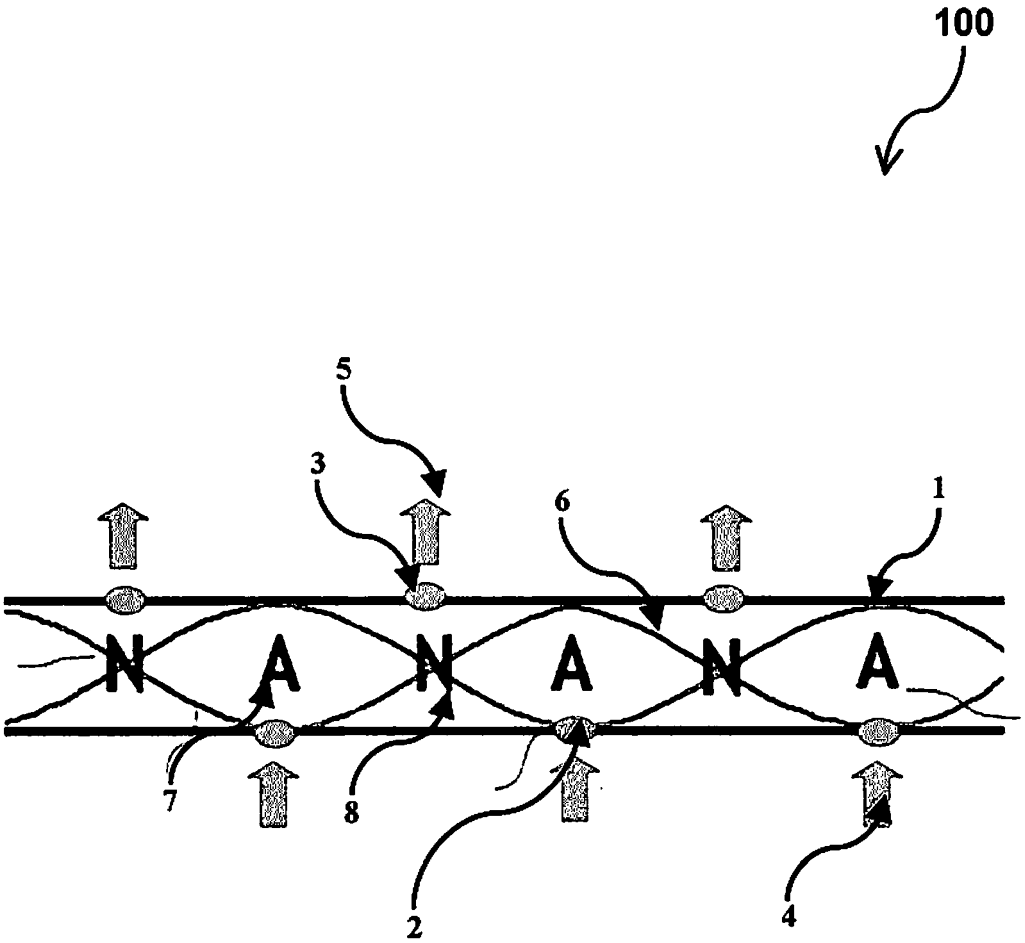

Fig. 1

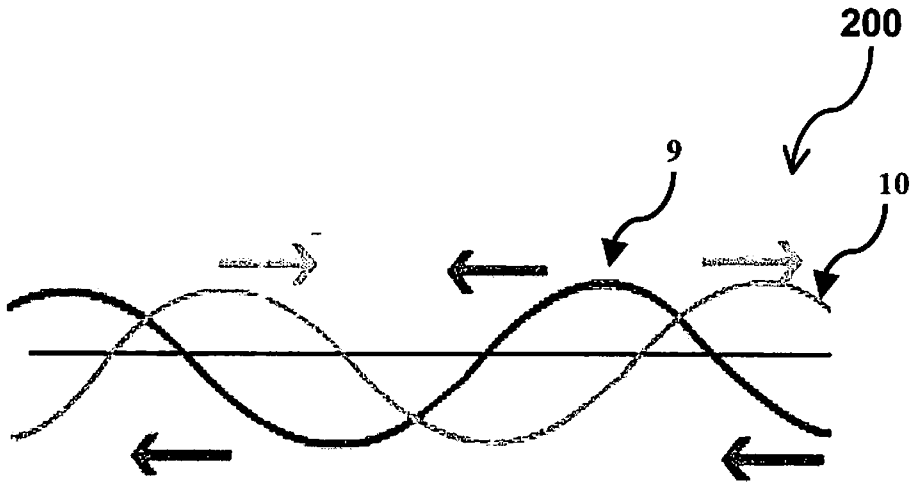

Fig. 2

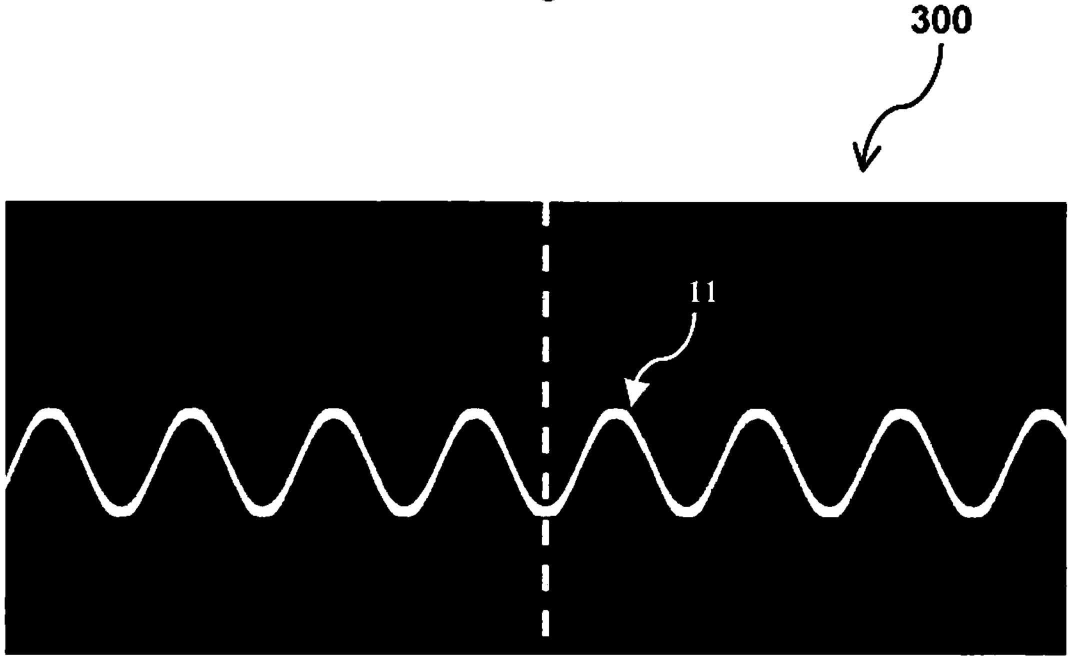

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 17 19 9195

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 6 079 214 A (BISHOP RICHARD PATTEN [US]) 27 June 2000 (2000-06-27) * Col. 18, lines 27-29 and 37-41; Col. 20, lines 66-67; claim 1; figures 4,13 * -----	1-9	INV. F24C15/20 F04F7/00
X	US 2003/124006 A1 (DOOLEY KEVIN ALLAN [CA]) 3 July 2003 (2003-07-03) * paragraph [0033]; claim 5; figures 1,4b * -----	1	

TECHNICAL FIELDS SEARCHED (IPC)

F04F
F02G
F24C

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	11 April 2018	Adant, Vincent

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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11-04-2018

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
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US 2003124006	A1	03-07-2003	CA	2470681	A1	24-07-2003
			EP	1458983	A1	22-09-2004
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- US 4393708 A **[0004]**
- US 4218921 A **[0005]**
- US 4688199 A **[0006]**