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(71) Applicant: **HEWLETT-PACKARD DEVELOPMENT COMPANY, L.P.** [US/US]; 10300 Energy Drive, Spring, Texas 77389 (US).

(72) Inventors: **LI, Ai-Tsung**; 10F-2, No.66, JingMao 2nd Road, NanGang District, Taipei City, 11568 (TW). **HUANG, Lung-Chi**; 10F-2, No.66, JingMao 2nd Road, NanGang District, Taipei City, 11568 (TW). **LIAO, Ting-Huei**; 10F-2, No.66, JingMao 2nd Road, NanGang District, Taipei City, 11568 (TW). **CHEN, Kuan-Yu**; 10F-2, No.66, JingMao 2nd Road, NanGang District, Taipei City, 11568 (TW).

(74) Agent: **SU, Benjamin**; 3390 E Harmony Road, Fort Collins, Colorado 80528 (US).

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- as to the identity of the inventor (Rule 4.17(i))
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(54) Title: NOISE CANCELLATION CHAMBERS

(57) Abstract: Examples of a chamber for noise cancellation emitted by a cooling device operating at an operational speeds, are described.

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NOISE CANCELLATION CHAMBERS

BACKGROUND

[0001] An electronic device may include a plurality of components which may generate heat during operation. To dissipate the heat generated by such plurality of components, the electronic device may include a cooling device, for example, a cooling fan, which may be provided within a chassis of the electronic device. In operation, the cooling device may regulate flow of a fluid, such as air, within the chassis of the electronic device for dissipating the heat generated by the plurality of components.

BRIEF DESCRIPTION OF DRAWINGS

[0002] The following detailed description references the drawings, wherein:

[0003] FIGS. 1 and 2 are example computing devices with cooling devices, as per an example of the present subject matter;

[0004] FIG. 3 is block diagram of an electronic device, as per another example of the present subject matter;

[0005] FIG. 4 is a detailed block diagram of an example electronic device, as per another example of the present subject matter;

[0006] FIG. 5 illustrates an adaptable chamber for attenuating acoustic noise emitted by a cooling fan of an electronic device, as per an example;

[0007] FIG. 6 illustrates an adaptable chamber for attenuating acoustic noise emitted by a cooling fan of an electronic device, as per another example; and

[0008] FIG. 7 illustrates an adaptable chamber for attenuating acoustic noise emitted by a cooling fan, as per an example.

[0009] Throughout the drawings, identical reference numbers designate similar, but not necessarily identical, elements. The drawings provide examples and/or implementations consistent with the description; however, the description is not limited to the examples and/or implementations provided in the drawings.

DETAILED DESCRIPTION

[0010] A cooling device may be installed within an electronic device to dissipate the heat generated by components of the electronic device. The cooling device may cause circulation of a cooling fluid, such as ambient air, within a chassis of the electronic device. The movement of the cooling fluid within the chassis may extract the thermal energy being generated by the components, so that the components may continue to operate within prescribed temperature thresholds. Example of the cooling device include, but is not limited to, a cooling fan, which may be fitted onto a component of the electronic device. Examples of the electronic device include, but are not limited to, a desktop computer, a laptop computer, a printing device, and a multimedia device.

[0011] The operation of the cooling device may result in generation of acoustic noise. As would be understood, acoustic waves (corresponding to the acoustic noise) generated by the cooling device may have an excitation frequency. The excitation frequency of the acoustic wave may, in turn, depend on an operating speed of the cooling device. To suppress or attenuate the acoustic noise, the cooling device may include a cancellation chamber. The cancellation chamber may result in resonance when a natural frequency corresponding to the cancellation chamber matches the excitation frequency of the acoustic waves produced by the cooling device. The resonance causes formation of a standing wave in the cancellation chamber that destructively interferes with the acoustic waves generated by the cooling device. As a result, the acoustic waves are attenuated or suppressed.

[0012] As may be understood, the natural frequency for the cancellation chamber may be dependent on physical dimensions of the cancellation chamber. As a result, the cancellation chamber may be effective for a certain excitation frequency of the acoustic waves, generated at a certain operating speed. In certain cases, the cooling device may operate at different operating speeds depending on an operational state of the electronic device. For example, the cooling device may operate at a higher operating speed in instances when higher rate of thermal dissipation is to be achieved, such as using the electronic device over extended periods of time. In certain other cases, the cooling device may operate at a lower operating speed, such as during idle conditions. In such instances, the cancellation chamber may not be able to attenuate acoustic noises of different

frequencies which may be generated due to the cooling device operating at different operating speeds. Furthermore, even in cases where the cancellation chamber may be adapted for different frequencies, it may not be able to effectively attenuate the acoustic noise. Neither are such mechanisms suitable for compact devices, for example, notebooks, laptops, and similar such computing devices.

[0013] Examples of an adaptable noise cancellation chamber for a cooling device are described. In an example, the adaptable noise cancellation chamber (hereinafter referred to as an adaptable chamber) has a first end, a second end, and a sidewall. The sidewall extends longitudinally between the first end and the second end. The adaptable chamber may further include an opening for the entry of the acoustic waves into the adaptable chamber. The acoustic waves correspond to acoustic noise emitted by cooling device during its operation.

[0014] The adaptable chamber may be adapted to attenuate acoustic noise having different excitation frequencies emanating from the cooling device. The excitation frequency of the acoustic noise is dependent on the operating speed of the cooling device. The adaptable chamber may be adapted in response to a detected operating speed of the cooling device. Adapting may be considered as any change in state, configuration, or shape of the adaptable chamber that may be brought about in response to the detected operating speed. For example, based on the detected operating speed of the cooling device, the chamber may be adapted to vary a volume of the chamber. The change in the volume further results in the formation of standing waves of different frequencies, which are to destructively interfere with the acoustic waves generated by the cooling device.

[0015] In one example, the adaptable chamber may include an actuating member mounted onto an inner surface of the adaptable chamber. The actuating member is pivotally moveable between a first position and a second position in response to a detected operating speed of the cooling device. In an example, the movement of the actuating member changes a volume of the adaptable chamber. In operation, the actuating member may be moved to the first position in response to detection of a first operating speed. It may be noted that the term operating speed and rotational speed may be used interchangeably without impacting the scope of the present subject

[0016] When in the first position, the actuating member may divide an internal volume of the adaptable chamber into a first sub-chamber and a second sub-chamber. The first sub-chamber, having a volume less than the internal volume, is to result in formation of standing waves which may attenuate acoustic waves generated by the cooling device operating at the first rotational speed. In a similar manner, the actuating member may move to the second position in response to detection of a second rotational speed. When in the second position, an effective volume is a combination of the volume of the first sub-chamber and a volume of the second sub-chamber. The resulting effective volume is to result in the formation of another standing wave which may attenuate acoustic waves generated by the cooling device operating at the second rotational speed.

[0017] The volume of the adaptable chamber may be varied through a variety of different mechanisms. In yet another example, the adaptable chamber includes a longitudinally extending first chamber and a second chamber, wherein the first chamber and the second chamber are positioned adjacent to each other. The dimensions of the second chamber may be different from the dimensions of the first chamber. The first chamber and the second chamber may have a first open end and a second open end, respectively, such that the first open end and the second open end are in proximity to the cooling device.

[0018] Continuing with the present example, an actuating member may be arranged in proximity to the first open end and the second open end. The actuating member may be pivotally moveable between a first position and a second position, in response to a detected rotational speed of the cooling device. In this regard, the actuating member, when in the first position, is to cover the first open end. In such a case, acoustic waves corresponding to an acoustic noise produced by the cooling device operating at a first rotational speed is directed to the second chamber. The acoustic waves may form standing waves in the second chamber that may destructively interfere with the acoustic waves generated by the cooling device. In a similar manner, the actuating member when in the second position, is to cover the second open end. In such a case, acoustic waves produced by the cooling device operating at a second rotational speed is directed to the first chamber. The acoustic waves may form standing in the first chamber that may destructively interfere with the acoustic waves generated by the cooling device.

[0019] In another example, the adaptable chamber may include a first portion coupled to a second portion, wherein the second portion is longitudinally moveable with respect to the first portion. The movement of the second portion with respect to the first portion enables varying an effective length of the adaptable chamber. Depending on a detected rotational speed of the cooling device, the positioning of the second portion may be varied. For example, for a first rotational speed, the second portion may be so positioned such that the adaptable chamber has a first effective length. In a similar manner, if the rotational speed of the cooling device changes to a second rotational speed, the second portion may be moved such that the adaptable chamber has a second effective length. Depending on the effective length of the adaptable chamber, the standing waves produced therein may attenuate acoustic noise produced by the cooling device when operating at different rotational speeds.

[0020] The adaptable chamber, as per the various examples, may be coupled to a controller. The controller may generate control signals which adapt the adaptable chamber based on the detected rotational speed of the cooling device. In an example, the controller may generate control signals for operating an actuator (e.g., a servo motor) for controlling the actuating member, or for affecting the movement of the second portion with respect to the first portion, to adapt the adaptable chamber. As would be further explained, the adaptable chamber described herein may be adapted to match different excitation frequencies corresponding to acoustic noise emitted by the cooling device operating at different rotational speeds. The adaptable chamber arranged within the cooling devices may have a compact set-up thus enabling deployment within compact spaces. It may be noted that the manner in which the present subject matter may be implemented, may vary. Such different examples are described in conjunction with the accompanying figures.

[0021] FIG. 1 illustrates a computing device 100 having a cooling device 102, as per an example. The computing device 100 may be any processor enabled device which performs certain specific functions. Examples of the computing device 100 includes, but is not limited to, a laptop computer, a desktop computer, and a remote server. The present examples may also be implemented in other types of the electronic devices that includes

the cooling device 102, for example, a printing device and a multimedia device, without deviating from the scope of the present subject matter.

[0022] The computing device 100 may further include different components (not shown in FIG. 1), which may operate to enable the computing device 100 to implement different functions. Examples of the components include, but are not limited to, a processor, display device, graphic card, video card, memory, communication interfaces, and installable components which may be installed within the computing device 100.

[0023] Continuing with the present example, the cooling device 102 may include a housing 104 enclosing a cooling fan 106. The cooling fan 106 may rotate with a rotational speed for cooling the components of the computing device 100. The rotational speed of the cooling fan 106 may be adjusted according to thermal conditions within the chassis of the computing device 100.

[0024] The cooling device 102 may further include an adaptable chamber 108. The adaptable chamber 108 is to cause attenuation of an acoustic noise emitted by the cooling fan 106. The adaptable chamber 108 includes a first end 110, a second end 112 and a longitudinally extending sidewall 114 between the first end 110 and the second end 112. In one example, an opening 116 may be defined at the sidewall 114 of the adaptable chamber 108, near the first end 110, while the second end 112 may form a closed end. It may be noted that the construction of the adaptable chamber 108 is only illustrative and should not be construed as limiting in any way. In other implementations, the opening 116 may be defined at any one of the first end 110 or the second end 112 of the adaptable chamber 108.

[0025] Continuing further, an actuating member 118 is arranged within the adaptable chamber 108. The actuating member 118 may be mounted on an inner surface of the adaptable chamber 108. In operation, the actuating member 118 may be pivotally mounted within the adaptable chamber 108. During operation, the actuating member 118 may be controlled to move between a first position and a second position. In an example, the movement of the actuating member 118 may be in response to a detected operating speed or rotational speed of the cooling fan 106. Further, varying the position of the actuating member 118 may adapt a volume of the adaptable chamber 108 for attenuation of acoustic waves having different excitation frequency.

[0026] In operation, the actuating member 118 may be moved to the first position (as shown in the expanded view of the adaptable chamber 108) in response to detecting a first rotational speed of the cooling fan 106. When in the first position (as depicted in FIG. 1), the actuating member 118 may divide an internal volume of the adaptable chamber 108 into a first sub-chamber 120 and a second sub-chamber 122. The first sub-chamber 120 is to result in the formation of standing waves which may attenuate acoustic waves generated by the cooling fan 106 operating at the first rotational speed. In a similar manner, the actuating member 118 may be moved to the second position (shown in dotted line in FIG. 1) in response to detecting the cooling fan 106 operating at a second rotational speed. When in the second position, a volume of the adaptable chamber 108 is a combination of volume of the first sub-chamber 120 and the second sub-chamber 122. The volume is to result in the formation of standing waves which may attenuate acoustic waves generated by the cooling fan 106 operating at the second rotational speed. Although the present example has been explained with respect to a single actuating member 118, the adaptable chamber 108 may include a plurality of such actuating members, without deviating from the scope of the present subject matter.

[0027] FIG. 2 illustrates a computing device 200 having a cooling device 202, as per an example. The computing device 200 may be similar to the computing device 100 as described in conjunction with FIG. 1. Similar to the cooling device 102, the cooling device 202 may also include a circulating device, such as the circulating device 204 enclosed within a housing 206. In one example, the circulating device 204 may be a variable axial fan or centrifugal fan. The circulating device 204 may circulate a volume of cooling fluid, such as air, to remove the thermal energy generated by components of the computing device 200.

[0028] The cooling device 202 may be arranged within a chassis of the computing device 200 in a manner so as to maximize the volume of cooling fluid which may be directed onto components of the computing device 200. For example, the cooling device 202 may be directly mounted onto a central processing unit (CPU), a graphic card, a video card, and the like, of the computing device 200.

[0029] The cooling device 202 further includes a longitudinally extending first chamber 208 and a second chamber 210. The first chamber 208 has a respective open

end 212-1 and a respective closed end 214-1, with a longitudinal sidewall 216-1 extending between the respective open end 212-1 and the respective closed end 214-1. Similarly, the second chamber 210 has a respective open end 212-2 and a respective closed end 214-2, with a longitudinal sidewall 216-2 extending between the respective open end 212-2 and the respective closed end 214-2. In an example, a dimension of the first chamber 208 is different from a corresponding dimension of the second chamber 210. In the present example, the first chamber 208 is depicted as having a greater cross-sectional area as compared to the cross-sectional area of the second chamber 210.

[0030] The first chamber 208 and the second chamber 210 may be arranged adjacent to each other, such that the open end 212-1 and the open end 212-2 (collectively referred to as open ends 212) are in proximity to the circulating device 204. In an example, the first chamber 208 and the second chamber 210 may be arranged adjacent to each other and positioned tangentially at outer circumference of the housing 206 of the circulating device 204. In one example, the first chamber 208 and the second chamber 210 may have a hollow cylindrical structure.

[0031] Continuing further, the cooling device 202 further includes an actuating member 218, arranged in proximity to the open ends 212. The actuating member 218 may be pivotally moveable between a first position and a second position, in response to a detected rotational speed of the circulating device 204. The actuating member 218 when in the first position is to cover the open end 212-1 of the first chamber 208. In a similar manner, the actuating member 218 when in the second position is to cover the open end 212-2 of the second chamber 210.

[0032] On detecting a first rotational speed of the circulating device 204, the actuating member 218 may be moved to the first position (as depicted in FIG. 2). In such a case, acoustic waves corresponding to an acoustic noise produced by the circulating device 204 are directed to the second chamber 210. Similarly, on detecting a second rotational speed of the circulating device 204, the actuating member 218 may be moved to the second position (depicted by way of dotted lines in FIG. 2). In such a case, acoustic waves corresponding to an acoustic noise produced by the circulating device 204 are directed to the first chamber 208. Since the dimensions of the first chamber 208 and the second chamber 210 are different, the volume of the space enclosed, therein, is also

different. As a result, the first chamber 208 and the second chamber 210 may result in standing waves of different frequencies which may then destructively interfere with the acoustic waves produced by the circulating device 204.

[0033] FIG. 3 illustrates an electronic device 300, as per another example. The electronic device 300 may include a cooling fan 302 enclosed within a housing 304. The cooling fan 302 may affect removing thermal energy which may be generated by components of the electronic device 300. The cooling fan 302 may be similar to the cooling fan 106 and the circulating device 204, as described in conjunction with the previous examples. During operation, the cooling fan 302 may emit acoustic noise which in turn may be characterized by an excitation frequency. The excitation frequency of the acoustic waves may be dependent on a rotational speed of the cooling fan 302. In an example, the electronic device 300 may be a computing device, such as a laptop computer, a desktop computer, a notebook and the like, a printing device, a multimedia device, and so forth.

[0034] The cooling fan 302 may further include an adaptable chamber 306, which may be tangential positioned with respect to the housing 304, such that a longitudinal axis of the adaptable chamber 306 lies in plane of rotation of the cooling fan 302, and is tangential to the rotational direction of the cooling fan 302. The adaptable chamber 306 may be composed of a first portion 308 coupled to a second portion 310. The first portion 308 and the second portion 310 are concentrically positioned such that they are to telescopically move into one another. The second portion 310 may slide with respect to the first portion 308 to vary an effective length of the adaptable chamber 306. An opening 312 may be defined in the adaptable chamber 306, wherein the opening 312 is to enable entry of acoustic waves emitted by the cooling fan 302 into the adaptable chamber 306.

[0035] The movement of the second portion 310 with respect to the first portion 308 may be controlled by a controller 314. The controller 314 may be a microprocessor, microcomputer, microcontroller, digital signal processor, central processing unit, state machine, logic circuitry, and/or any device that may manipulate signals based on certain operational instructions. Among other functions, the controller 314 may fetch and execute the computer-readable instructions stored in a memory (not depicted in FIG. 3) of the electronic device 300, to move the second portion 310 of the adaptable chamber 306.

The controller 314 may perform a series of functions in response to execution of executable instructions stored in the electronic device 300. In another example, the controller 314 may also detect the rotational speed of the cooling fan 302.

[0036] In operation, the controller 314 may initially detect the rotational speed of the cooling fan 302. On detecting a first rotational speed of the cooling fan 302, the controller 314 may control the second portion 310 to position it such that the adaptable chamber 306 has a first effective length. The first effective length of the adaptable chamber 306 may cause acoustic waves emitted by the cooling fan 302 to form standing waves within the adaptable chamber 306, which may then destructively interfere to attenuate the acoustic waves generated by the cooling fan 302. In a similar manner, on detecting a second rotational speed of the cooling fan 302, the controller 314 may move the second portion 310 such that the adaptable chamber 306 has a second effective length. The second effective length of the adaptable chamber 306 may cause acoustic waves emitted by the cooling fan 302 to form standing waves that may destructively interfere with the acoustic waves to attenuate an acoustic noise generated at the second rotational speed. As may be understood, the controller 314 may accordingly move the second portion 310 to different positions, thereby resulting in different effective lengths. In this manner, the adaptable chamber 306 may be utilized for attenuating acoustic waves of a ranging frequencies by adjusting the position of the second portion 310.

[0037] FIG. 4 illustrates an electronic device 402, as per an example. The electronic device 402 includes a cooling device 404. The cooling device 404 may be located within a chassis of the electronic device 402, such as at a front, back, or sides thereof. In certain cases, the cooling device 404 may be mounted onto components of the electronic device 402. The cooling device 404 may be arranged within the electronic device 402 using fastening means, such as screws, bolts, snap-in brackets, and the like. The cooling device 404 includes a cooling fan 406 enclosed within a housing 408, wherein the cooling fan 406 is to circulate ambient air within the chassis of the electronic device 402. The cooling device 404 further includes a chamber 410 that may be adapted for attenuating acoustic noise generated by the cooling fan 406, operating at different rotational speeds.

[0038] The electronic device 402 further includes, controller 412, interface(s) 414, memory(s) 416, and data 418. The controller 412 may be a single processing unit or may include a number of units, all of which could include multiple computing units. The controller 412 may be implemented as one or more microprocessor, microcomputers, embedded controller, digital signal processors, central processing units, state machines, logic circuitries, and/or any devices that manipulate signals based on operational instructions. Such operational instructions may be implemented by device firmware of the electronic device 402. The controller 412 may be adapted to fetch and execute processor-readable instructions stored in the memory(s) 416 to implement one or more functionalities. The controller 412 may be operable to extract, receive, process, share and store information based on instructions that drive the electronic device 402.

[0039] The electronic device 402 may further include components which may be operatively assembled and enable the electronic device 402 to perform appropriate functions. Examples of such components include, but are not limited to, display device, storage module, graphic card, video card, sound card, input/output devices, motherboard, and so forth.

[0040] In certain cases, the operational instructions for enabling functionality of the controller 412 may be implemented by the device firmware of the electronic device 402. In an example, the device firmware may be a Basic Input/output System (BIOS). In this regard, the BIOS refers to a hardware or a hardware and instructions that initializes, controls, or operates the electronic device 402 prior to execution of an operating system (OS) of the electronic device 402. Instructions included within the BIOS may be software, firmware, microcode, or other programming that defines or controls functionality or operation of the BIOS. In one example, the BIOS may be implemented using instructions, such as platform firmware of the electronic device 402, executable by the controller 412. The BIOS may operate or execute prior to the execution of the OS of the electronic device 402. The BIOS may initialize, control, or operate the components of the electronic device 402 and may load or boot the OS of the electronic device 402.

[0041] In some examples, the BIOS may provide or establish an interface between hardware component(s) or a platform firmware of the electronic device 402 and an OS of the electronic device 402, via which the OS of the electronic device 402 may control or

operate the hardware component(s) or the platform firmware of the electronic device 402. In certain examples, the BIOS may be a Unified Extensible Firmware Interface (UEFI) specification of the BIOS or another specification or standard for initializing, controlling, or operating the electronic device 402.

[0042] Returning to the present example, the interface(s) 414 may include a variety of software and hardware interfaces that allow the electronic device 402 to interact with other devices, such as other electronic devices and computing devices, in addition to other devices such as network entities, web servers, and external repositories, and peripheral devices such as input/output (I/O) devices (not shown in FIG. 4 for sake of brevity). The memory(s) 416 may include any computer-readable medium known in the art including, for example, volatile memory, such as Static Random-Access Memory (SRAM) and Dynamic Random-Access Memory (DRAM), and/or non-volatile memory, such as Read-Only Memory (ROM), Erasable Programmable ROMs (EPROMs), flash memories, hard disks, optical disks, and magnetic tapes.

[0043] The data 418 includes information pertaining to different rotational speeds 420 of the cooling fan 406, configuration data 422 for the chamber 410 and other data 424. The configuration data 422 may provide a mapping between different rotational speeds 420 and various configuration states of the chamber 410. For example, the configuration data 422 may specify a position of an actuating member, such as the actuating member 118 depending on a detected rotational speed of the cooling fan 106 (as depicted in FIG. 1). In another example, the configuration data 422 may determine the position in which another actuating member 218 is to be moved to, for the circulating device 204 (as depicted in FIG. 2), or the position to which the second portion 310 is to be moved relative to the first portion 308, for the cooling fan 302 (as depicted in FIG. 3). Depending on detected rotational speed of the cooling fan 406, the controller 412 may fetch a corresponding configuration data 422, and accordingly generate control signals to change a configuration or state of the chamber 410. As may be understood, change in the configuration or state of the chamber 410 may be brought about, in one example, by controlling the movement of the actuating members 118, 218, or changing the position of the second portion 310 with respect to the first portion 308. Such examples are further described in detail, in conjunction with FIGS. 5-7.

[0044] FIG. 5 illustrates an adaptable chamber 502 for attenuating acoustic noise emitted by a cooling fan, such as the cooling fan 406 enclosed within a housing (such as the housing 408). Further, the adaptable chamber 502 may be arranged tangential to the housing 408, along an outer circumference thereof. In an example, the cooling fan 406 may be a computer fan that, in operation, circulates ambient air within an electronic device (such as the electronic device 402).

[0045] In the example as depicted, the adaptable chamber 502 may have a first end 504, a second end 506 and a sidewall 508 extending longitudinally between the first end 504 and the second end 506. It may be noted that the shape of the adaptable chamber 502 is depicted as rectilinear for purposes of explanation and should not be construed as a limitation. Other shapes of the adaptable chamber 502 are also possible, and such examples would fall within the scope of the present subject matter.

[0046] As depicted in FIG. 5, the adaptable chamber 502 may include an opening 510. In the present example, the opening 510 may be defined at a portion of the sidewall 508 of the adaptable chamber 502 and may be proximal to the first end 504. The adaptable chamber 502 may also have the closed second end 506. The opening 510 is to provide entry to acoustic waves (corresponding to the acoustic noise) emitted by the cooling fan 406 into the adaptable chamber 502. In one example, a passive acoustic filter 512 may be arranged within the adaptable chamber 502 in proximity to the opening 510. The filter 512 is to absorb some of the acoustic waves, for example, low-frequency acoustic waves.

[0047] The adaptable chamber 502 may include a first actuating member 514-1 and a second actuating member 514-2 (collectively referred to as actuating members 514). The actuating members 514 may be mounted on an inner surface of the sidewall 508, between the first end 504 and the second end 506. As described briefly, frequency of the acoustic noise generated by the cooling fan 406 may vary depending on the rotational speed of the cooling fan 406. For example, at higher rotational speeds, the cooling fan 406 may be producing acoustic noise having higher frequency. Similarly, at lower rotational speeds, the cooling fan 406 may be generating a low frequency acoustic noise. In one example, the actuating members 514 may be an electromechanically operated valve. For example, the valve may be coupled to an actuating mechanism which

is to cause the movement thereof, wherein the actuating mechanism may be controlled by the controller 412.

[0048] In operation, the actuating members 514 may be individually controlled by the controller 412 in response to the detected rotational speed of the cooling fan 406. The actuating members 514 may be individually moveable between a respective first and a second position. For example, when in the first position, the actuating members 514 may be such that they are perpendicular to the adaptable chamber 502. When in the first position, the actuating members 514 may limit the length within the adaptable chamber 502, through which the acoustic waves corresponding to the acoustic noise may traverse. When in the first position, the first actuating member 514-1 may form a first sub-chamber 516 (as represented in 500A), within which the acoustic waves will propagate. In a similar manner, when the second actuating member 514-2 is in the first position (while the first actuating member 514-1 is in the second position), it may form a second sub-chamber 518 (as represented in 500B). When both the actuating members 514 are in the second position (as represented in 500C), an entire inner volume of the adaptable chamber 502 is available for propagation of the acoustic waves. In the context of the present example, a volume enclosed by the adaptable chamber 502 is greater than a volume enclosed by the second sub-chamber 518, with the volume of the second sub-chamber 518 being greater than a volume enclosed by the first sub-chamber 516.

[0049] Different volumes result in attenuation or cancellation of acoustic waves with different frequencies. As may be understood, resonating chambers with greater length may be utilized for attenuating lower frequencies, while resonating chambers with shorter lengths may be utilized for attenuating higher frequencies. As a result, the first sub-chamber 516 may be utilized for attenuating acoustic waves with a frequency which may be greater than a frequency of acoustic waves which may be attenuated by the second sub-chamber 518. In a similar manner, a frequency of acoustic waves which may be attenuated by the entire length of the adaptable chamber 502, may be less than the frequency of the acoustic waves which may be attenuated by the first sub-chamber 516 and the second sub-chamber 518.

[0050] In operation, the controller 412 may detect a rotational speed of the cooling fan 406. On detecting the rotational speed, the controller 412 may query the configuration

data 422 based on the detected rotational speed. The configuration data 422, in one example, may include a mapping between a plurality of rotational speeds and corresponding indicator flags for the actuating members 514. The indicator flag may indicate a position for the actuating members 514, i.e., the respective first position or the second position for the actuating members 514. Depending on the indicator flags, the controller 412 may move the actuating members 514 to either the first position or the second position.

[0051] In the present example, on detecting a first rotational speed, the controller 412 may determine that the first actuating member 514-1 is to be in the first position based on the configuration data 422, as represented in 500A. Once the position of the first actuating member 514-1 is determined, the controller 412 may control the first actuating member 514-1, such that it is in the first position (i.e., perpendicular to the length of the adaptable chamber 502). When in the first position, the first actuating member 514-1 forms the first sub-chamber 516. The first sub-chamber 516 may then result in the formation of standing waves which may then destructively interfere with acoustic waves corresponding to an acoustic noise generated by the cooling fan 406 operating at the first rotational speed.

[0052] In a similar manner, the controller 412 may detect the cooling fan 406 to be operating at a second rotational speed, with the second rotational speed being less than the first rotational speed. The controller 412 may accordingly query the configuration data 422 to determine indicator flags for the actuating members 514. In the present example, on detecting the cooling fan 406 to be operating at the second rotational speed, the controller 412 may control the actuating members 514 such that the first actuating member 514-1 is in the second position (i.e., extending parallel to the adaptable chamber 502), with the second actuating member 514-2 in the first position to form the second sub-chamber 518, as represented in 500B. The second sub-chamber 518 is to result in the formation of standing waves which may then destructively interfere with acoustic waves corresponding to an acoustic noise generated by the cooling fan 406 operating at the second rotational speed. In a similar manner, on detecting a third rotational speed, the controller 412 may move both the actuating members 514 to the second position, as represented in 500C, thereby providing the entire length of the adaptable chamber 502

for propagation of acoustic waves. The adaptable chamber 502 is to result in the formation of standing waves which may then destructively interfere with acoustic waves generated by the cooling fan 406 operating at the third rotational speed. It may be noted that other examples involving additional actuating members are also possible without deviating from the scope of the present subject matter. In such cases, the controller 412 may control such other actuating members to attenuate acoustic waves of other frequencies.

[0053] FIG. 6 illustrates another example adaptable chamber 602 for attenuating acoustic noise emitted by a cooling fan, such as the cooling fan 406 of the electronic device 402. During operation, the cooling fan 406 may emit acoustic noise due to rotation thereof. The adaptable chamber 602 is composed of longitudinally extending first chamber 208 and a second chamber 210 for attenuating acoustic noise of different frequencies, which may be emitted by the cooling fan 406 when operating at a first rotational speed and a second rotational speed. In this example, the first rotational speed is greater than the second rotational speed.

[0054] The first chamber 208 has an open end 212-1, a closed end 214-1 and a longitudinal sidewall 216-1 extending between the open end 212-1 and the closed end 214-1. Similarly, the second chamber 210 has an open end 212-2, a corresponding closed end 214-2 and a longitudinal sidewall 216-2 extending between the open end 212-2 and the closed end 214-2. The dimensions of the first chamber 208 and the second chamber 210 are different. In an example, a cross-sectional area of the first chamber 208 is greater than the cross-sectional area of the second chamber 210. As a result, a volume enclosed within the first chamber 208 is greater than a volume enclosed in the second chamber 210. It may be noted that although the first chamber 208 and the second chamber 210 are depicted to have rectilinear shape, they may be of any shape without deviating from the scope of the present subject matter.

[0055] As may be noted, different chambers with different volumes result in attenuation or cancellation of acoustic waves of different frequencies. The resonating frequency is inversely proportional to the volume of the chamber. Therefore, resonating chambers with larger volumes may be utilized for attenuating lower frequencies, while resonating chambers with smaller volumes may be utilized for attenuating higher frequencies. In the context of the present example, since the volume enclosed by the first

chamber 208 is greater than the volume enclosed by the second chamber 210, the first chamber 208 may be utilized for attenuating an acoustic wave with a frequency which may be less than a frequency of an acoustic wave which may be attenuated by the second chamber 210. In an example, the open ends 212 may be provided with filters 604-1 and 604-2 to allow certain frequencies to pass through and enter, either the first chamber 208 or the second chamber 210. In an example, the filters 604-1, 2 may be a sponge filter.

[0056] The adaptable chamber 602 may be further provided with an actuating member 218 arranged within the cooling device 404. The actuating member 218 may be arranged in proximity to the open ends 212 of the first chamber 208 and the second chamber 210. The actuating member 218 may be an electromechanically operated valve, for example a solenoid valve. Other types of example valves may also be possible without deviating from the scope of the present subject matter. In operation, the controller 412 may detect a rotational speed of the cooling fan 406. Depending on the detected rotational speed, the controller 412 may control the movement of the actuating member 218, such that it is either at a first position or a second position. When at the first position, the actuating member 218 is to cover the open end 212-1, and when in the second position, is to cover the open end 212-2.

[0057] In operation, the controller 412 on detecting a first rotational speed of the cooling fan 406, may move the actuating member 218 to the first position (as represented in 600A). The actuating member 218 in the first position covers the open end 212-1 of the first chamber 208. Since the first chamber 208 is covered, acoustic waves corresponding to an acoustic noise emitted by the cooling fan 406 are directed into the second chamber 210. This results in the creation of standing waves in the second chamber 210. The standing waves thus produced, are to destructively interfere with the acoustic wave generated by the cooling fan 406. The destructive interference results in the attenuation or cancellation of the acoustic waves generated by the cooling fan 406 operating at the first rotational speed.

[0058] In a similar manner, the controller 412 on detecting a second rotational speed of the cooling fan 406, may move the actuating member 218 to the second position (as represented in 600B). When in the second position, the actuating member 218 covers the open end 212-2 of the second chamber 210. Since the second chamber 210 is

covered, the acoustic waves corresponding to an acoustic noise emitted by the cooling fan 406 are directed into the first chamber 208. Within the first chamber 208, standing waves may be formed which then may destructively interfere with the acoustic wave generated by the cooling fan 406. The destructive interference results in the attenuation or cancellation of the acoustic waves generated by the cooling fan 406 operating at the second rotational speed. In this manner, the adaptable chamber 602 thus described may be utilized for attenuating acoustic noise having different frequencies, which are generated when the cooling fan 406 that is to operate at different rotational speeds.

[0059] It may be noted that the adaptable chamber 602 may be composed of additional chambers having cross-sectional areas which are different from the first chamber 208 and the second chamber 210. Such examples would also fall within the scope of the present subject matter.

[0060] FIG. 7 illustrates yet another example of an adaptable chamber 702 for attenuating acoustic noise emitted by a cooling fan, such as the cooling fan 406. The adaptable chamber 702 may include a first portion 704 and a second portion 706. The first portion 704 and the second portion 706 are concentrically positioned and are to move telescopically with respect to each other. The first portion 704 may have a first end 708-1, a second end 710-1 and a sidewall 712-1 extending longitudinally between the first end 708-1 and the second end 710-1. In a similar manner, the second portion 706 may have a first end 708-2, a second end 710-2 and a sidewall 712-2 extending longitudinally between the first end 708-2 and the second end 710-2. For example, the second portion 706 may be operatively coupled to the first portion 704. In this regard, the second portion 706 is longitudinally movable with respect to the first portion 704. The second end 710-1 of the first portion 704 and the first end 708-2 of the second portion 706 may be open to define an internal volume within the adaptable chamber 702.

[0061] Continuing further, the adaptable chamber 702 may have an opening 714 present at the sidewall 712-1 of the first portion 704, and proximal to the first end 708-1. The second end 710-2 of the second portion 706 may form a closed end of the adaptable chamber 702. The opening 714 is to allow acoustic waves emitted by the cooling fan 406, to enter the adaptable chamber 702. Moreover, a filter 716 may be arranged within the adaptable chamber 702 in proximity to the opening 714. The filter 716 is to absorb some

of the acoustic waves, for example, low-frequency acoustic waves. In an example, the filter 716 may be a sponge filter.

[0062] The cooling device 404 may further include an actuator 718 coupled to the adaptable chamber 702. The actuator 718 may be an electromechanical device, such as a motor, configured to move the second portion 706 between a first position and a second position, in response to a detected rotational speed of the cooling fan 406. The movement of the second portion 706 may cause change in a length of the adaptable chamber 702. In one example, the controller 412 may detect the rotational speed of the cooling fan 406, and further execute control signals to trigger the actuator 718.

[0063] In an example, the controller 412 on detecting a first rotational speed of the cooling fan 406, triggers the actuator 718 to move the second portion 706 onto the first portion 704, and to the first position (as shown in 700A). When in the first position, the adaptable chamber 702 may define a first effective length, which in the present example is less than a maximum length of the adaptable chamber 702. In operation, acoustic waves corresponding to an acoustic noise emitted by the cooling fan 406 may result in formation of a standing wave in the adaptable chamber 702. The standing wave may then destructively interfere with a corresponding acoustic wave 720. The destructive interference in turn results in the attenuation or cancellation of the acoustic wave 720.

[0064] Continuing further, the rotational speed may change. At this stage, the controller 412 may detect a second rotational speed of the cooling fan 406. The second rotational speed is less than the first rotational speed. Once the second rotational speed is detected, the controller 412 may trigger the actuator 718 to move the second portion 706 to the second position (as shown in 700B). The second portion 706 in the second position may define a second effective length of the adaptable chamber 702, wherein the second effective length is greater than the first effective length. As discussed previously, chambers with longer lengths may be utilized for attenuating or cancelling acoustic noise with lower frequencies, whereas chambers with shorter lengths may be utilized for attenuating acoustic noise with higher frequencies. With the second portion 706 in the second position, the adaptable chamber 702 results in formation of a standing wave which may then destructively interfere with a corresponding acoustic wave 722, which in turn causes cancellation or attenuation of the acoustic wave 722. In such a manner, an

acoustic noise emitted by the cooling fan 406 operating at the second rotational speed may be attenuated. The second portion 706 may accordingly be moved to other different positions, which in turn may enable cancelling of acoustic noise of different frequencies.

[0065] Although examples for the present disclosure have been described in language specific to structural features and/or methods, it should be understood that the appended claims are not necessarily limited to the specific features or methods described. Rather, the specific features and methods are disclosed and explained as examples of the present disclosure.

CLAIMS:

1. A computing device comprising:
a cooling device, the cooling device comprising:
a housing enclosing a cooling fan;
a longitudinally extending adaptable chamber for noise cancellation with an opening and a closed end and having an internal volume, wherein the adaptable chamber is coupled to the housing; and
an actuating member pivotably mounted on an inner surface of the adaptable chamber, wherein the actuating member is to:
move between a first position and a second position in response to a detected operating speed of the cooling fan; and
when in the first position, divide the internal volume of the adaptable chamber into a first sub-chamber and a second sub-chamber.
2. The computing device as claimed in claim 1, wherein the first sub-chamber is a resonating chamber and, through the opening, is to receive acoustic waves corresponding to an acoustic noise generated by the cooling fan operating at a first operating speed.
3. The computing device as claimed in claim 1, wherein the actuating member, when in the second position, is to form another resonating chamber with the internal volume, wherein the internal volume is greater than a volume of the first sub-chamber.
4. The computing device as claimed in claim 3, wherein the other resonating chamber is to receive acoustic waves corresponding to acoustic noise generated by the cooling fan operating at a second operating speed.
5. The computing device as claimed in claim 1, further comprising a second actuating member mounted on the inner surface of the adaptable chamber between the actuating member and the closed end.

6. The computing device as claimed in claim 5, wherein the second actuating member is to:

while the first actuating member is in the second position, move to a corresponding second position in response to a detected third operating speed of the cooling fan to form a third sub-chamber, wherein the third sub-chamber is a resonating chamber and, through the opening, is to receive acoustic waves corresponding to acoustic noise generated by the cooling fan operating at the third operating speed.

7. The computing device as claimed in claim 6, wherein a volume of the third sub-chamber is greater than a volume of the first sub-chamber.

8. The computing device as claimed in claim 1, wherein the actuating member is an electromechanically operated valve.

9. A computing device comprising:

a housing enclosing a circulating device for circulating a cooling fluid through components of the computing device;

a longitudinally extending first chamber and a second chamber for noise cancellation, each having a respective open end and a respective closed end, wherein a dimension of the second chamber is different from a corresponding dimension of the first chamber; and

an actuating member pivotally moveable in response to a detected operating speed of the circulating device between a first position and a second position, wherein:

when in the first position, the actuating member is to cover the open end of the first chamber; and

when in the second position, the actuating member is to cover the open end of the second chamber.

10. The computing device as claimed in claim 9, wherein the actuating member is to: move to the first position in response to detection of a first operating speed of the circulating device; and

move to the second position in response to detection of a second operation speed of the circulating device.

11. The computing device as claimed in claim 9, wherein the dimensions of the first chamber are greater than the dimensions of the second chamber.

12. The computing device as claimed in claim 9, wherein:

when in the first position, the second chamber is to receive acoustic waves corresponding to an acoustic noise generated by the circulating device operating at a first operating speed; and

when in the second position, the first chamber is to receive acoustic waves corresponding to an acoustic noise generated by the circulating device operating at a second operating speed.

13. An electronic device comprising:

a cooling fan enclosed within a housing; and

an adaptable chamber for noise cancellation, tangentially arranged with respect to the housing having an opening and a closed end, and further comprises:

a first portion;

a second portion coupled to, and moveable with respect to, the first portion in response to a detected rotational speed of the cooling fan; and

a controller coupled to the second portion, wherein the controller is to:

detect a rotational speed of the cooling fan; and

in response to the detected rotational speed, cause movement of the second portion to a first position with respect to the first portion, wherein the first position corresponds to the detected rotational speed.

14. The electronic device as claimed in claim 13, wherein the controller is to move the second portion so as to vary an effective length of the adaptable chamber.

15. The electronic device as claimed in claim 13, wherein the adaptable chamber is to receive acoustic waves corresponding to acoustic noise generated by the cooling device operating at the detected rotational speed and is to form standing waves within the adaptable chamber.

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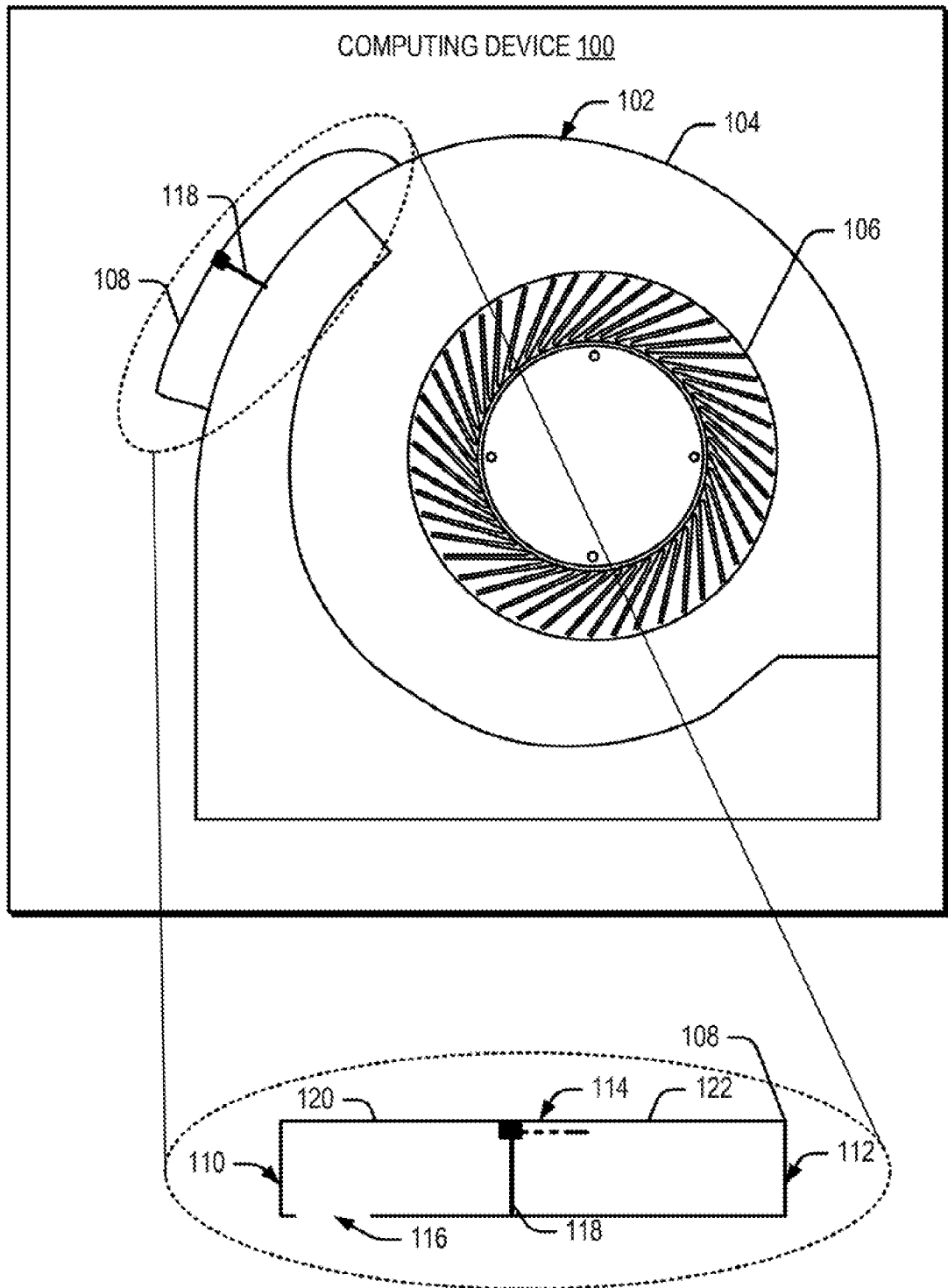


FIG. 1

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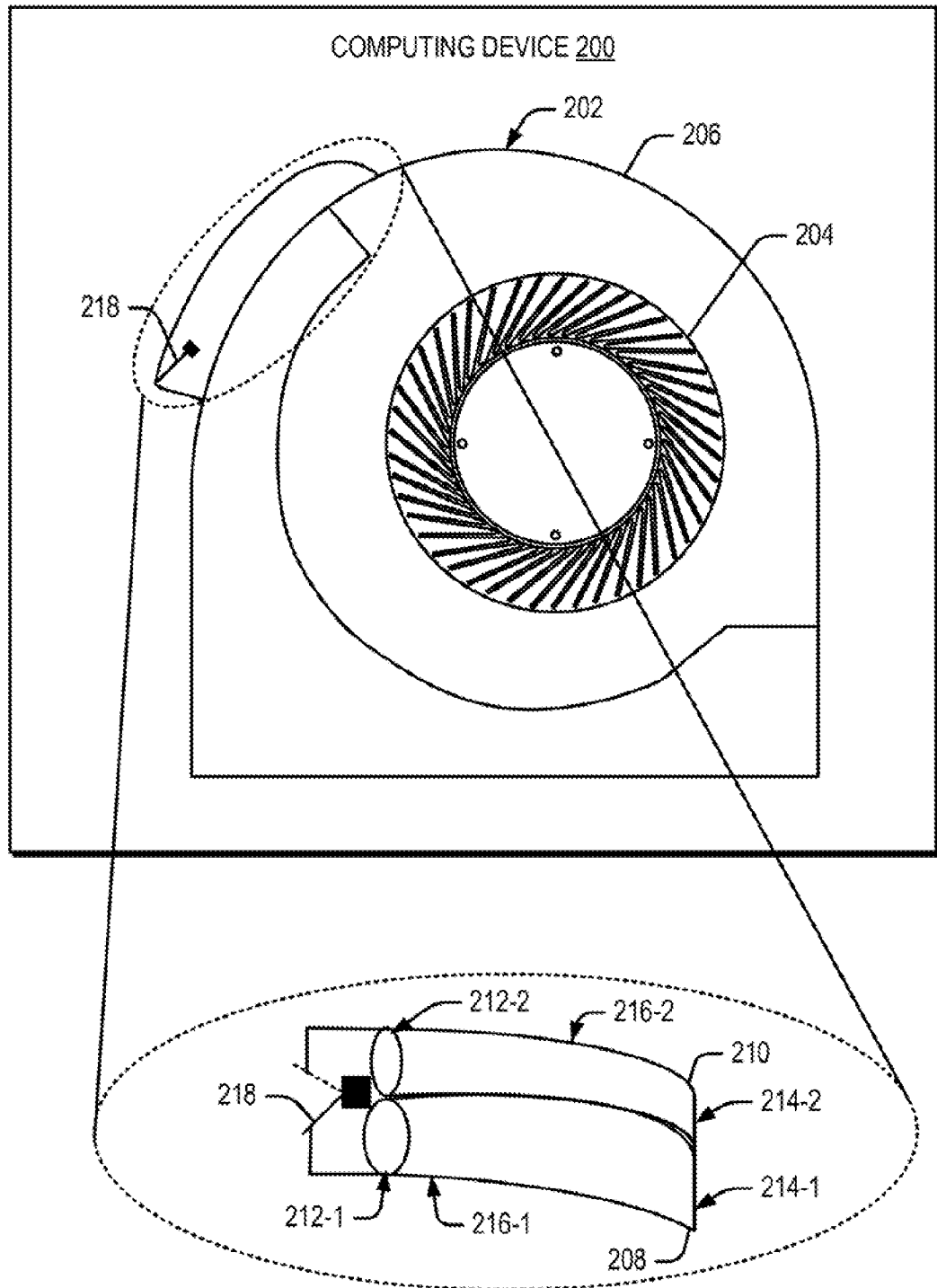


FIG. 2

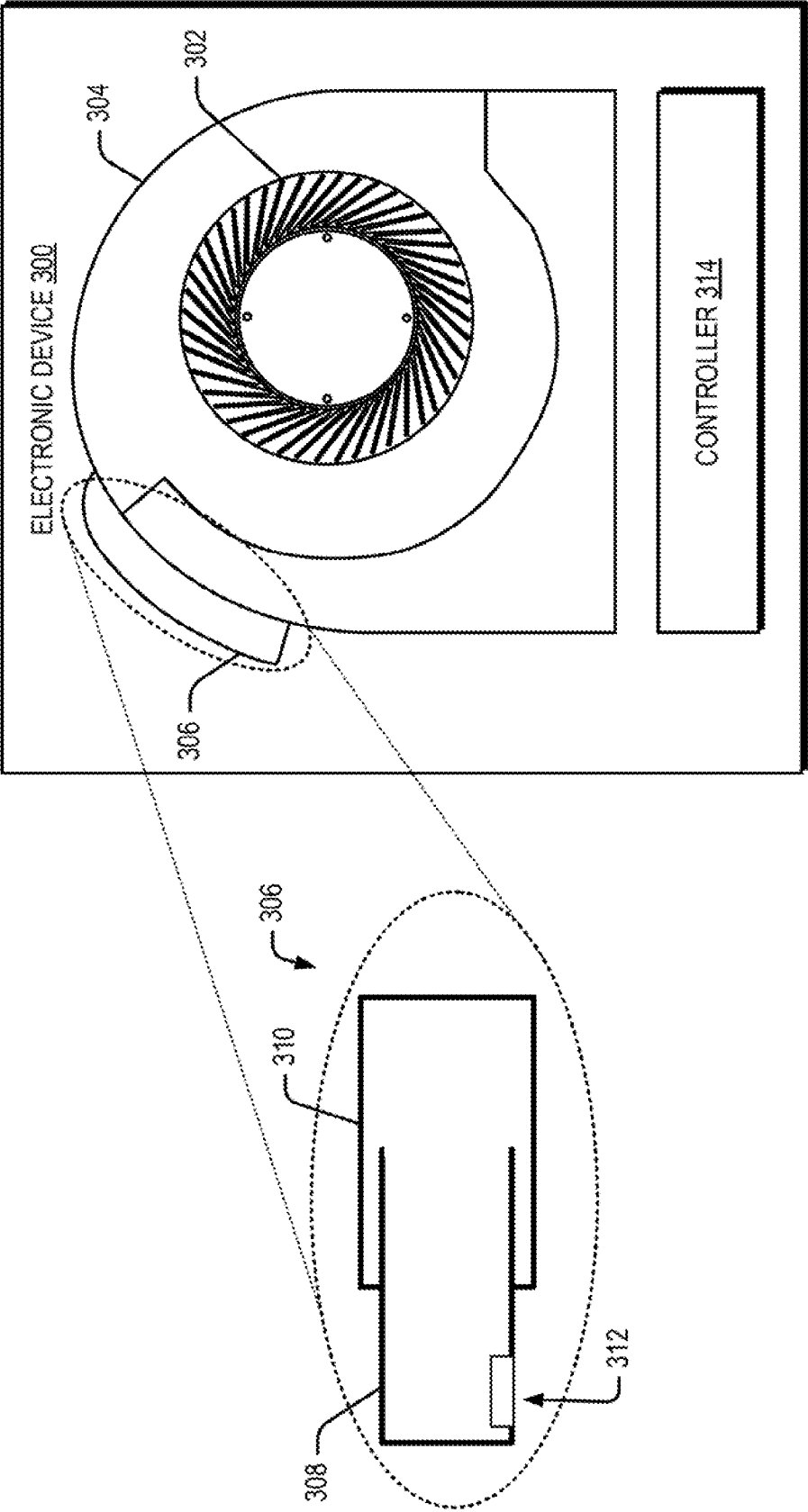


FIG. 3

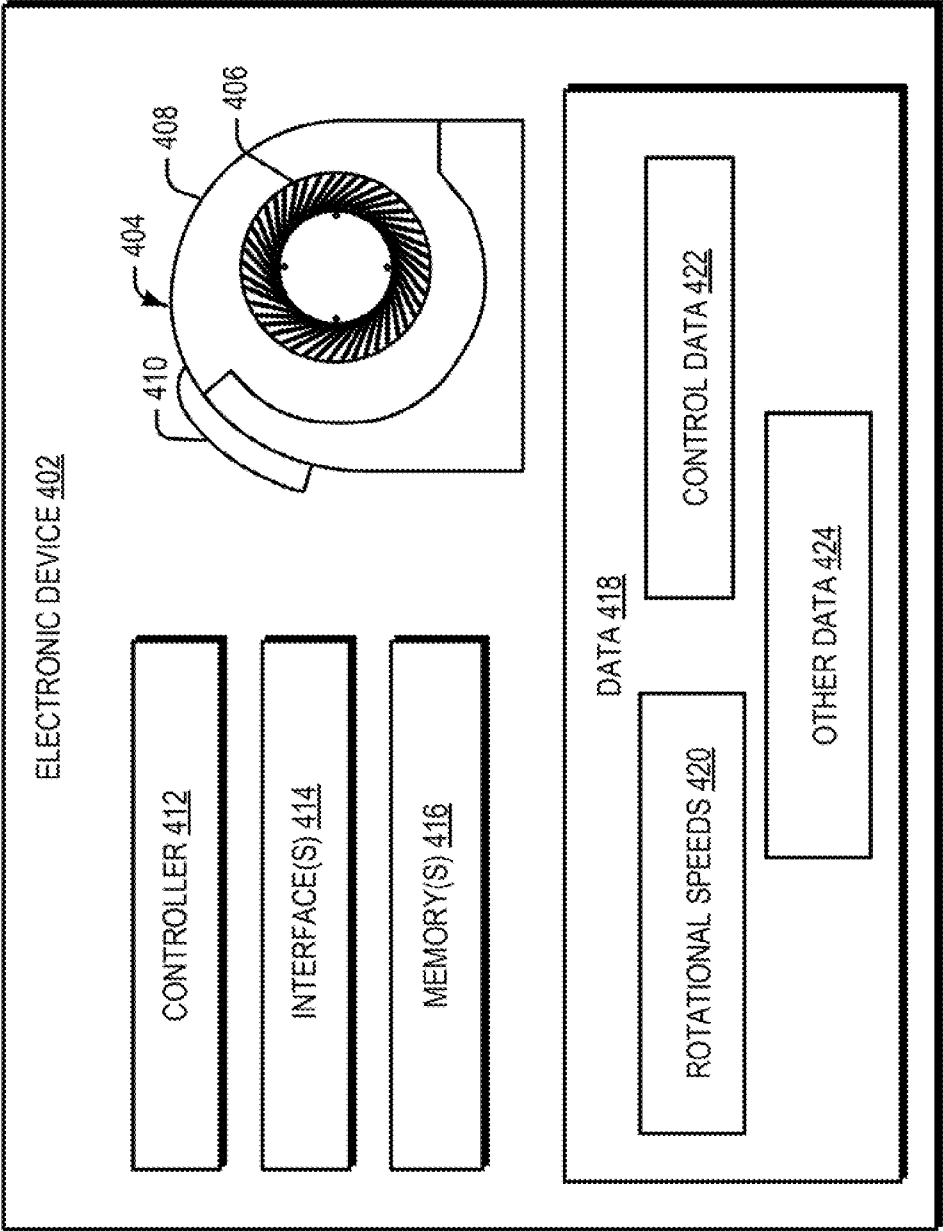


FIG. 4

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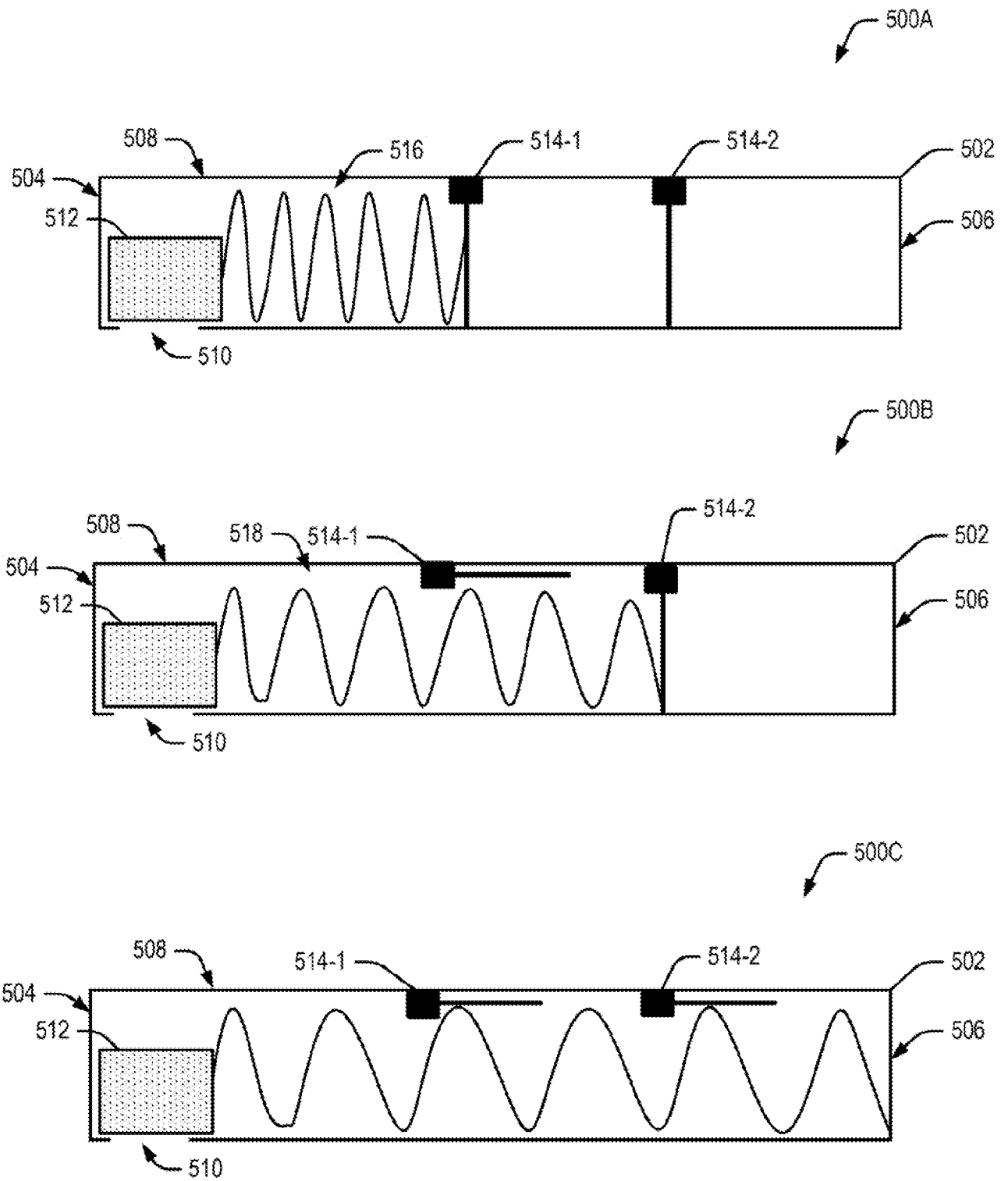


FIG. 5

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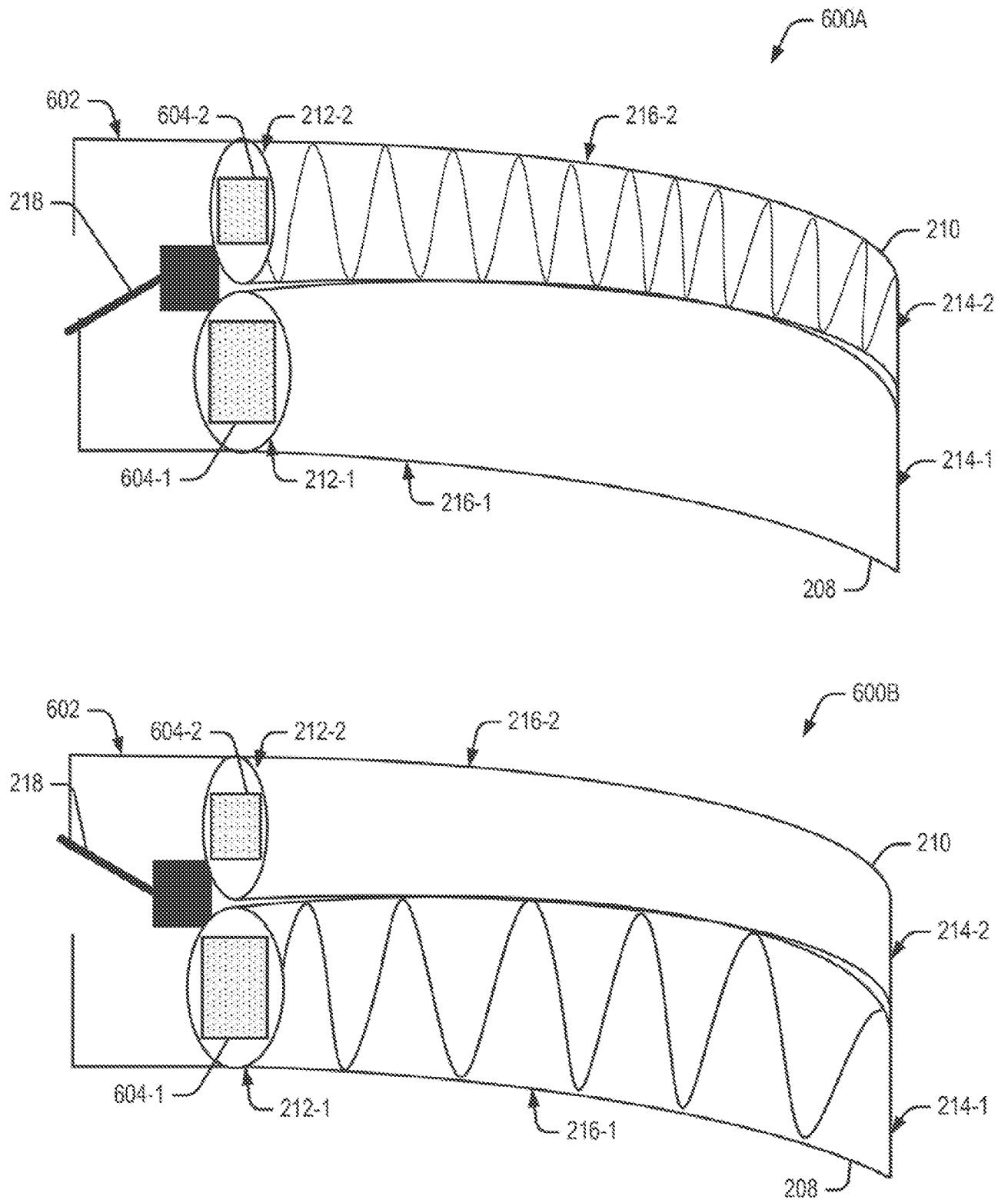


FIG. 6

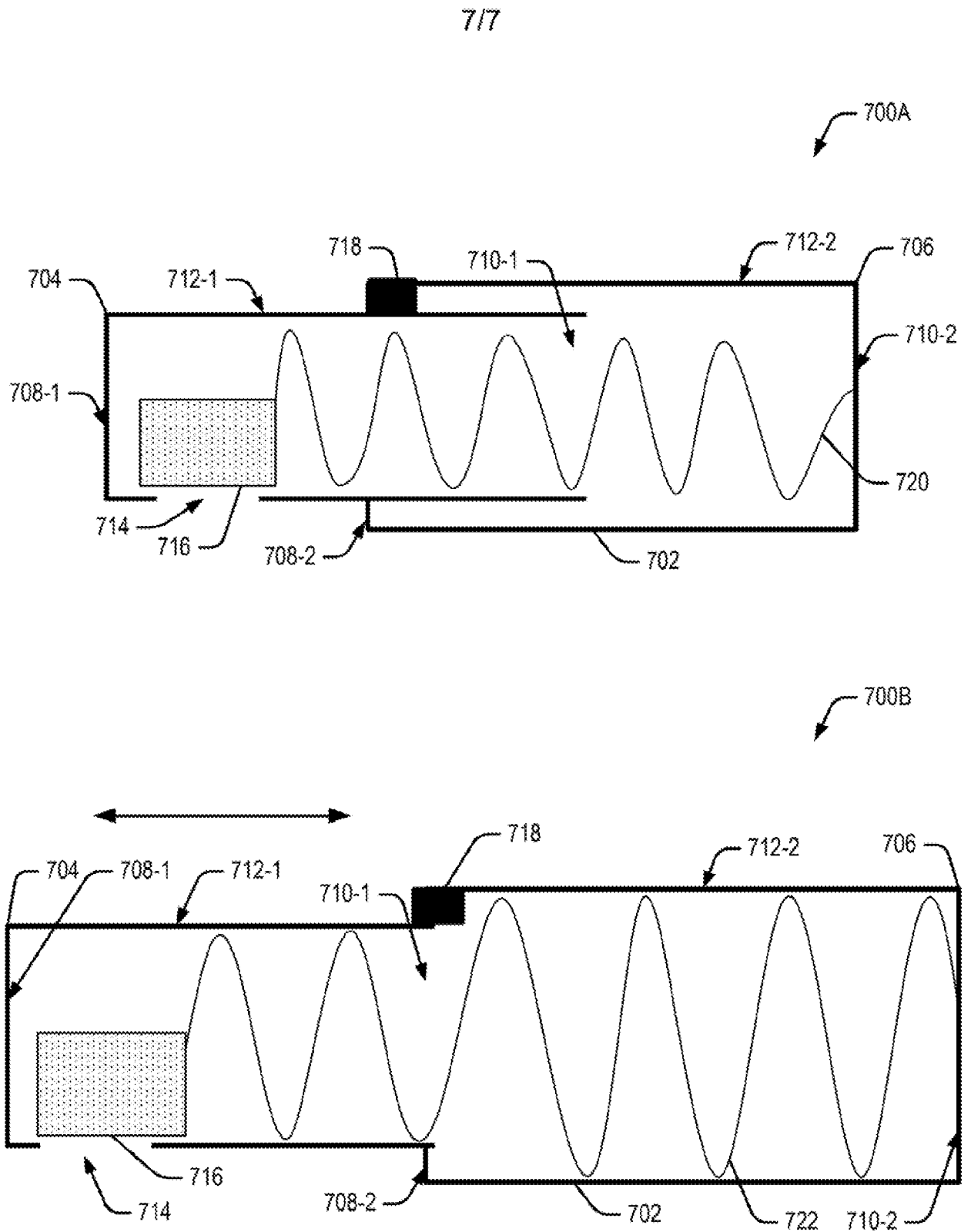


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 2020/047922

A. CLASSIFICATION OF SUBJECT MATTER <i>G11B 33/08 (2006.01)</i> <i>G12B 9/02 (2006.01)</i> <i>G12B 15/02 (2006.01)</i>		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
G11B 33/00-33/08, G12B 9/00-9/02, 15/00-15/02, H01L 23/00-23/473		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
PatSearch (RUPTO internal), USPTO, PAJ, K-PION, Esp@cenet, Information Retrieval System of FIPS		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5452362 A (SUN MICROSYSTEMS INC.) 19.09.1995	1-15
A	US 2006/0118279 A1 (ERIC STAFFORD) 08.06.2006	1-15
A	US 8855329 B2 (SILENTIUM LTD.) 07.10.2014	1-15
A	US 7353908 B1 (EMC CORPORATION) 08.04.2008	1-15
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “D” document cited by the applicant in the international application “E” earlier document but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family	
Date of the actual completion of the international search 27 April 2021 (27.04.2021)	Date of mailing of the international search report 13 May 2021 (13.05.2021)	
Name and mailing address of the ISA/RU: Federal Institute of Industrial Property, Berezhkovskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993 Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37	Authorized officer A. Semenova Telephone No. 499-240-60-15	