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PARTITION DEVICE WITH AIRFOIL-SHAPED AIRFLOW DEFLECTORS

Abstract

A partition device for improving cooling of a heat-generating electronic device includes a grid panel and an airflow deflector. The grid panel has one or more apertures and a thickness that extends from a leading surface to a trailing surface. The apertures of the grid panel extend parallel to an airflow direction of forced air flowing across the thickness of the grid panel and through the apertures. The airflow deflector is attached at least in part within one of the apertures, and the airflow deflector has an airfoil shape for reducing air resistance between the forced air and the grid panel. The airfoil shape has a leading edge that redirects initial contact with the forced air and a trailing edge that continues redirecting the forced air.

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Background/Summary

RELATED APPLICATIONS [0001] This application claims priority to and the benefit of U.S. Provisional Application No. 63/333,015, filed on Apr. 20, 2022, which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates generally to an electronic chassis for improving cooling of a heat-generating device, and more specifically, to a partition device for improving cooling of a heat-generating electronic device that is enclosed within an electronic chassis.

BACKGROUND OF THE INVENTION

[0003] Many computer systems, and especially server systems, include heat-generating electronic devices that require cooling for proper and efficient working condition. The concern with cooling is particularly acute when the electronic devices are encased in a chassis. Typically, the electronic devices are equipped with fans for ventilation; heated air generated by the electronic devices is expelled by fans through ventilation grids in the chassis. However, the sharp rectangular vent openings on conventional ventilation grids abruptly contract and expand the airflow passageway, causing disruption to the airflow and increasing airflow resistance. Consequently, conventional ventilation grids reduce efficiency of the cooling fans and detrimentally affect the cooling of the heat-generating electronic devices.

SUMMARY OF THE INVENTION

[0004] The term embodiment and like terms, e.g., implementation, configuration, aspect, example, and option, are intended to refer broadly to all of the subject matter of this disclosure and the claims below. Statements containing these terms should be understood not to limit the subject matter described herein or to limit the meaning or scope of the claims below. Embodiments of the present disclosure covered herein are defined by the claims below, not this summary. This summary is a high-level overview of various aspects of the disclosure and introduces some of the concepts that are further described in the Detailed Description section below. This summary is not intended to identify key or essential features of the claimed subject matter. This summary is also not intended to be used in isolation to determine the scope of the claimed subject matter. The subject matter should be understood by reference to appropriate portions of the entire specification of this disclosure, any or all drawings, and each claim.

[0005] According to certain aspects of the present disclosure, a partition device for improving cooling of a heat-generating electronic device includes a grid panel and an airflow deflector. The grid panel has one or more apertures and a thickness that extends between a leading surface and a trailing surface. The apertures of the grid panel extend parallel to an airflow direction of forced air flowing across the thickness of the grid panel and through the apertures. The airflow deflector is attached at least in part within one of the apertures, and the airflow deflector has an airfoil shape for reducing air resistance between the forced air and the grid panel. Furthermore, the airfoil shape has a leading edge that redirects initial contact with the forced air and a trailing edge that continues redirecting the forced air.

[0006] According to another aspect of the partition device described above, the leading edge of the airflow deflector extends from the leading surface of the grid panel towards the airflow direction.

[0007] According to another aspect of the partition device described above, the trailing edge of the airflow deflector extends from the trailing surface of the grid panel away from the airflow direction.

[0008] According to another aspect of the partition device described above, the airfoil shape of the airflow deflector is symmetrically biconvex.

[0009] According to another aspect of the partition device described above, the airflow deflector has a length and a thickness. The length is defined by distance of a chord line that runs from the leading edge to the trailing edge. The thickness is defined by the longest distance between the biconvex surfaces of the airflow deflector in a plane perpendicular to the chord line. A ratio of the length to the thickness is between about 1.01 and about 25.

[0010] According to another aspect of the partition device described above, the airfoil shape of the airflow deflector includes a convex surface that redirects flow of the forced air, and an attachment surface that attaches the airflow deflector to an aperture. The attachment surface is opposite the convex surface.

[0011] According to another aspect of the partition device described above, the airflow deflector matches a first airflow deflector and the partition device further includes a second airflow deflector. The second airflow deflector is attached at least in part within the aperture to which the first airflow deflector is attached. The second airflow deflector has an airfoil shape for reducing air resistance between the forced air and the grid panel. The airfoil shape of the second airflow deflector has a leading edge that redirects initial contact with the forced air, a trailing edge that continues redirecting the forced air and an opposing convex surface facing a convex surface of the first airflow deflector.

[0012] According to another aspect of the partition device described above, the convex surface of the first airflow deflector and the opposing convex surface of the second airflow deflector are separated by a gap distance. The gap distance is configured to create a low-pressure region between the convex surface of the first airflow deflector and the opposing convex surface of the second airflow deflector. The air pressure of the low-pressure region is lower than air pressure near the leading surface of the grid panel.

[0013] According to another aspect of the partition device described above, the aperture extends longitudinally along the leading surface and the trailing surface of the grid panel. The airflow aperture includes a top, a midsection and a bottom.

[0014] According to another aspect of the partition device described above, the airflow deflector matches a middle deflector that is attached to the midsection of the airflow aperture. The middle deflector has a biconvex airfoil shape. The partition device further includes an upper deflector and a lower deflector. The upper deflector and the lower deflector are attached to the top and the bottom of the airflow aperture, respectively. The upper deflector and the lower deflector each have an airfoil shape for reducing air resistance between the forced air and the grid panel. The airfoil shape of the upper deflector and the lower deflector each have a leading edge that redirects initial contact with the forced air, a trailing edge that continues redirecting the forced air, and a convex surface facing the middle deflector.

[0015] According to other aspects of the present disclosure, a method is directed to improving cooling of a heat-generating electronic device. The method includes positioning an airflow deflector within an aperture of a grid panel that is located within a computer chassis. The airflow deflector has an airfoil shape. The method also includes causing forced air to pass through the aperture of the grid panel. The method further includes, in response to the forced air making contact with the airflow deflector, redirecting the forced air around the airfoil shape to reduce air resistance between the forced air and the grid panel.

[0016] According to another aspect of the method described above, the aperture of the grid panel extends longitudinally along a surface of the grid panel. The surface of the grid panel is perpendicular to an airflow direction of the forced air.

[0017] According to another aspect of the method described above, the airflow deflector matches a first airflow deflector and the method further includes positioning a second airflow deflector within the aperture of the grid panel. The second airflow deflector also has an airfoil shape. The method also includes configuring a convex surface of the first airflow deflector to face an opposing convex surface of the second airflow deflector.

[0018] According to other aspects of the present disclosure, the method described above further includes separating the convex surface of the first airflow deflector and the opposing convex surface of the second airflow deflector by a gap distance. The gap distance is configured to create a low-pressure region between the convex surface of the first airflow deflector and the opposing convex surface of the second airflow deflector. The air pressure of the low-pressure region is lower than air pressure near a leading surface of the grid panel. The method also includes causing the low-pressure region to draw forced air through the aperture.

[0019] According to other aspects of the present disclosure, an electronic chassis for improving cooling of a heat-generating electronic device includes one or more panels. Each panel has a one or more apertures and one or more of deflectors for reducing air resistance between airflow through the apertures and the grid panels. Each aperture has a longitudinal shape across the panel in a first plane and extends through the thickness of the respective panel. The first plane is perpendicular to a direction of airflow through the apertures. Each panel also has a thickness that extends across a second plane that is parallel to the direction of the airflow. Each deflector has an airfoil shape and at least a portion of each deflector is positioned within one of the apertures. Each deflector has a leading edge and a trailing edge. The leading edge has a blunt shape that redirects initial contact with the airflow and the trailing edge has a sharp shape that continues redirecting the airflow after passing through the respective aperture.

[0020] According to another aspect of the electronic chassis described above, the electronic chassis further includes a frame for encasing the heat-generating electronic device. The frame has one or more frame walls that define an interior space. The panels are distributed across the interior space in a direction parallel to the second plane.

[0021] According to another aspect of the electronic chassis described above, the airfoil shape of at least one of the airflow deflectors is symmetrically biconvex.

[0022] According to another aspect of the electronic chassis described above, the deflector with symmetrically biconvex airfoil shape has a length and a thickness. The length is defined by distance of a chord line between the leading edge and the trailing edge. The thickness is defined by the longest distance between the biconvex surfaces of the airflow deflector in a plane perpendicular to the chord line. The ratio of the length to the thickness is between about 1.01 and about 25.

[0023] According to another aspect of the electronic chassis described above, the airfoil shape of at least some of the deflectors include a convex surface that reduces resistance between the airflow and the grid panel, and an attachment surface that attaches the airflow deflector to the respective aperture. The attachment surface is opposite the convex surface.

[0024] According to another aspect of the electronic chassis described above, at least one of the apertures has a top, a midsection, and a bottom. An upper deflector, a middle deflector and a lower deflector are attached to the top, the midsection and the bottom of the airflow aperture, respectively. The middle deflector has a biconvex airfoil shape. The upper deflector and the lower deflector each has a convex surface facing the middle deflector.

[0025] The above summary is not intended to represent each embodiment or every aspect of the present disclosure. Rather, the foregoing summary merely provides an example of some of the novel aspects and features set forth herein. The above features and advantages, and other features and advantages of the present disclosure, will be readily apparent from the following detailed description of representative embodiments and modes for carrying out the present invention, when taken in connection with the accompanying drawings and the appended claims. Additional aspects of the disclosure will be apparent to those of ordinary skill in the art in view of the detailed description of various embodiments, which is made with reference to the drawings, a brief description of which is provided below.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The disclosure, and its advantages and drawings, will be better understood from the following description of representative embodiments together with reference to the accompanying drawings. These drawings depict only representative embodiments, and are therefore not to be considered as limitations on the scope of the various embodiments or claims.

[0027] FIG. **1** is an isometric view illustrating internal aspects of an electronic chassis, which is fitted with partition devices for improving cooling of one or more heat-generating electronic devices, according to certain aspects of the present disclosure.

[0028] FIG. **2**A is a front view of a grid panel, which is included in a partition device of the electronic chassis of FIG. **1**, according to other aspects of the present disclosure.

[0029] FIG. **2**B is a perspective view of the grid panel of FIG. **2**A.

[0030] FIG. **3**A is a perspective view of a partition device, which is included in the electronic chassis of FIG. **1**.

[0031] FIG. **3**B is a side view of the partition device of FIG. **3**A.

[0032] FIG. **4**A is a side view of the partition device of FIG. **3**A, illustrating airflow direction and air pressure regions.

[0033] FIG. **4**B is another side view of the partition device of FIG. **3**A, illustrating the airflow direction and the air pressure regions.

[0034] FIG. **4**C is an enlarged, partial side view of the partition device of FIG. **3**A, illustrating the airflow direction and the air pressure regions.

[0035] FIG. **5** is a cross-sectional side illustration of a symmetrically biconvex airflow deflector, according to an aspect of the present disclosure.

[0036] FIG. **6**A is a flowchart illustrating an exemplary method for improving cooling of a heat-generating electronic device with a partition device, in accordance with certain aspects of the present disclosure.

[0037] FIG. **6**B is a continuation flowchart of FIG. **6**B.

DETAILED DESCRIPTION

[0038] Various embodiments are described with reference to the attached figures, where like reference numerals are used throughout the figures to designate similar or equivalent elements. The figures are not necessarily drawn to scale and are provided merely to illustrate aspects and features of the present disclosure. Numerous specific details, relationships, and methods are set forth to provide a full understanding of certain aspects and features of the present disclosure, although one having ordinary skill in the relevant art will recognize that these aspects and features can be practiced without one or more of the specific details, with other relationships, or with other methods. In some instances, well-known structures or operations are not shown in detail for illustrative purposes. The various embodiments disclosed herein are not necessarily limited by the illustrated ordering of acts or events, as some acts may occur in different orders and/or concurrently with other acts or events. Furthermore, not all illustrated acts or events are necessarily required to implement certain aspects and features of the present disclosure.

[0039] For purposes of the present detailed description, unless specifically disclaimed, and where appropriate, the singular includes the plural and vice versa. The word “including” means “including without limitation.” Moreover, words of approximation, such as “about,” “almost,” “substantially,” “approximately,” and the like, can be used herein to mean “at,” “near,” “nearly at,” “within 3-5% of,” “within acceptable manufacturing tolerances of,” or any logical combination thereof. Similarly, terms “vertical” or “horizontal” are intended to additionally include “within 3-5% of” a vertical or horizontal orientation, respectively. Additionally, words of direction, such as “top,” “bottom,” “left,” “right,” “above,” and “below” are intended to relate to the equivalent direction as depicted in a reference illustration; as understood contextually from the object(s) or element(s) being referenced, such as from a commonly used position for the object(s) or element(s); or as otherwise described herein.

[0040] Generally, an embodiment of the present invention is directed to a partition device for improving cooling of a heat-generating electronic device. The partition device includes a grid panel and an airflow deflector. The grid panel has one or more apertures and a thickness that extends from a leading surface to a trailing surface. The apertures of the grid panel extend parallel to an airflow direction of forced air flowing across the thickness of the grid panel and through the apertures. The airflow deflector is attached at least in part within one of the apertures. The airflow deflector also has an airfoil shape for reducing air resistance between the forced air and the grid panel. The airfoil shape has a leading edge that redirects initial contact with the forced air and a trailing edge that continues redirecting the forced air.

[0041] The present invention also discloses an electronic chassis that includes one or more of the above-described partition device and a method for improving cooling of a heat-generating electronic device using the above-described partition device.

[0042] FIG. **1** shows an electronic chassis **100** with partition devices **104** for improving cooling of one or more heat-generating electronic devices (not shown) mounted within the chassis **100**. The heat-generating electronic device mounted within the chassis **100** may be a server, computer, switch, router, storage device, telecommunication component and the like that requires air-based cooling. The electronic chassis **100** includes a frame **102** and one or more partition devices **104**. The partition devices **104** each include a grid panel **106**. According to some of the embodiments, each grid panel **106** has one more apertures **108**. Some of these apertures **108** are airflow apertures **110** that are fitted with one or more airflow deflectors **112**. According to some embodiments, each airflow aperture **110** has a longitudinal shape across a first plane **120** of its respective panel **106** and extends through the thickness **106***c* of the respective panel **106**. The first plane **120** is perpendicular to a direction of airflow **124** through the apertures **108**. The thickness **106***c* of each panel **106** extends across a second plane **122** that is parallel to the direction of airflow **124**. At least a portion of each airflow deflector **112** is positioned within one of the airflow apertures **110**. Furthermore, each airflow deflector **112** has an airfoil shape for reducing air resistance between airflow and the one or more grid panels **106** as forced air expelled by one or more heated electronic devices (not shown) moves through the airflow apertures **110**.

[0043] FIGS. **2**A and **2**B show a grid panel **106** of the partition device **104** (shown in FIG. **1**) without the airflow deflectors. Referring to FIG. **2**A, the grid panel **106** has one or more apertures **108**. In some embodiments, a subset of the apertures **108** are airflow apertures **110** designed to facilitate the flow of forced air expelled from one or more heat-generating electronic devices. FIG. **2**B further shows that, in some embodiments, the airflow apertures **110** are longitudinally-shaped and extend through the thickness **106***c* of the grid panel **106** from a leading surface **106***a* to a trailing surface **106***b*. The longitudinally-shaped airflow apertures **110** each have a top **110***a*, a midsection **110***b*, and a bottom **110***c*. It should be recognized that each airflow aperture **110** does not have to be a contiguous opening. For instance, the midsection **110***b* of some airflow apertures **110** could be partially filled and be used as an attachment point for an airflow deflector.

[0044] FIG. **3**A illustrates an embodiment of the partition device **104**. The partition device **104** includes the grid panel **106** shown in FIGS. **2**A and **2**B, as well as one or more airflow deflectors **112**. In some embodiments, the airflow deflectors **112** include an upper deflector **112***a*, a middle deflector **112***b* and a lower deflector **112***c*, each respectively fitted to the top **110***a*, the midsection **110***b* and the bottom **110***c* of an airflow aperture **110**. Furthermore, the airflow deflectors **112** could be configured such that each of the middle deflectors **112***b* has a biconvex airfoil shape, and each of the upper deflectors **112***a* and the lower deflectors **112***c* has a convex surface facing the respective middle deflector **112***b*.

[0045] It should be recognized that an airflow aperture **110** may have fewer or more airflow deflectors **112** than that is shown in FIG. **3**A. Furthermore, as mentioned above, the airfoil shape of the deflectors **112** improves flow of the forced air through the apertures **110** by reducing the air resistance between the forced air and the grid panel **106**. Thus, the specific airfoil shape of the airflow deflectors **112** can also be varied, such as by modifying the convex curvature of the airfoil shape or adjusting an aspect ratio between the length and the thickness of the airfoil shape.

[0046] Referring to FIG. **3**B, the partition device **104** is shown from a side view and a set of the airflow deflectors **112***a*, **112***b*, and **112***c* are illustrated and described in more detail. Each of the airflow deflectors **112***a*, **112***b*, and **112***c* is attached at least in part within an airflow aperture **110**. Each airflow deflector has an airfoil shape for reducing air resistance between the forced air and the grid panel **106**. The airfoil shape has a leading edge **302** that redirects initial contact with the forced air, and a trailing edge **304** that continues redirecting the forced air. In some embodiments, the leading edge **302** of each airflow deflector **112***a*, **112***b*, and **112***c* extends from the leading surface **106***a* of the grid panel **106** towards the airflow direction. In some embodiments, the trailing edge **304** of each airflow deflector **112***a*, **112***b*, and **112***c* extends from the trailing surface **106***b* of the grid panel **106** away from the airflow direction. In some embodiments, the airfoil shape of the middle deflector **112***b* is symmetrically biconvex, with an upper convex surface **306***a* and a lower convex surface **306***b* joined at the leading edge **302** and the trailing edge **304**. On the other hand, the airfoil shape of the upper deflector **112***a* and the lower deflector **112***c* only includes one convex surface **306**. According to some embodiments, each of the upper deflector **112***a* and the lower deflector **112***b* have an attachment surface **308** opposite the respective convex surface **306**. The attachment surface **308** in this instance is a flat surface, however it is not restricted to being so. The upper deflector **112***a* and the lower deflector **112***b* are attached to the top **110***a* and the bottom **110***c* of the airflow aperture **110**, respectively. The upper deflector **112***a* and the lower deflector **112***c* are configured such that their convex surfaces **306** face the upper convex surface **306***a* and the lower convex surface **306***b*, respectively.

[0047] FIGS. **4**A and **4**B show side views of the partition device **104**, with arrows added to indicate the direction of airflow as the forced air interacts with the airflow deflectors **112**. Referring specifically to FIG. **4**A, forced air expelled by one or more heat-generating electronic devices (not shown) flows in a direction **402** approximately perpendicular to the grid panel **106** and makes contact with both the leading surface **106***a* of the grid panel **106** and the leading edges **302** of the airflow deflectors **112**. The blunt leading edges **302** of the airflow deflectors **112** redirect initial contact with the airflow. Referring specifically to FIG. **4**B, after the forced air contacts the airflow deflectors **112**, the airfoil shapes of the airflow deflectors **112***a*, **112***b*, and **112***c* cause the forced air to attach as attached air **404** to the convex surfaces **306** of the deflectors **112** and postpones the separation of the forced air **406** until it has reached the trailing edges **304** of the airflow deflectors **112**. Resultantly, the airflow deflectors **112** are able to guide the forced air through the aperture **110** smoothly. Furthermore, the airflow deflectors **112** mitigate disruption to airflow that is caused by a sudden contraction and expansion of the airflow passageway, as in the case of conventional ventilation grids.

[0048] FIG. **4**C shows a side view of a portion of the partition device **104**. The arrows indicate the direction of airflow and the regions delimited by dashed lines indicate air pressure regions. According to an embodiment, the forced air stays attached to and travels along the convex surfaces **306** of the airflow deflectors **112***b* and **112***c* as attached air **404**. The attached air **404** behaves as a fluid jet and causes air from the immediate surroundings to become entrained air **408**. This in turn creates a low-pressure region **410** in the immediate surroundings where air was pulled away from. By having two airflow deflectors **112***b* and **112***c* positioned at least in part within an airflow aperture **110**, and having a convex surface **306** of one airflow deflector **112***b* facing a convex surface **306** of the other airflow deflector **112***c*, a low-pressure region **410** is created between the two airflow deflectors **112***b* and **112***c*. This configuration further improves airflow by drawing forced air through the aperture **110** from a region of higher air pressure **412** to the low-pressure region **410**.

[0049] Referring to FIG. **5**, the airfoil shape and aspect ratio of a symmetrically biconvex deflector is described in detail. A symmetrically biconvex deflector **500** has a blunt leading edge **502**, a sharp trailing edge **504**, and two outwardly facing convex surfaces **506***a* and **506***b* that are joined at the leading edge **502** and the trailing edge **504**. The deflector **500** has a length **508** and a thickness **510**. The length **508** is the distance of a chord line **512**, which is a straight line that runs from the leading edge **502** to the trailing edge **504**. The thickness **510** is the longest distance between the convex surfaces **506***a* and **506***b* in a plane **514** that is perpendicular to the chord line **512**. In some embodiments, a ratio of the length **508** to the thickness **510** is between about 1.01and about 25.

[0050] With reference to FIGS. **6**A and **6**B, an exemplary method **600** for improving cooling of a heat-generating electronic device with a partition device, in accordance with certain aspects of the present disclosure, is shown. It should be understood that the exemplary method **600** is presented solely for illustrative purposes, and that in other methods in accordance with the present disclosure can include additional, fewer, or alternative steps performed in similar or alternative orders, or in parallel.

[0051] Referring specifically to FIG. **6**A, at step **602**, the method begins with positioning an airflow deflector within an aperture of a grid panel located within a computer chassis. The airflow deflector has an airfoil shape. Next, at step **604**, the air flow deflector causes forced air to pass through the aperture of the grid panel. At step **606**, in response to the forced air making contact with the airflow deflector, the forced air is redirected around the airfoil shape to reduce air resistance between the forced air and the grid panel. According to some embodiments, the aperture of the grid panel has a shape that extends longitudinally along a surface of the grid panel with the surface of the grid panel being perpendicular to an airflow direction of the forced air. The foregoing steps allow the airflow deflectors to guide the forced air through the aperture **110** smoothly and mitigate disruption to airflow caused a sudden contraction and expansion of the airflow passageway. The method **600** could end at step **606** or to continue with steps **608** through **614**.

[0052] Referring specifically to FIG. **6**B, the method **600** further may include arranging the airflow deflectors to further improve airflow by creating a low-pressure region between two airflow deflectors and drawing forced air through the aperture from a region of higher air pressure to the low-pressure region. According to some embodiments, the airflow deflector described in step **602** matches a first airflow deflector and the method further includes step **608**, positioning a second airfoil-shaped airflow deflector within the aperture of the grid panel. Next, at step **610**, a convex surface of the first airflow deflector is configured to face a convex surface of the second airflow deflector. Moving on to step **612**, the convex surfaces of the first airflow deflector and the second airflow deflector is separated by a gap distance. The gap distance should be configured to create a low-pressure region between the convex surfaces of the first airflow deflector and the second deflector. The low-pressure region should have a pressure lower than air pressure on a leading surface side of the grid panel. Lastly, on step **614**, the low-pressure region draws the forced air through the aperture.

[0053] Although the disclosed embodiments have been illustrated and described with respect to one or more implementations, equivalent alterations and modifications will occur or be known to others skilled in the art upon the reading and understanding of this specification and the annexed drawings. In addition, while a particular feature of the invention may have been disclosed with respect to only one of several implementations, such feature may be combined with one or more other features of the other implementations as may be desired and advantageous for any given or particular application.

[0054] While various embodiments of the present disclosure have been described above, it should be understood that they have been presented by way of example only, and not limitation. Numerous changes to the disclosed embodiments can be made in accordance with the disclosure herein, without departing from the spirit or scope of the disclosure. Thus, the breadth and scope of the present disclosure should not be limited by any of the above described embodiments. Rather, the scope of the disclosure should be defined in accordance with the following claims and their equivalents.

Claims

1-10. (canceled)
11. A method for improving cooling of a heat-generating electronic device, the method comprising: positioning a plurality of airflow deflectors within respective apertures of a grid panel, each of the plurality of airflow deflectors having a respective airfoil shape, the grid panel being located within a computer chassis; causing forced air to pass through the respective apertures of the grid panel; in response to the forced air making contact with the plurality of airflow deflectors, redirecting the forced air around each respective airfoil shape to reduce air resistance between the forced air and the grid panel; forming an airflow path, via the plurality of airflow deflectors, that includes a high-pressure region and a low-pressure region, the high-pressure region being formed between respective leading edges of the plurality of airflow deflectors, the low-pressure region being formed between respective trailing edges of the plurality of airflow deflectors; and drawing the forced air from the high-pressure region to the low-pressure region through one or more respective apertures of the grid panel.
12. The method of claim 11, wherein the apertures of the grid panel extend longitudinally along a surface of the grid panel, the surface of the grid panel being perpendicular to an airflow direction of the forced air.
13. The method of claim 11, wherein the plurality of airflow deflectors includes a first airflow deflector and a second airflow deflector, the method further comprising configuring a convex surface of the first airflow deflector to face an opposing convex surface of the second airflow deflector.
14. The method of claim 13 further comprising separating the convex surface of the first airflow deflector and the opposing convex surface of the second airflow deflector by a gap distance, the gap distance being configured to create the low-pressure region between the convex surface of the first airflow deflector and the opposing convex surface of the second airflow deflector, air pressure of the low-pressure region near the trailing edges being lower than air pressure of the high-pressure region near a leading surface of the grid panel.
15-20. (canceled)
21. A method for improving cooling in a heat-generating electronic device, the method comprising: causing forced air to flow along an airflow path that passes through apertures of a grid panel; making initial contact between the forced air and leading edges of a plurality of airflow deflectors that are positioned in the apertures; forming a high-pressure region between two adjacent leading edges of the plurality of airflow deflectors; redirecting the forced air, after the initial contact with the leading edges, towards trailing edges of the plurality of airflow deflectors, the leading edges forming with respective trailing edges airfoil shapes for each of the plurality of airflow deflectors; forming a low-pressure region between two adjacent trailing edges of the airflow deflectors; in response to the forming of the high-pressure region and the low-pressure region, drawing the forced air from the high-pressure region to the low-pressure region through the apertures of the grid panel, the forced air continuing to flow past the trailing edges in a space trailing the airfoil shapes.
22. The method of claim 21, further comprising attaching in the apertures of the grid panel a first airflow deflector of the plurality of airflow deflectors adjacent to a second airflow deflector of the plurality of airflow deflectors.
23. The method of claim 22, wherein the leading edges include a first leading edge of the first airflow deflector and the trailing edges include a first trailing edge of the first airflow deflector, the first leading edge being joined with the first trailing edge via two first convex surfaces.

24. The method of claim 23, wherein the first leading edge includes a blunt portion that is generally perpendicular to an airflow direction.
25. The method of claim 23, wherein the two first convex surfaces are outwardly facing.
26. The method of claim 23, wherein the two first convex surfaces are symmetrical relative to a center line of the first airflow deflector.
27. The method of claim 23, wherein the first airflow deflector has a length defined by distance of a chord line running from a respective leading edge to a respective trailing edge.
28. The method of claim 27, wherein the first airflow deflector has a thickness defined by a longest distance between the two first convex surfaces in a plane perpendicular to the chord line, a ratio of the length to the thickness being between about 1.01 and about 25.
29. The method of claim 22, wherein the leading edges include a second leading edge of the second airflow deflector and the trailing edges include a second trailing edge of the second airflow deflector, the second leading edge being joined with the second trailing edge via a single second convex surface on one side.
30. The method of claim 29, wherein the second leading edge is joined with the second trailing edge via a single flat surface on an opposite side.
31. The method of claim 30, further comprising position the single second convex surface closer to the first airflow deflector than the single flat surface.
32. The method of claim 29, wherein the second leading edge includes a blunt portion that is generally perpendicular to an airflow direction.
33. The method of claim 21, wherein one or more of the apertures is an airflow aperture extending longitudinally along a leading surface and a trailing surface of the grid panel, the airflow aperture having a top, a midsection and a bottom.
34. The method of claim 21, further comprising positioning the plurality of airflow deflectors in the same aperture of the apertures of the grid panel, a first airflow deflector of the plurality of airflow deflectors being attached on one end of the same aperture, a second airflow deflector of the plurality of airflow deflectors being attached at another end of the same aperture.
35. The method of claim 34, further comprising positioning the first airflow deflector above the second airflow deflector.
36. The method of claim 34, further comprising positioning the first airflow deflector below the second airflow deflector.