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MacManus

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(54) **HEATSINK CHASSIS WITH AEROFOIL**

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H05K 7/20 (2006.01)

(52) **U.S. Cl.**
CPC ***H05K 7/20409*** (2013.01)

(58) **Field of Classification Search**
CPC H05K 7/20409
See application file for complete search history.

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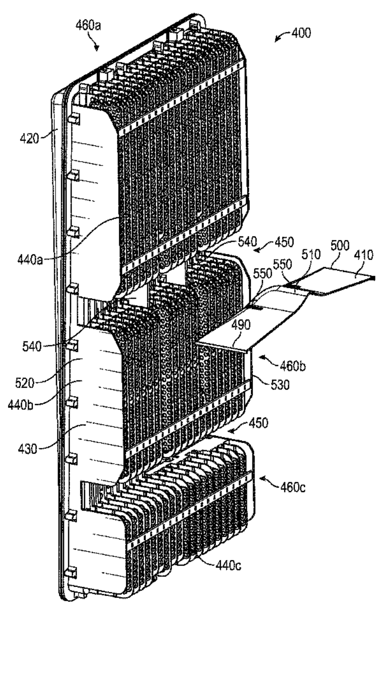
(57) **ABSTRACT**

A chassis is provided for a circuit board, the chassis having a heatsink. The chassis includes a plurality of fins extending from the chassis for extracting heat from electronics mounted on the chassis. The plurality of fins are organized into at least two fin sections, wherein a first fin section has a first set of fins of the plurality of fins and a second fin section has a second set of fins of the plurality of fins. The chassis further provides a thermal break between the first fin section and the second fin section, the thermal break being an air gap between the first set of fins and the second set of fins. An aerofoil is then fixed in the air gap and inhibits air flow between the first fin section and the second fin section.

12 Claims, 9 Drawing Sheets



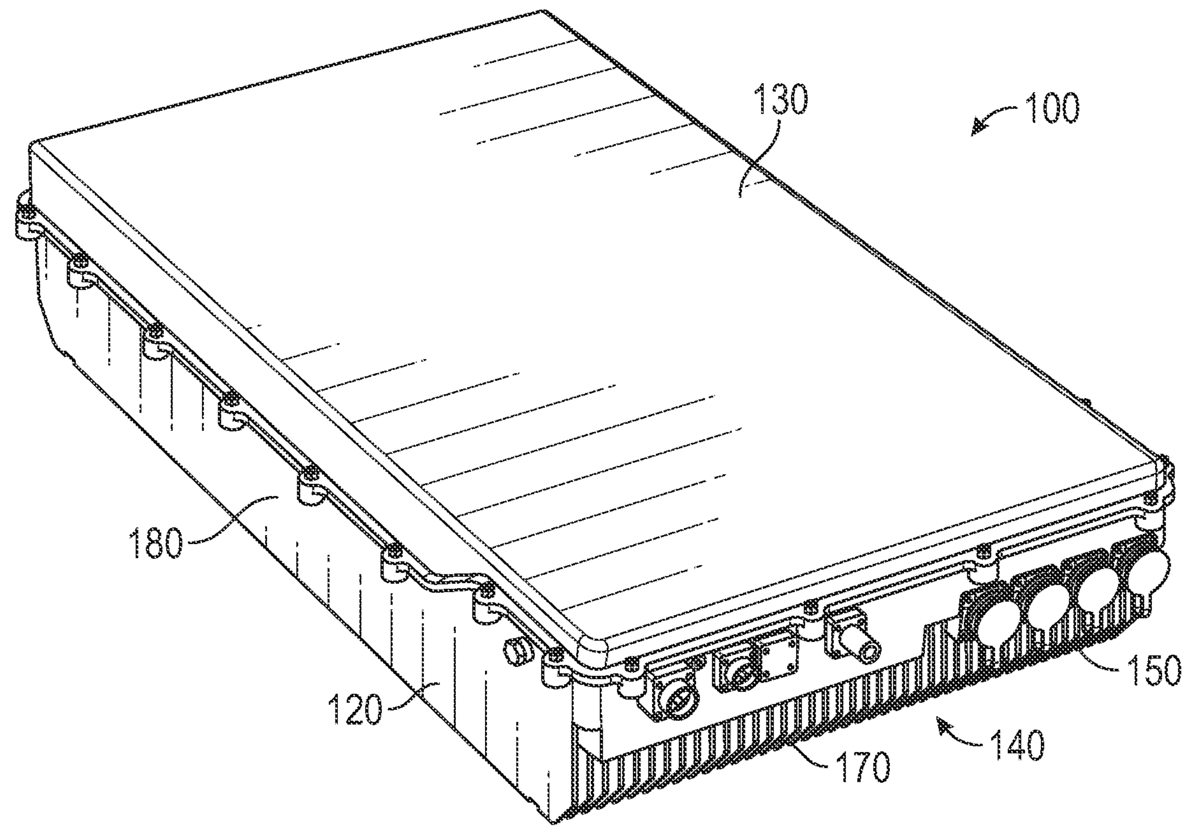


FIG. 1

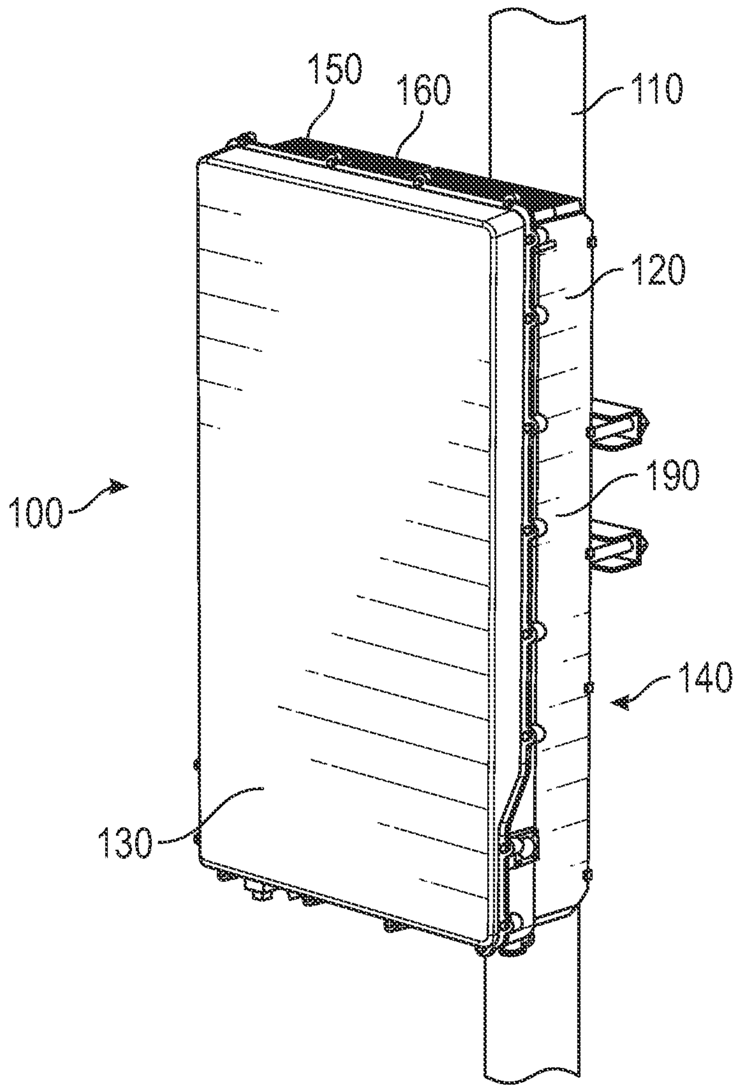


FIG. 2

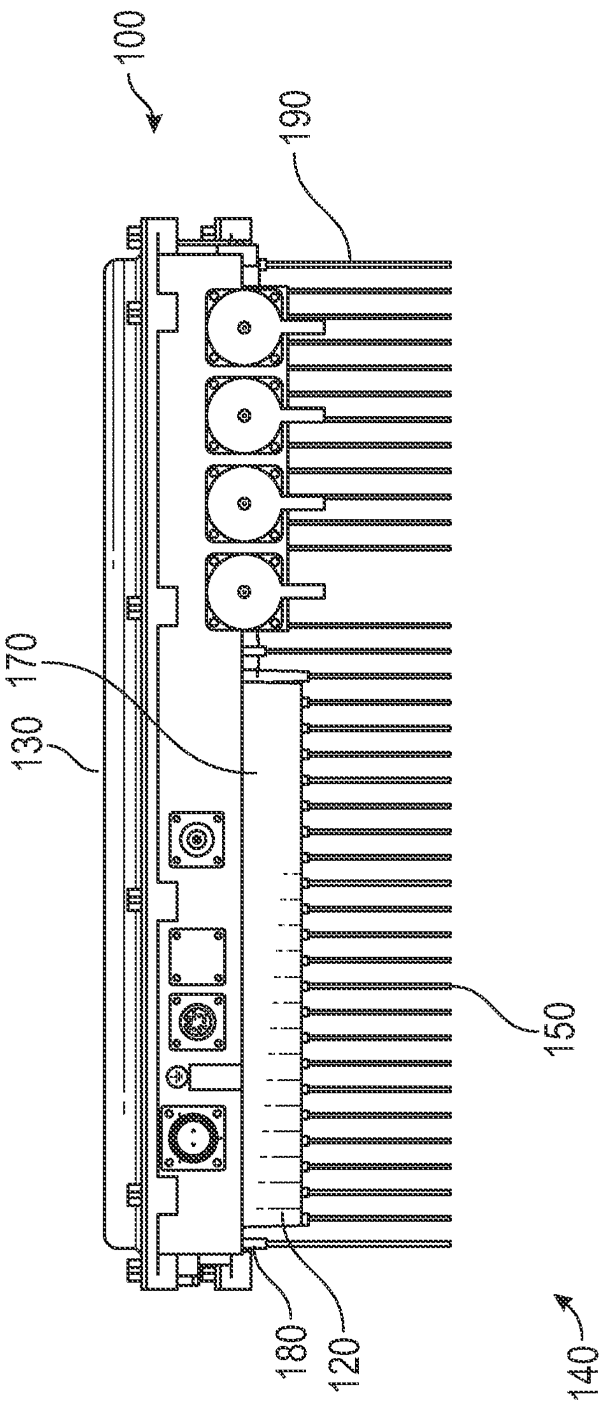


FIG. 3

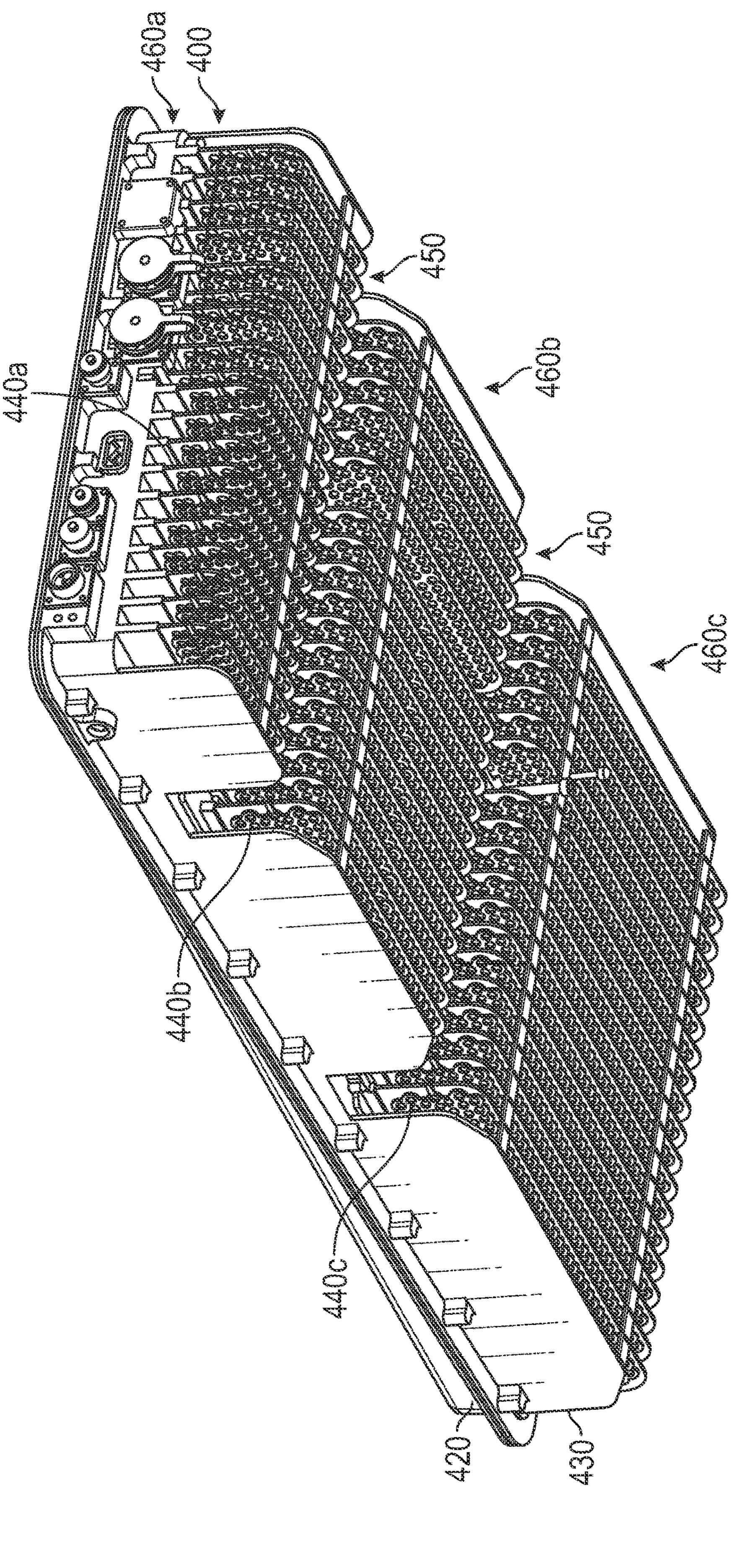


FIG. 4

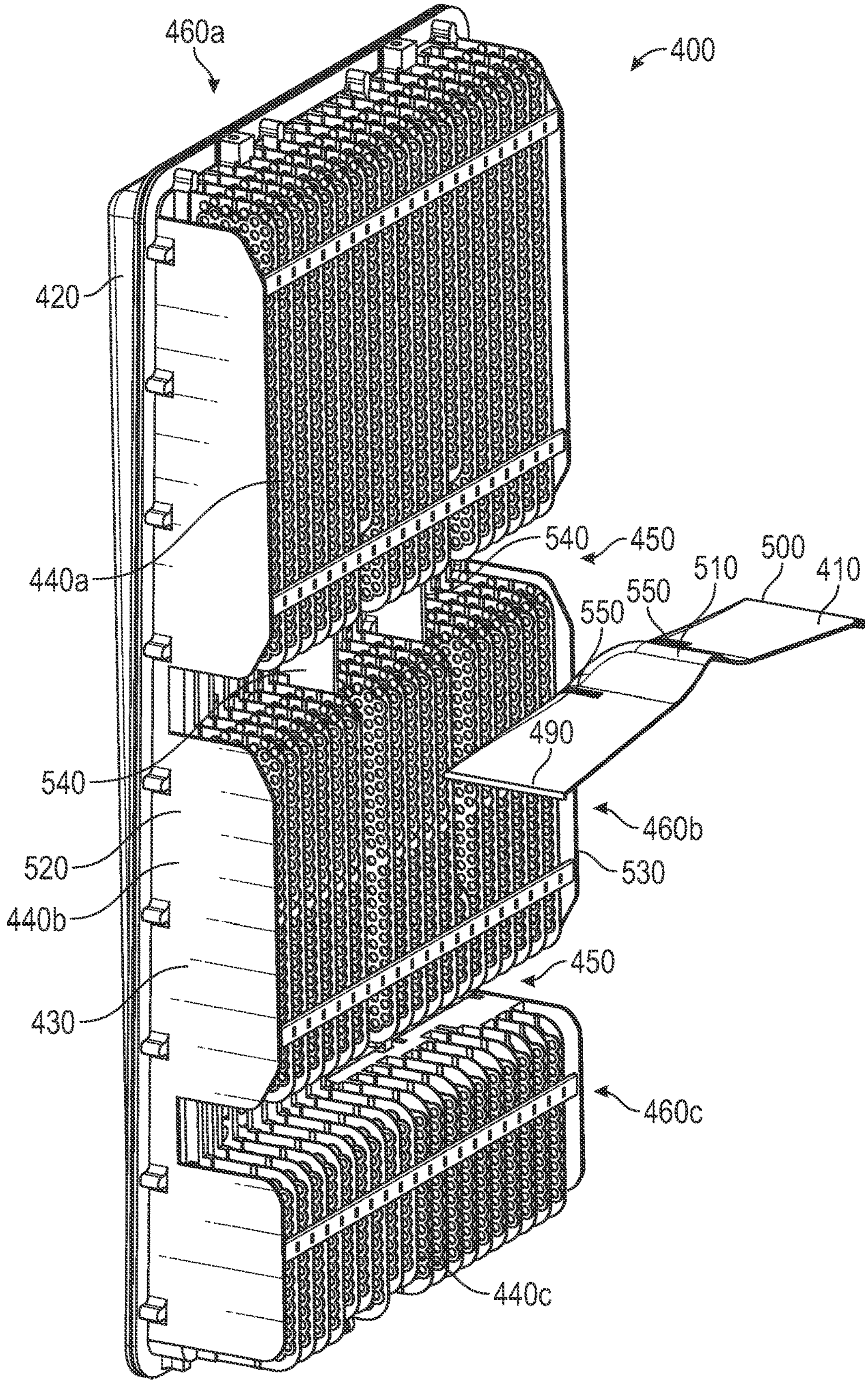

460a
400
420
440a
540
450
500
510
410
550
550
490
540
460b
520
530
440b
450
430
460c
440c

FIG. 5

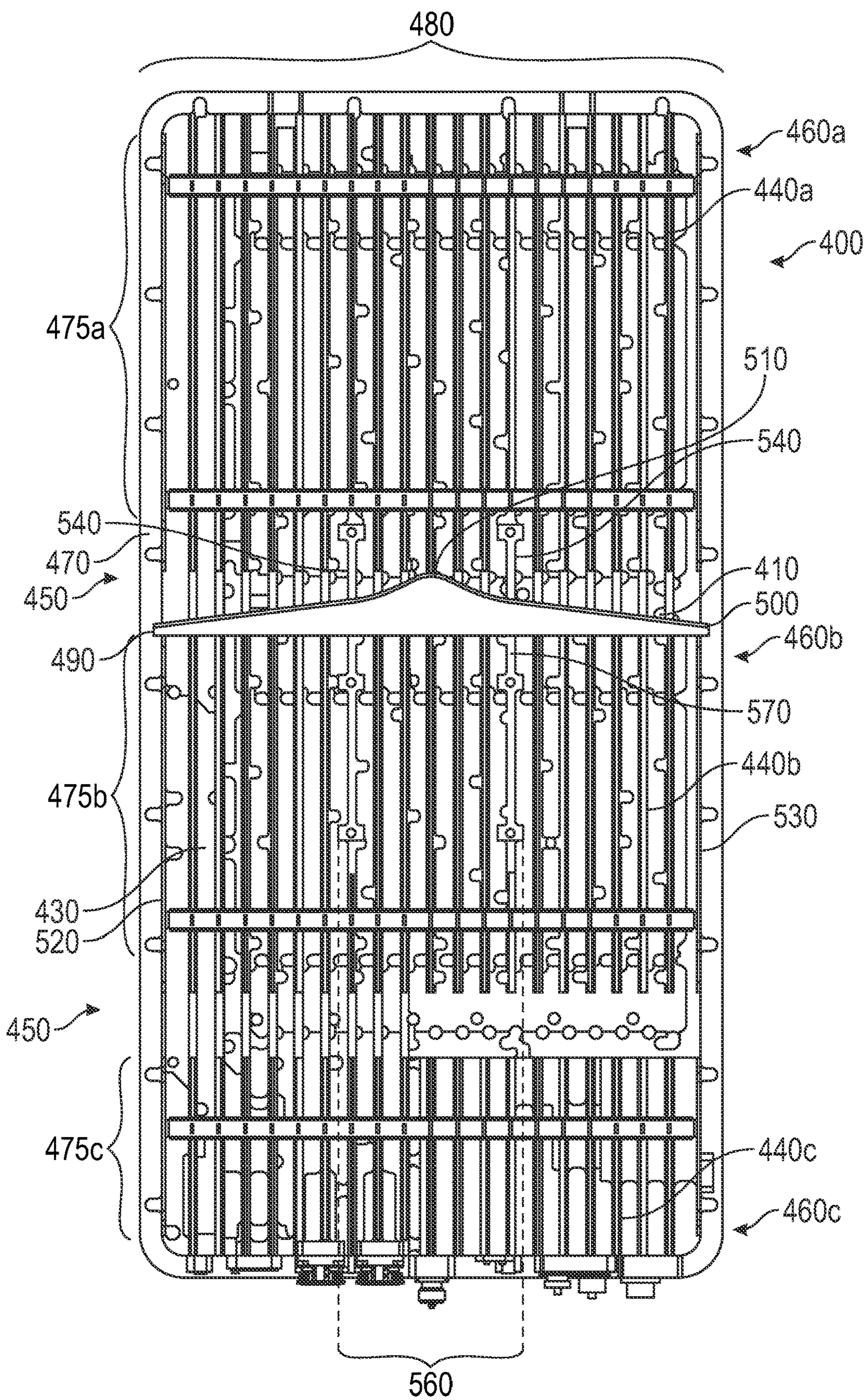
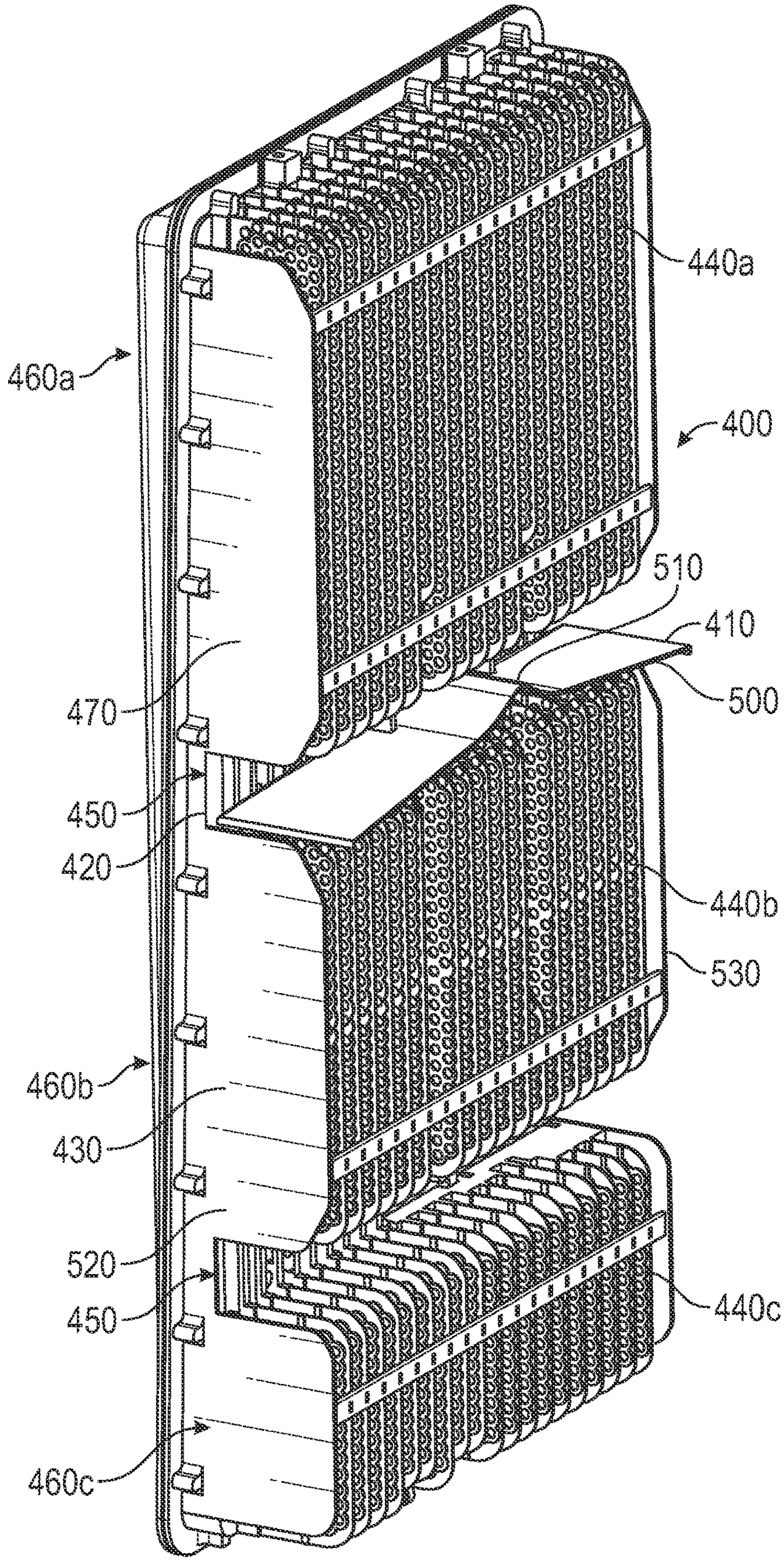

480
460a
440a
400
475a
510
540
540
470
410
450
500
460b
490
570
440b
475b
530
430
520
450
475c
440c
460c
560

FIG. 6



440a
460a
400
510
410
470
500
450
420
440b
530
460b
430
520
450
440c
460c

FIG. 7

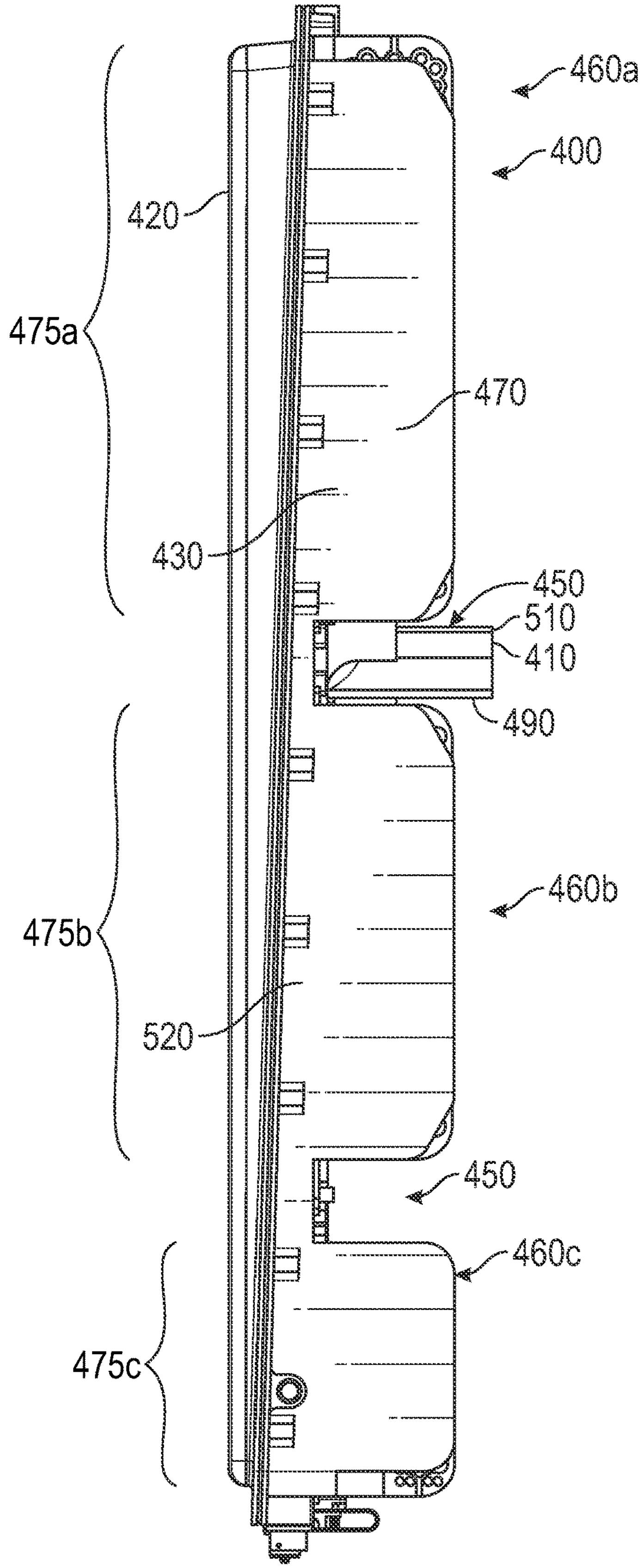

460a
400
420
475a
470
430
450
510
410
490
460b
475b
520
450
460c
475c

FIG. 8

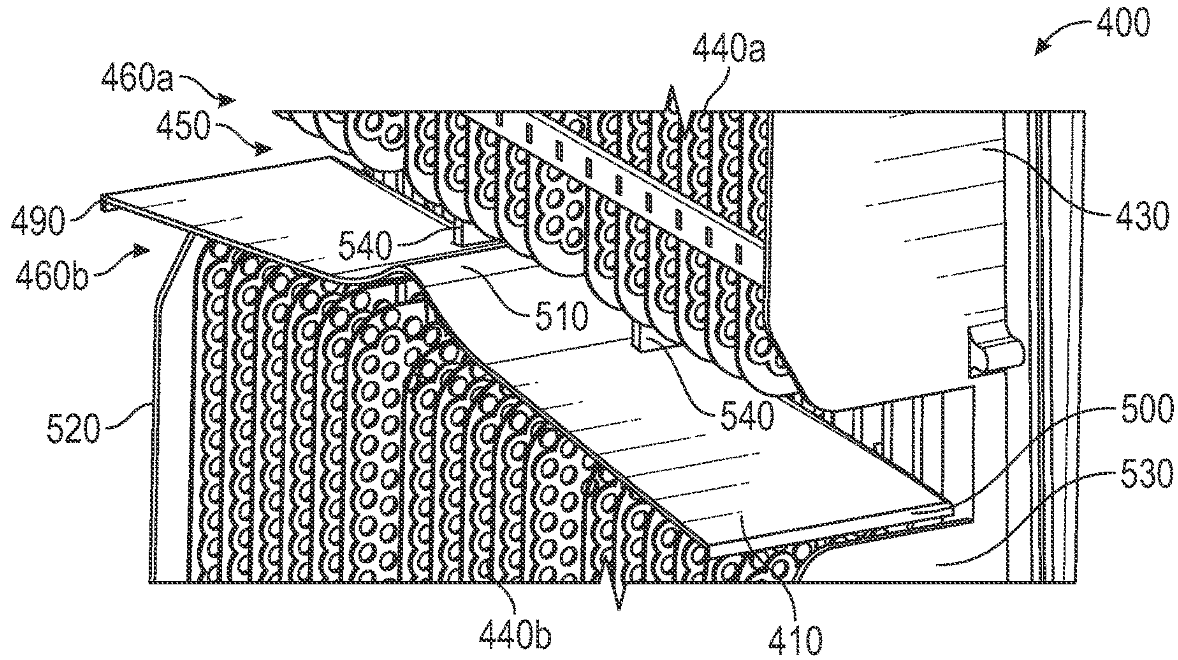

400
440a
460a
450
490
540
460b
430
510
540
520
500
530
440b
410

FIG. 9

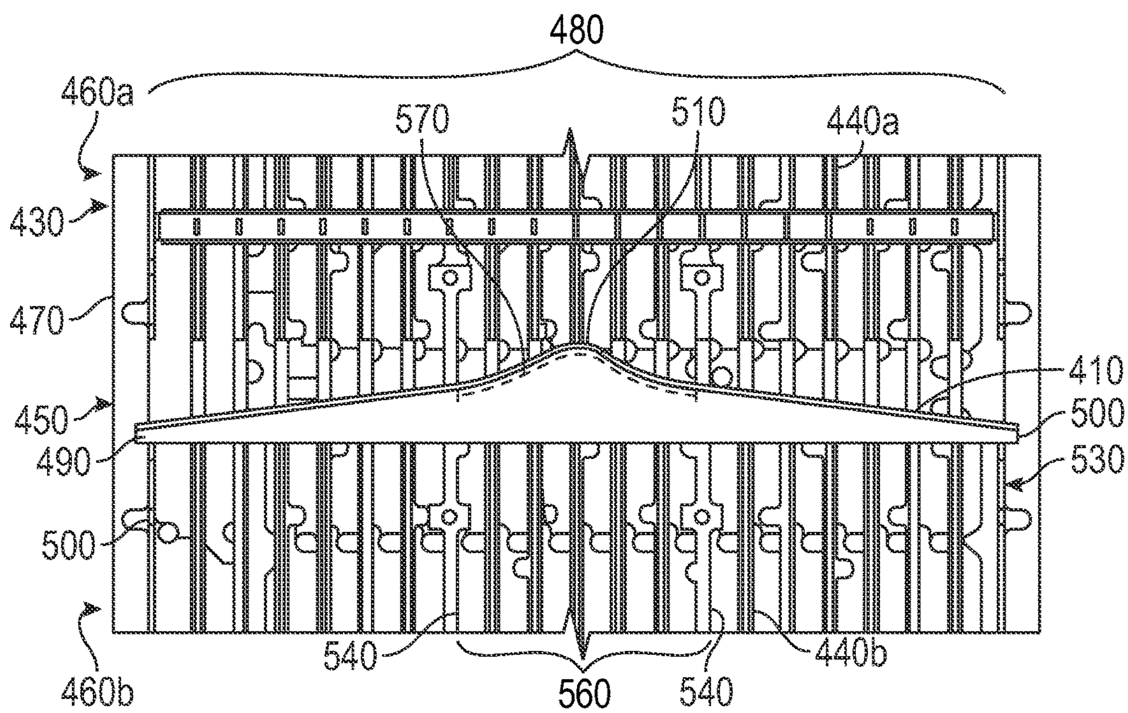

480
460a
570
510
440a
430
470
410
450
500
490
530
500
540
440b
560
540
460b

FIG. 10

HEATSINK CHASSIS WITH AEROFOIL

CROSS-REFERENCE TO RELATED APPLICATION

This application is a national stage application of International Application No. PCT/US2022/038770, filed on Jul. 29, 2022 and designated the U.S., which claims priority to U.S. Provisional Patent Application No. 63/345,786, filed on May 25, 2022. The contents of each are herein incorporated by reference.

FIELD OF THE INVENTION

This application relates to a chassis for supporting PCB having heatsinks for dissipating heat.

BACKGROUND

Various electronic devices may comprise various circuit boards and other electronic components mounted on cooling structures. Such cooling structures may include a chassis with a mounting surface on one side and various cooling features integrated into the chassis. Such cooling features may include cooling fins on a side of the chassis opposite the mounting surface, such that the cooling fins can draw heat away from a circuit board or other electronic components mounted on the mounting surface.

As an example, wireless communication devices such as mMIMO (massive Multiple-Input Multiple-Output) devices may be cooled using a chassis having a mounting surface on one side and may be cooled by either a fan or a fanless structure. This may include a fanless conductor, such as a finned heatsink, or a combination of fanless and fan-cooled structures, depending on the size of the device and/or power consumption requirements. Devices are typically designed and constructed to be either fanless or fan-cooled.

In some such electronic devices, circuit boards may be installed on a mounting surface of a chassis, the chassis including a heat sink, such as a finned heat sink. The circuit boards may then be enclosed in a housing or otherwise configured such that most or all heat generated by the circuit boards and related electronics must be dissipated by way of the heat sink.

There is a need, particularly in the context of fanless devices primarily cooled by a heat sink or the like, for improved devices for addressing heat management.

SUMMARY

A chassis is provided for a circuit board, the chassis having a heatsink. The chassis includes a plurality of fins extending from the chassis for extracting heat from electronics mounted on the chassis. The plurality of fins are organized into at least two fin sections, wherein a first fin section of the at least two fin sections comprises a first set of fins of the plurality of fins and a second fin section of the at least two fin sections comprises a second set of fins of the plurality of fins.

The chassis further provides a thermal break between the first fin section and the second fin section, the thermal break being an air gap between the first set of fins and the second set of fins.

An aerofoil is then fixed in the air gap and inhibits air flow between the first fin section and the second fin section.

In some embodiments, the fins of the first set of fins and the fins of the second set of fins are each arranged in

substantially parallel planes to each other. The aerofoil then extends from the chassis in the same direction as the plurality of fins but is not parallel to the first set of fins.

In some such embodiments, at least a portion of the aerofoil is angled with respect to a line perpendicular to the first set of fins. In some such embodiments, the first fin section and the second fin section each have a width and a length, and each fin of the second set of fins is elongated substantially in parallel to the length of the second fin section and the second set of fins are spaced apart along the width of the second fin section. The aerofoil is then bent such that it extends along the width of the second fin section and angles towards the second fin section at both ends of the width.

In some embodiments, during use, the second fin section is located below the first fin section.

In some embodiments, the aerofoil generates a temperature differential between the first fin section and the second fin section.

In some embodiments, the thermal break forms a channel perpendicular to the fins of the first set of fins and the fins of the second set of fins. The aerofoil then directs air flow entering the channel towards the first fin section.

In some such embodiments, the aerofoil has a first end, a second end, and a center. Each of the first end and the second end is then closer to the second fin section than the center. In some such embodiments, the first end and the second end are adjacent a first and last fin of the second set of fins respectively. The first and second end may then inhibit air flow entering the channel from entering the second fin section.

In some such embodiments, the first fin section and the second fin section are not enclosed by a housing. Accordingly, even when air flow does not cool the second fin section by way of the thermal breaks, heated air still exits the second fin section in a direction perpendicular to the plurality of fins and the aerofoil.

In some embodiments, the chassis includes at least one support structure for locating the aerofoil relative to the first fin section and the second fin section. In some such embodiments, the support structure is at least one blade extending from the chassis in parallel with the plurality of fins. The support structure may then extend into each of the first fin section and the second fin section and pass between fins of each of the first set of fins and the second set of fins.

In some such embodiments, the aerofoil comprises at least one slot. The aerofoil may then be located by positioning the slot on the at least one blade. In some such embodiments the at least one support structure is two blades, and the aerofoil comprises two slots. The two slots have a first distance between them along a surface of the aerofoil, and the two blades are spaced apart by a second distance smaller than the first distance.

In some embodiments, the chassis includes a circuit board mounting surface on a first side, and the plurality of fins extend from the chassis on a side opposite the circuit board mounting surface.

In some such embodiments, the chassis includes a first group of circuitry opposite the first fin section and a second group of circuitry opposite the second fin section. The first group of circuitry may then have different temperature requirements than the second group of circuitry.

Similarly, the chassis may include a first group of circuitry opposite the first fin section and a second group of circuitry opposite the second fin section, and the first group of circuitry generates a different amount of heat than the second group of circuitry.

In some embodiments, a third fin section is provided comprising a third set of fins and a second thermal break between the third fin section and the first and second fin sections.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a device in accordance with this disclosure.

FIG. **2** is the device of FIG. **1** mounted on a post.

FIG. **3** is a top view of the device of FIG. **1**.

FIG. **4** is a perspective view of a device in accordance with this disclosure without an aerofoil installed.

FIG. **5** is a perspective view of the device of FIG. **4** with an uninstalled aerofoil.

FIG. **6** is an elevation view of the device of FIG. **4** with the aerofoil installed.

FIG. **7** is a perspective view of the device of FIG. **4** with the aerofoil installed.

FIG. **8** is a side view of the device of FIG. **4** with the aerofoil installed.

FIG. **9** is a detailed perspective view of a portion of the device of FIG. **4** with the aerofoil installed.

FIG. **10** is a detailed elevation view of a portion of the device of FIG. **4**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The description of illustrative embodiments according to principles of the present invention is intended to be read in connection with the accompanying drawings, which are to be considered part of the entire written description. In the description of embodiments of the invention disclosed herein, any reference to direction or orientation is merely intended for convenience of description and is not intended in any way to limit the scope of the present invention. Relative terms such as "lower," "upper," "horizontal," "vertical," "above," "below," "up," "down," "top" and "bottom" as well as derivative thereof (e.g., "horizontally," "downwardly," "upwardly," etc.) should be construed to refer to the orientation as then described or as shown in the drawing under discussion. These relative terms are for convenience of description only and do not require that the apparatus be constructed or operated in a particular orientation unless explicitly indicated as such. Terms such as "attached," "affixed," "connected," "coupled," "interconnected," and similar refer to a relationship wherein structures are secured or attached to one another either directly or indirectly through intervening structures, as well as both movable or rigid attachments or relationships, unless expressly described otherwise. Moreover, the features and benefits of the invention are illustrated by reference to the exemplified embodiments. Accordingly, the invention expressly should not be limited to such exemplary embodiments illustrating some possible non-limiting combination of features that may exist alone or in other combinations of features; the scope of the invention being defined by the claims appended hereto.

This disclosure describes the best mode or modes of practicing the invention as presently contemplated. This description is not intended to be understood in a limiting sense, but provides an example of the invention presented solely for illustrative purposes by reference to the accompanying drawings to advise one of ordinary skill in the art of the advantages and construction of the invention. In the various views of the drawings, like reference characters designate like or similar parts.

FIG. **1** is a device **100** in accordance with this disclosure. FIG. **2** is the device **100** of FIG. **1** mounted on a post **110**. FIG. **3** is a top view of the device **100** of FIG. **1**.

As shown, the device **100** may include a chassis **120** supporting various electronics, such as an mMIMO (massive Multiple-Input Multiple-Output) device with significant cooling requirements. The electronics may be installed in a housing **130** installed on the chassis **120**. As such, the housing **130** may enclose a mounting surface supporting various circuit boards and other electronic devices that require cooling.

Opposite the housing **130**, the chassis **120** may provide a cooling heatsink **140**, which may be a fanless structure comprising a large number of fins **150**. The fins **150**, along with portions of the chassis **130** itself, are typically formed from a conductive material and thereby draw heat away from the housing **130**. Accordingly, the chassis **120** typically has a mounting surface on a first side, and the fins **150** extend from the chassis on a second side opposite the circuit board mounting surface.

As shown in FIG. **2**, during use, the device **100** may be installed on a post **110**, such that at least some of the fins **150** are located adjacent the post. As such, the chassis **120** may be designed such that as much heat as possible can be removed from the fins at the top **160**, bottom **170**, and sides **180**, **190** of the device **100**.

FIG. **4** is a perspective view of a device **400** in accordance with this disclosure without an aerofoil **410** installed. FIG. **5** is a perspective view of the device **400** of FIG. **4** with an uninstalled aerofoil **410**. FIG. **6** is an elevation view of the device **400** of FIG. **4** with the aerofoil **410** installed. FIG. **7** is a perspective view of the device **400** of FIG. **4** with the aerofoil **410** installed. FIG. **8** is a side view of the device **400** of FIG. **4** with the aerofoil **410** installed. FIGS. **9** and **10** are detailed perspective and elevation views respectively of a portion of the device **400** of FIG. **4** with the aerofoil **410** installed.

As shown, the device **400** is a heatsink chassis. The device typically supports various electronics which may be installed on a mounting surface enclosed within a housing **420**. This disclosure relates to the heatsink structure **430** located opposite the mounting surface. Accordingly, the chassis **400** typically comprises a circuit board mounting surface on a first side. The heatsink structure **430** then typically includes fins **440***a, b, c* that extend from the chassis **400** on a second side opposite the circuit board mounting surface.

The heatsink chassis **400** typically includes the heatsink structure **430** which has a plurality of fins **440***a, b, c*, divided into various sets of fins, extending from the Chassis **400** for extracting heat from electronics, such as a circuit board or the like, mounted on the chassis.

The heatsink structure **430** may be provided with thermal breaks **450** dividing the heatsink into the various fin sections **460***a, b, c*. Each such thermal break **450** takes the form of an air gap between the corresponding sets of fins **440***a, b, c*, thereby defining the various fin sections **460***a, b, c*. Accordingly, the plurality of fins **440***a, b, c* are organized into at least two, and in the embodiment shown, three, fin sections **460***a, b, c*. A first fin section **460***a* then includes a first set of fins **440***a*, and a second fin section **460***b* includes a second set of fins **440***b*. In the embodiment shown, a third fin section **460***c* is provided as well, and that includes a third set of fins **440***c*.

Accordingly, the sets of fins **440***a, b, c* each comprise a separate plurality of fins, all of which are portions of the heatsink structure **430**. The sets of fins **440***a, b, c*, are then divided from each other by thermal breaks **450**. Such thermal breaks **450** prevent heat from one set of fins **440***a* from conducting heat to a second set of fins **440***b*, and therefore allow cooling at different portions of the heatsink structure **430** to be managed independently. However, this approach also reduces the total heat capacity of the individual fin sections **460***a, b, c* of the heatsink structure **430**.

The provision of the thermal breaks **450** provides an additional benefit of allowing air flow to pass through the heatsink structure **430** from a side **470** of the chassis **400**. Accordingly, while the total heat capacity of the fin **440***a, b, c* of the heatsink structure **430** may be reduced, the ability of the device to shed heat by convection may be kept at a high level by allowing for additional air flow. However, if the thermal break **450** does not provide an interruption between the individual fin sections **460***a, b, c*, heat can still cross between fin sections by way of convection.

The heatsink chassis **400** is then further provided with an aerofoil **410** fixed in at least one of the air gaps defining a corresponding thermal break **450**. As such, the aerofoil **410** inhibits air flow between a first fin section **460***a* and a second fin section **460***b*, thereby preventing convection between the fin sections.

It is noted that the aerofoil **410** provided is referring to any relatively planar structure for inhibiting airflow between fin sections **460***a, b, c*. Such an element is not intended to be limited to a structure having a curved surface for generating lift, as in an aircraft wing. The term is instead used here to describe the generally planar but typically curved nature of the structure. Further, in most embodiments discussed herein, the aerofoil **410** is shaped so as to direct airflow as appropriate.

Generally, as shown, the fins **440***a* of the first fin section **460***a* and the fins **440***b* of the second fin section **460***b*, as well as the fins **440***c* of the third fin section, are each arranged in substantially parallel planes to each other. As such, fins **440***a, b, c* extend in a direction perpendicular to a plane of the chassis **400** and in parallel with each other. Generally, the fins **440***a, b, c* may be arranged to that they would be generally contiguous between the fin sections **460***a, b, c* if the thermal breaks **450** are ignored. In contrast, while the aerofoil **410** extends from the chassis **400** in the same direction as the fins **440***a, b, c*, that is, perpendicular to the plane of the chassis, the aerofoil is not parallel to the first set of fins **440***a*.

Accordingly, while the flow of air might otherwise cross the thermal breaks **450** in the direction of a channel between adjacent fins **440***a* of the first fin section **460***a* and continue to a channel between adjacent fins **440***b* of the second fin section **460***b*, thereby generating convection across the fin sections **460***a, b*, such air flow is inhibited by the aerofoil **410**.

In some embodiments, a substantially planar aerofoil **410** may be provided that is perpendicular to fins **440***a, b, c* of the heatsink structure **430**. Such an aerofoil, not shown, would inhibit air flow, and would thereby allow each fin section **460***a, b, c* to be independently designed and regulated.

In contrast with this approach, in the embodiment shown, at least a portion of the aerofoil **410** is angled with respect to a line perpendicular to the first set of fins **440***a*. The configuration of the aerofoil **410** allows for control over air flow, such that one or more of the fin sections **460***a, b, c* may be provided with more air flow than another.

Generally, as shown, each of the fin sections **460***a, b, c* has a length **475***a, b, c*, and a width **480**. Each fin **440***a, b, c* of the fin sections **460***a, b, c* is the elongated substantially in parallel to the length **475***a, b, c* of the corresponding fin section. The fins **40***a, b, c* are then spaced apart along the width of the corresponding fin sections **460***a, b, c*. It is noted that because of the configuration of the different fin sections **460***a, b, c*, the fin sections may have different lengths **475***a, b, c*, but typically share a width **480**.

In this context, the aerofoil **410** is located in a thermal break **450** between two fin sections **460***a, b*, and extends along the width of the adjacent fin sections **460***a, b, c*. The aerofoil **410** is typically bent such that it angles towards the second fin section **460***b* at both ends of the width.

During use, and when installed as shown in FIG. **2**, the second fin section **460***b* may be located below the first fin section **460***a*. However, various configurations are contemplated.

The aerofoil **410** located between the first fin section **460***a* and the second fin section **460***b* generates a temperature differential between the first fin section and the second fin section. Such a temperature differential may be generated simply by preventing convection, as discussed above. This may be because, for example, circuitry opposite a first fin section **460***a* generates more heat than circuitry opposite a second fin section **460***b*. Accordingly, the aerofoil **410** simply prevents the heating of the portion of the heatsink opposite circuitry that runs cooler. This may be beneficial where certain circuitry is required to run cooler than other circuitry on the same board.

Further, by providing a bent aerofoil **410**, such as that shown, incoming cooling air flow may be directed so as to cool a portion of the heatsink that requires additional cooling. Accordingly, the aerofoil **410** may actively generate a temperature differential by directing incoming cooling air towards the first fin section **460***a* and away from the second fin section **460***b*.

Accordingly, where the thermal break **450** forms a channel perpendicular to the fins **440***a, b* of the first set of fins and the second set of fins, the aerofoil **410** may direct air flow entering the channel towards the first fin section **460***a* and away from the second fin section **460***b*.

Accordingly, in the embodiment shown, the aerofoil **410** has a first end **490**, a second end **500**, and a center **510**, and the first and second ends **490**, **500** are closer to the second fin section **460***b* than the center **510**. Further, the first end **490** and the second end **500** of the aerofoil **410** may be adjacent a first and last fin **520**, **530** of the second set of fins **460***a*. The first and second end **490**, **500** may then inhibit air flow entering the channel **450** from entering the second fin section **460***b*. As such, cooling air is directed primarily or exclusively towards the first fin section **460***a*, thereby resulting in a temperature differential between the first fin section **460***a* and the second fin section **460***b*.

In this way, if circuitry opposite one of the fin sections **460***a, b, c* is known to generate more heat than that opposite other sections, or if specific circuitry has cooling requirements different than other circuitry, cooling air can be appropriately directed and a differential can be maintained.

As shown, the first fin section **460***a* and the second fin section **460***b* are typically not enclosed by a housing, and as such, heated air exits the second fin section in a direction perpendicular to the fins **440***b* and the aerofoil **410**. Accordingly, even when the thermal breaks **450** do not provide cooling air flow directed towards a specific fin section, the corresponding fins **440***b* can still shed heat in the traditional manner.

As shown, the chassis **400** may include at least one support structure **540** for locating the aerofoil **410** relative to the first fin section **460***a* and the second fin section **460***b*. The support structure **540** may be at least one blade extending from the chassis in parallel with the fins **440***a, b, c*. As shown, the support structure **540** may be two blades which may extend into the fin sections **460***a, b, c* adjacent the intended location of the aerofoil **410**. Accordingly, the support structure **540** may pass between fins **440***a, b* of each of the surrounding fin sections **460***a, b*. In some embodiments, the support structure **540** may displace adjacent fins **440***a, b*, so as to provide additional space for the fins.

In the embodiment shown, the aerofoil **410** includes at least one slot **550**. The aerofoil is then located by positioning the slot **550** on the at least one blade **540** making up the support structure. Accordingly, where the support structure **540** comprises two blades, two slots **550** are provided in the aerofoil **410** in order to fix a position of the aerofoil. Further, in the embodiment shown, as discussed above, the aerofoil **410** is bent such that the first and second ends **490**, **500** extend towards the second fin section **460***b*. In such an embodiment, the two blades **540** may be provided with a distance **560** between them, while the slots **550** may have a distance between them **570** along a surface of the aerofoil **410**. The distance **570** between the two slots **550** may then be greater than the distance **560** between the two blades **540**.

As noted above, the aerofoil **410** is discussed in terms of a thermal break **450** between a first and second fin section **460***a, b*. However, as shown, a third fin section **460***c* may be provided as well, with a second thermal break **450** located between the second and third fin sections **460***b, c*. Accordingly, a third set of fins **440***c* may be provided, and in some embodiments, a second aerofoil **410** may be provided to improve heat characteristics associated with the second and third fin sections **460***b, c*. Such an aerofoil **410** may therefore be provided based on the heat requirements of circuitry located opposite the second and third fin sections **460***b, c*.

While the present invention has been described at some length and with some particularity with respect to the several described embodiments, it is not intended that it should be limited to any such particulars or embodiments or any particular embodiment, but it is to be construed with references to the appended claims so as to provide the broadest possible interpretation of such claims in view of the prior art and, therefore, to effectively encompass the intended scope of the invention. Furthermore, the foregoing describes the invention in terms of embodiments foreseen by the inventor for which an enabling description was available, notwithstanding that insubstantial modifications of the invention, not presently foreseen, may nonetheless represent equivalents thereto.

What is claimed is:

1. A chassis for a circuit board having a heatsink, the chassis comprising:

a first surface;

a plurality of fins extending from the first surface, the plurality of fins being organized into at least two fin sections, wherein a first fin section of the at least two fin sections comprises a first set of fins of the plurality of fins and a second fin section of the at least two fin sections comprises a second set of fins of the plurality of fins;

a thermal break between the first fin section and the second fin section, the thermal break being an air gap between the first set of fins and the second set of fins; and

an aerofoil fixed in the air gap and inhibiting air flow between the first fin section and the second fin section;

wherein the fins of the first set of fins and the fins of the second set of fins are each arranged in substantially parallel planes to each other; and

wherein, in a top view from a first direction perpendicular to the first surface, the aerofoil extends in a second direction parallel to a direction in which the fins of the second set of fins are aligned and has a central portion that is positioned closer to the first fin section in a third direction from the second fin section toward the first fin section than both ends of the aerofoil in the second direction.

2. The chassis of claim **1**, wherein the aerofoil directs air flow flowing along the second direction within the air gap towards the first fin section.

3. The chassis of claim **2**, wherein, in the top view from the first direction, the aerofoil extends in the second direction equal to or longer than a distance between a first and last fin of the second set of fins to inhibit air flow within the air gap from entering the second fin section.

4. The chassis of claim **3**, wherein the first fin section and the second fin section are not enclosed by a housing, such that heated air exits the second fin section in the first direction.

5. The chassis of claim **1** further comprising at least one support structure for locating the aerofoil relative to the first fin section and the second fin section.

6. The chassis of claim **5**, wherein the at least one support structure is at least one blade extending from the first surface in parallel with the plurality of fins, and wherein the at least one blade extends into each of the first fin section and the second fin section and passes between fins of each of the first set of fins and the second set of fins.

7. The chassis of claim **6**, wherein the aerofoil comprises at least one slot, and wherein the aerofoil is located by positioning the slot on the at least one blade.

8. The chassis of claim **7**, wherein the at least one support structure is two blades, and wherein the aerofoil comprises two slots, and wherein the aerofoil is positioned such that each of the two slots receives a respective one of the two blades.

9. The chassis of claim **1** further comprising a circuit board mounting surface, and wherein the first surface is opposite of the circuit board mounting surface.

10. The chassis of claim **9** further comprising a first group of circuitry and a second group of circuitry mounted on the circuit board mounting surface, wherein the first group of circuitry is mounted opposite the first fin section and the second group of circuitry is mounted opposite the second fin section, and wherein the first group of circuitry requires a lower operating temperature than the second group of circuitry.

11. The chassis of claim **9** further comprising a first group of circuitry and a second group of circuitry mounted on the circuit board mounting surface, wherein the first group of circuitry is mounted opposite the first fin section and the second group of circuitry is mounted opposite the second fin section, and wherein the first group of circuitry generates more heat than the second group of circuitry.

12. The chassis of claim **1** further comprising a third fin section comprising a third set of fins and a second thermal break between the third fin section and the first and second fin sections.

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