US 20250256547A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2025/0256547 A1**

(43) **Pub. Date: Aug. 14, 2025**

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(54) **HVAC MODULE INCLUDING A FILTER AND AN AIR FUNNEL**

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(21) Appl. No.: **18/440,485**

(22) Filed: **Feb. 13, 2024**

Publication Classification

(51) **Int. Cl.**

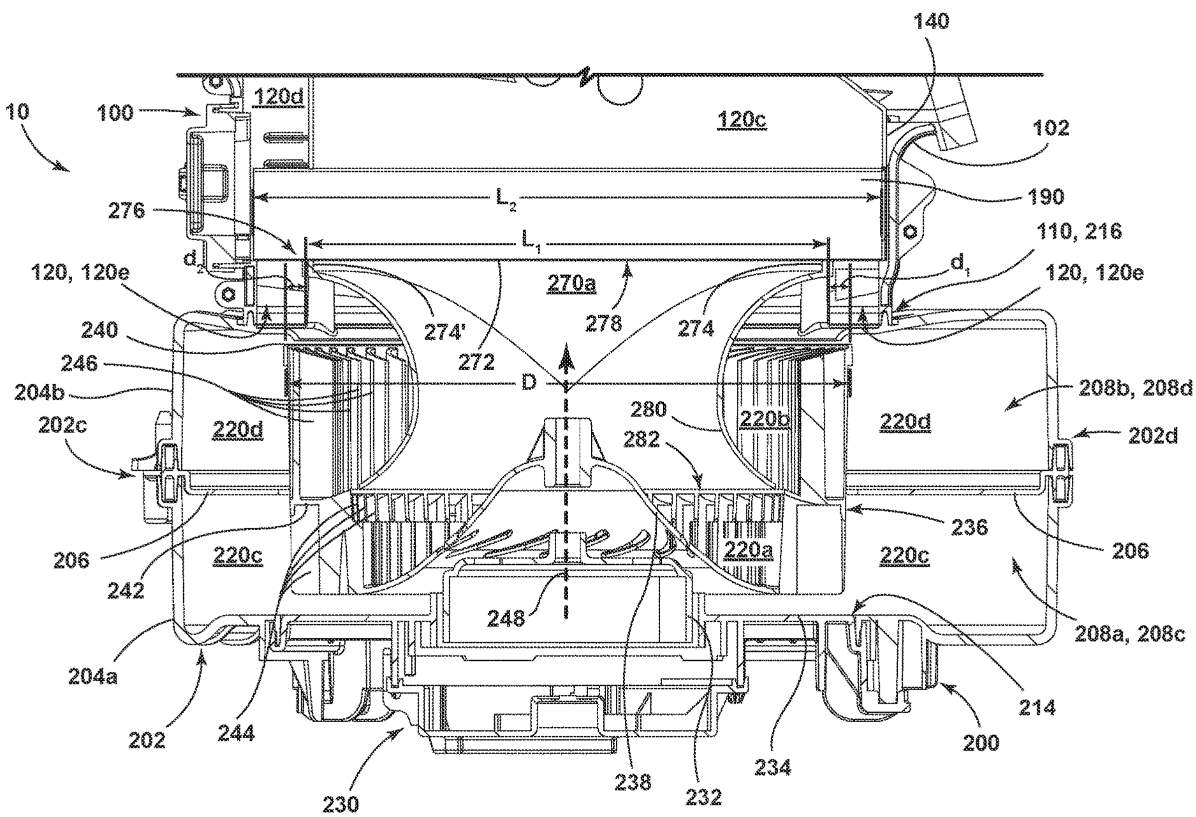
B60H 1/00	(2006.01)
B60H 3/06	(2006.01)

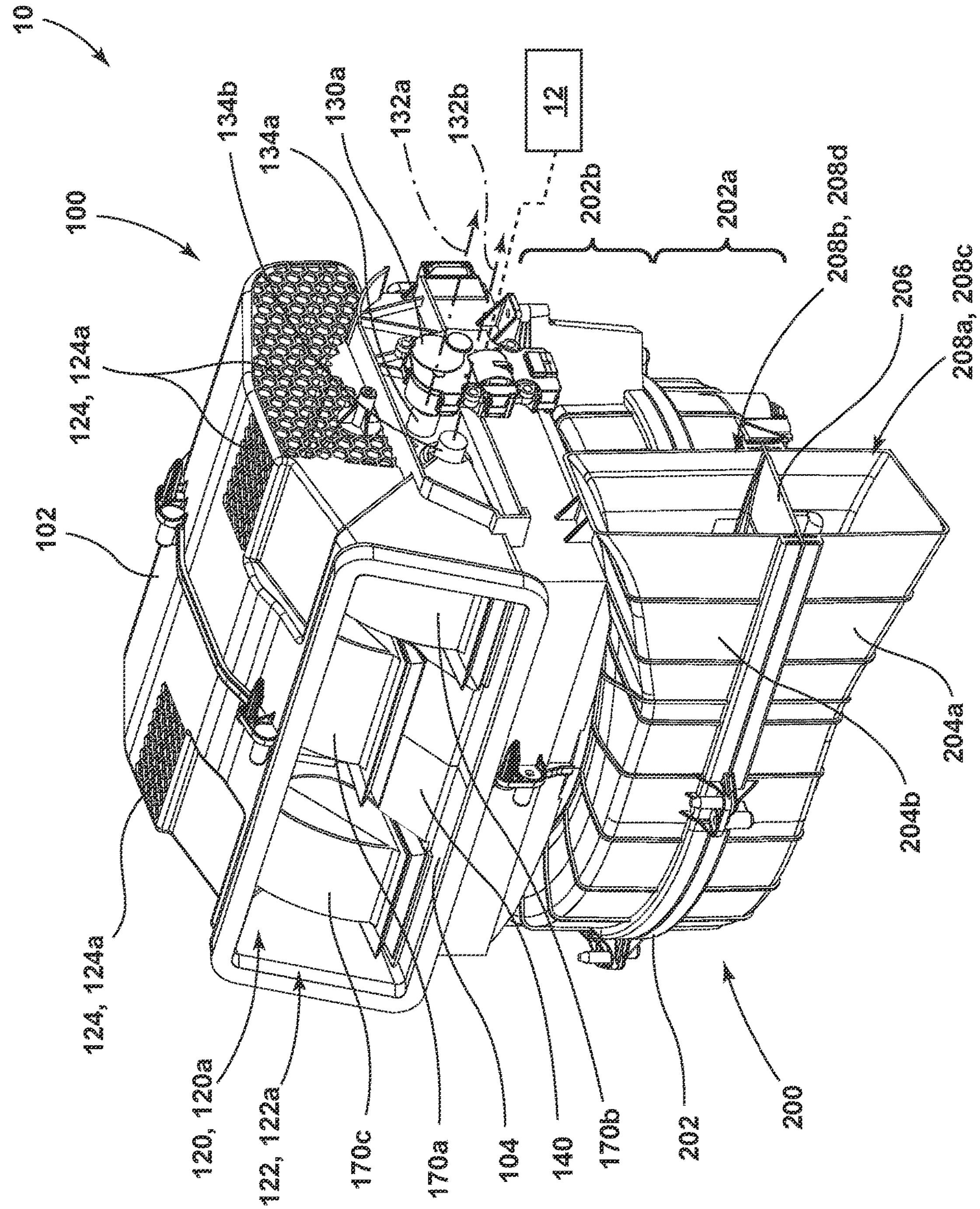
(52) **U.S. Cl.**

CPC ***B60H 1/00471*** (2013.01); ***B60H 3/0608*** (2013.01)

(57) **ABSTRACT**

A blower assembly for a heating, ventilation, and air conditioning (HVAC) module may include a blower and an air funnel. The blower may include a blower wheel. The air funnel may include a base portion and a circumferential wall connected to and projecting from the base portion. When viewed in a first direction parallel to a blower axis, a first flow area may be defined by and between a first side of the base portion and an outer perimeter of the blower wheel. When viewed in the first direction, a second flow area may also be defined by and between a second side of the base portion and the outer perimeter of the blower wheel.

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208a, 208c
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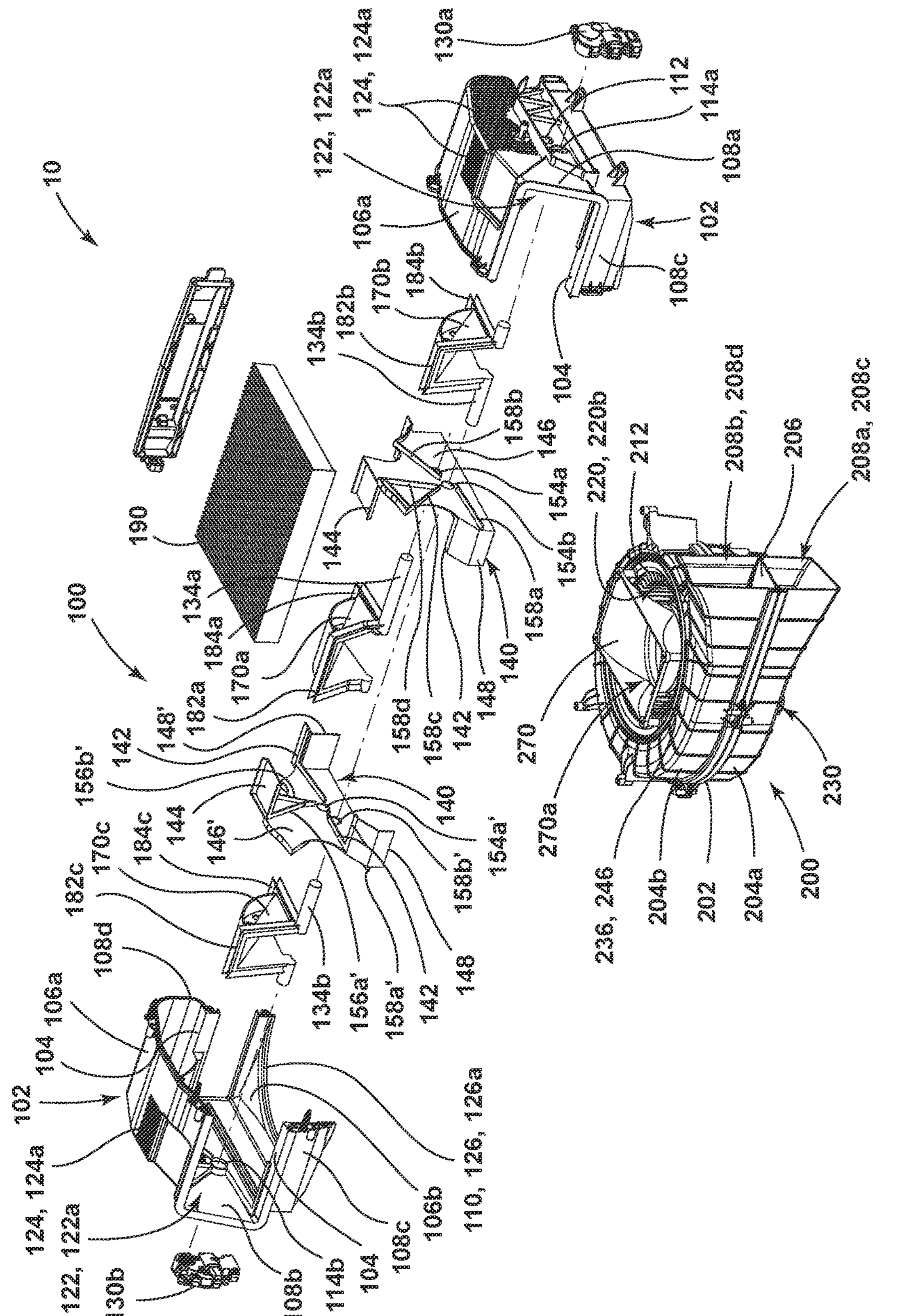
204b
124, 124a
120, 120a
122, 122a
170c
170a
104
140
170b
202
200

FIG. 1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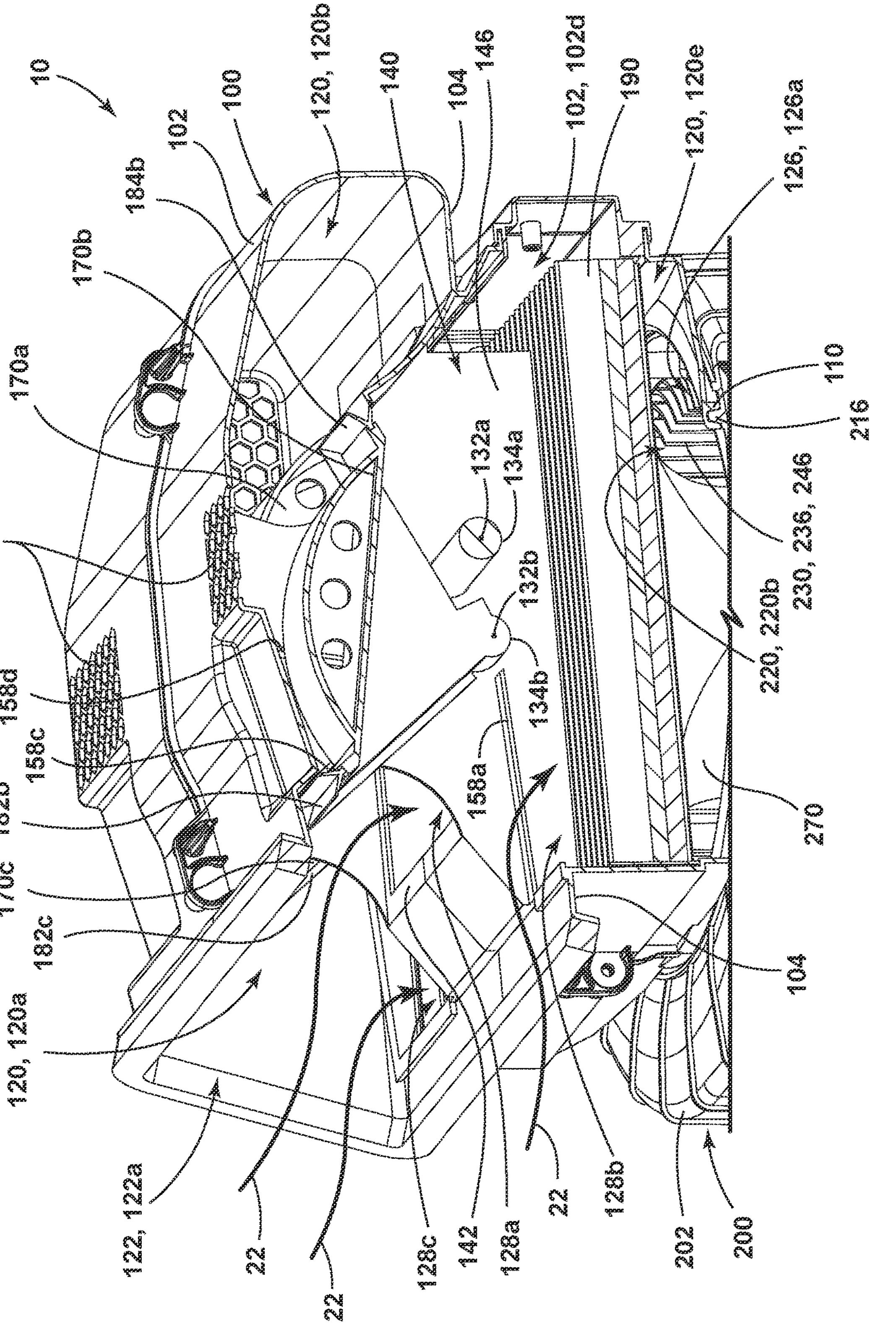
122, 122a
124, 124a
130a
130b
134a
134b
140
142
144
146
146'
148
148'
154a
154a'
154b
156a'
156b'
158a
158a'
158b
158b'
158c
158d
170a
170b
170c
182a
182b
182c
184a
184b
184c
190
200
202
204a
204b
206
208a, 208c
208b, 208d
212
220, 220b
230
236, 246
270
270a

FIG. 2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170a
124, 124a
158d
158c
182b
170c
182c
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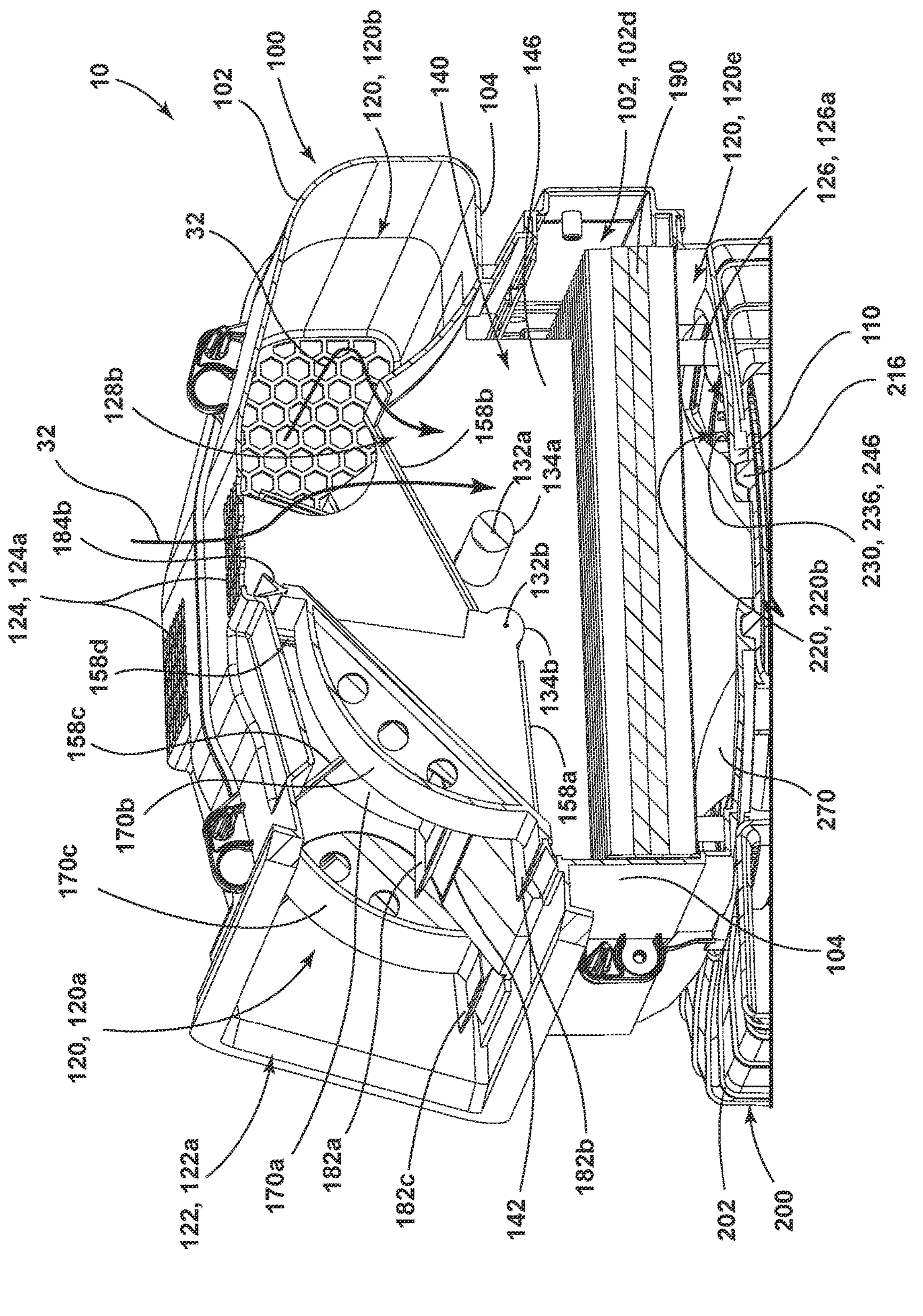
120, 120b
102, 102d
190
120, 120e
126, 126a
110
216
230, 236, 246
220, 220b
132a
134a
132b
134b
158a
270
104
122, 122a
22
22
128c
142
128a
22
128b
202
200

FIG. 3A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134a
110
216
184b
124, 124a
132b
230, 236, 246
220, 220b
158d
134b
158c
170b
158a
270
170c
104
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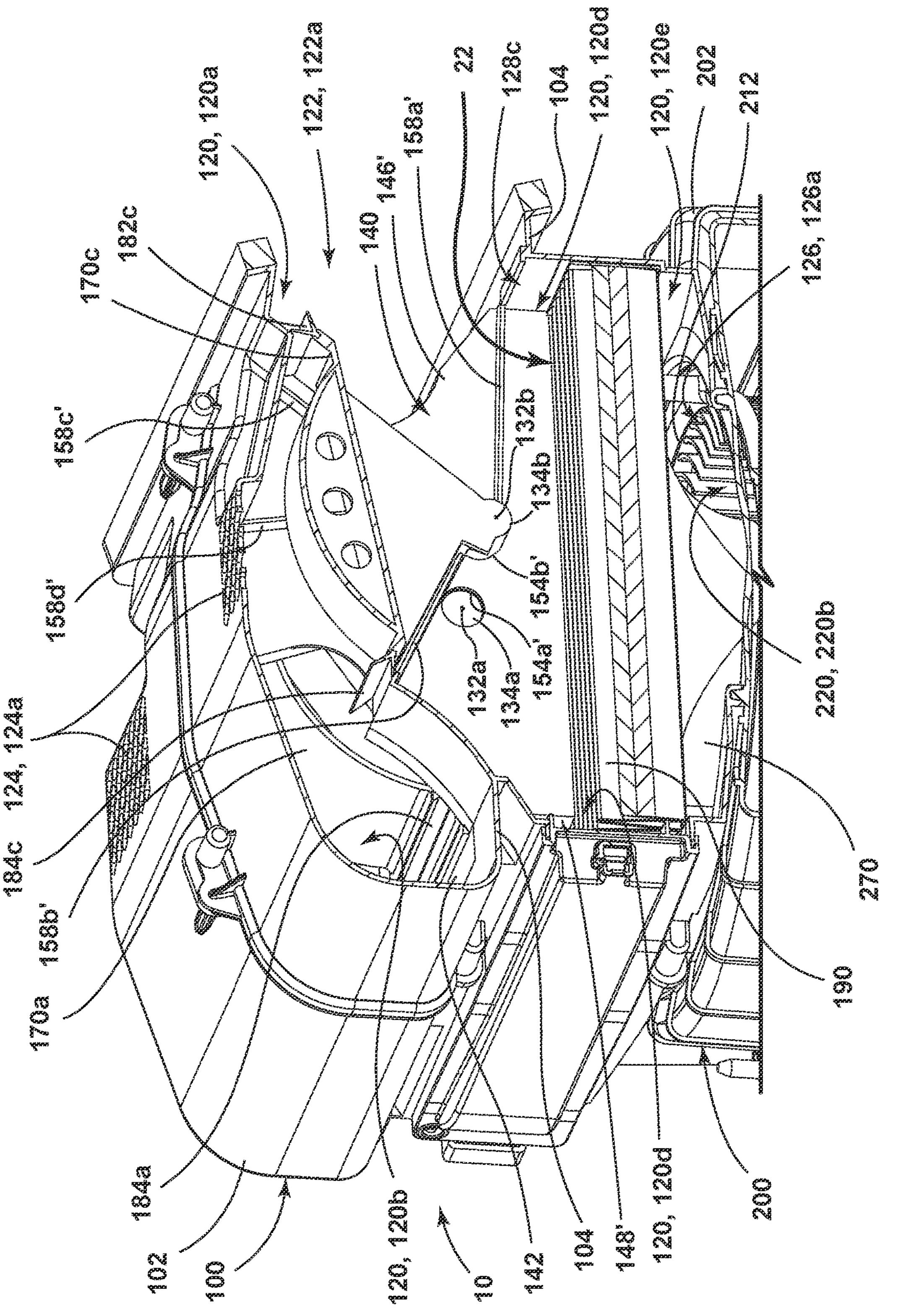
122, 122a
170a
182a
182c
142
182b
202
200

FIG. 3B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202
212
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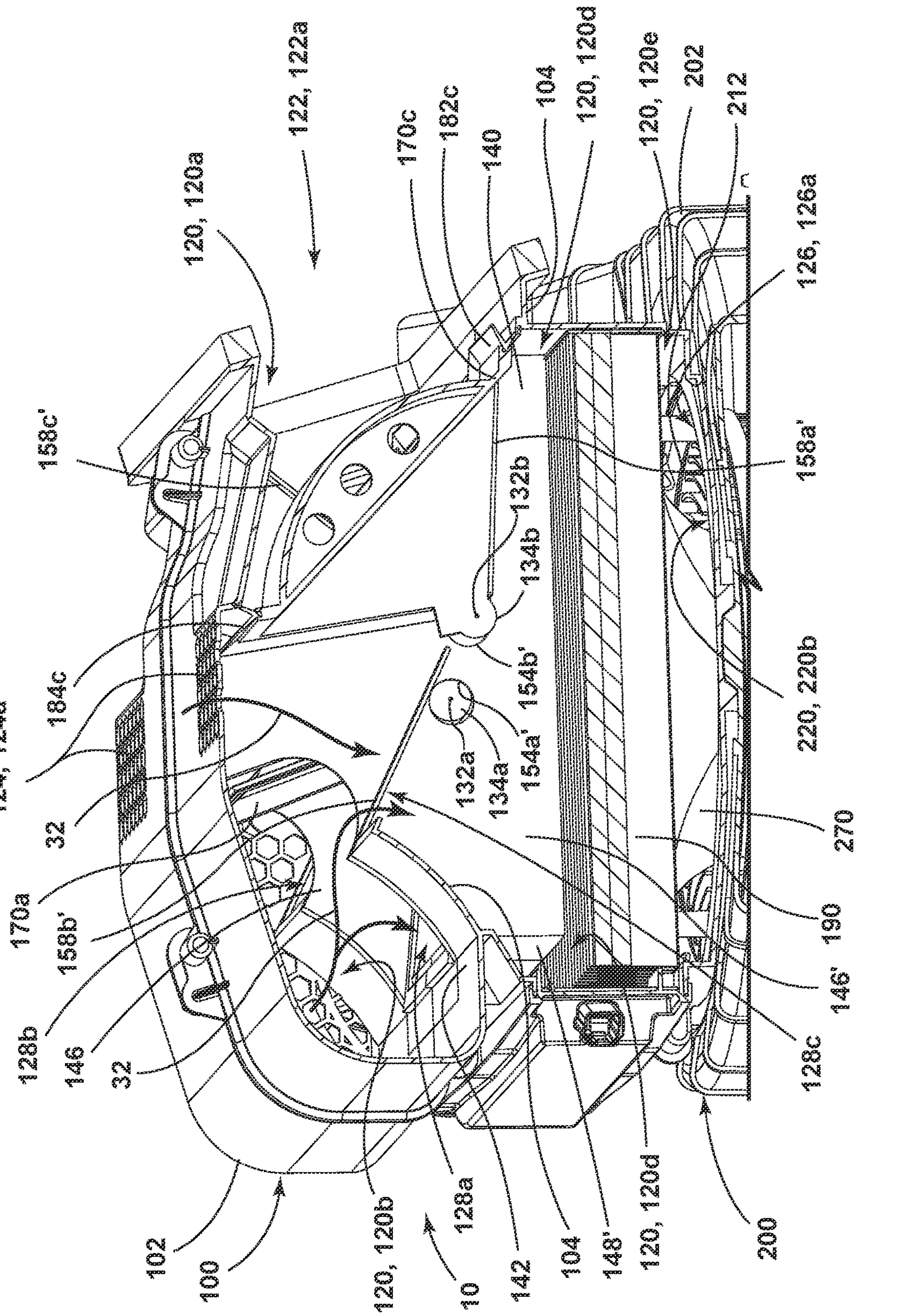
182c
170c
140
146'
158a'
158c'
132b
134b
154b'
158d'
132a
134a
154a'
220, 220b
184c
124, 124a
158b'
170a
270
190
184a
102
100
120, 120b
10
142
104
148'
120, 120d
200

FIG. 4A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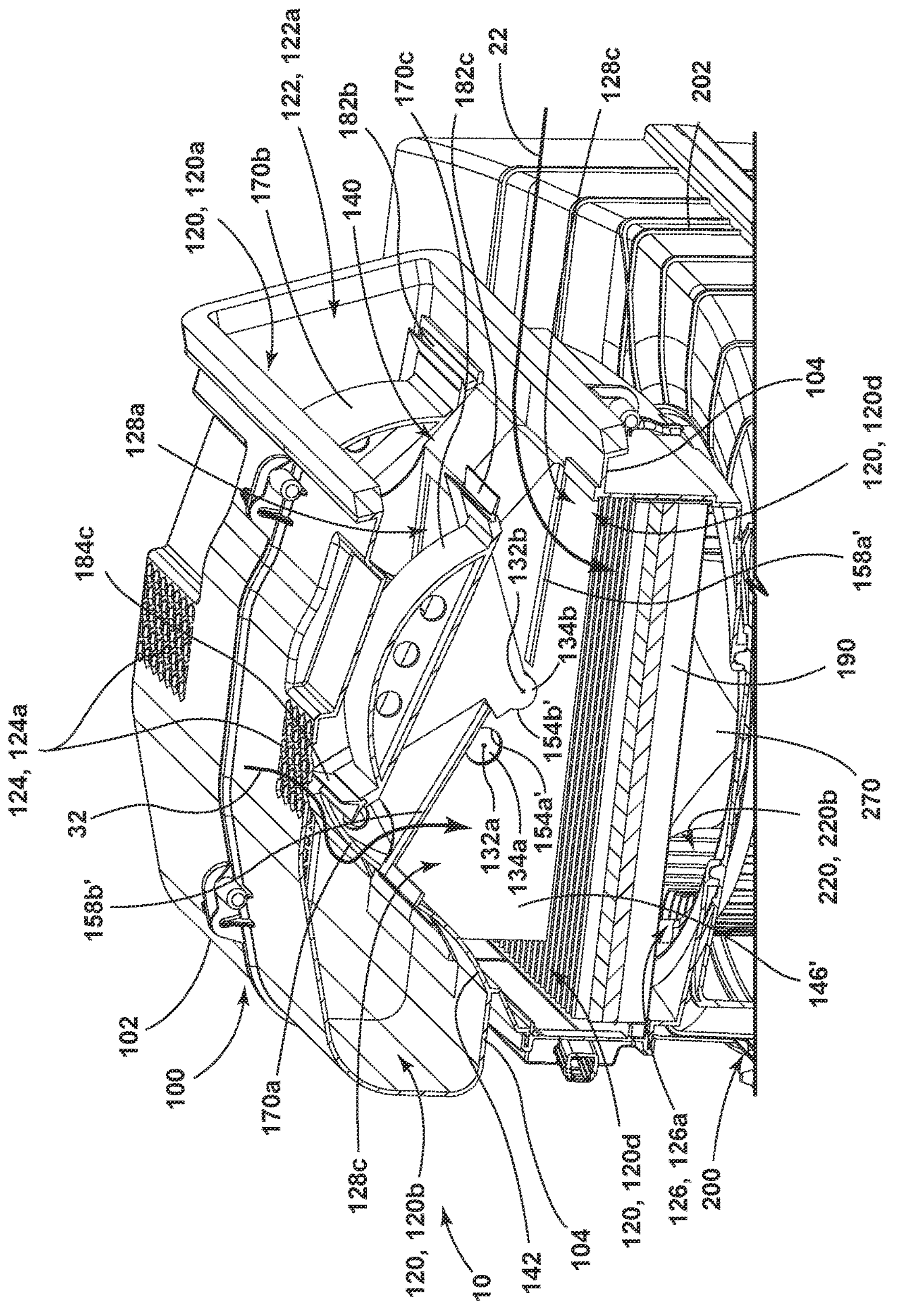
170c
182c
140
104
120, 120d
120, 120e
202
212
126, 126a
158c'
158a'
132b
134b
154b'
184c
124, 124a
32
132a
134a
154a'
220, 220b
270
190
146'
128c
170a
158b'
128b
146
32
102
100
120, 120b
10
128a
142
104
148'
120, 120d
200

FIG. 4B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182b
170c
182c
22
128c
202
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184c
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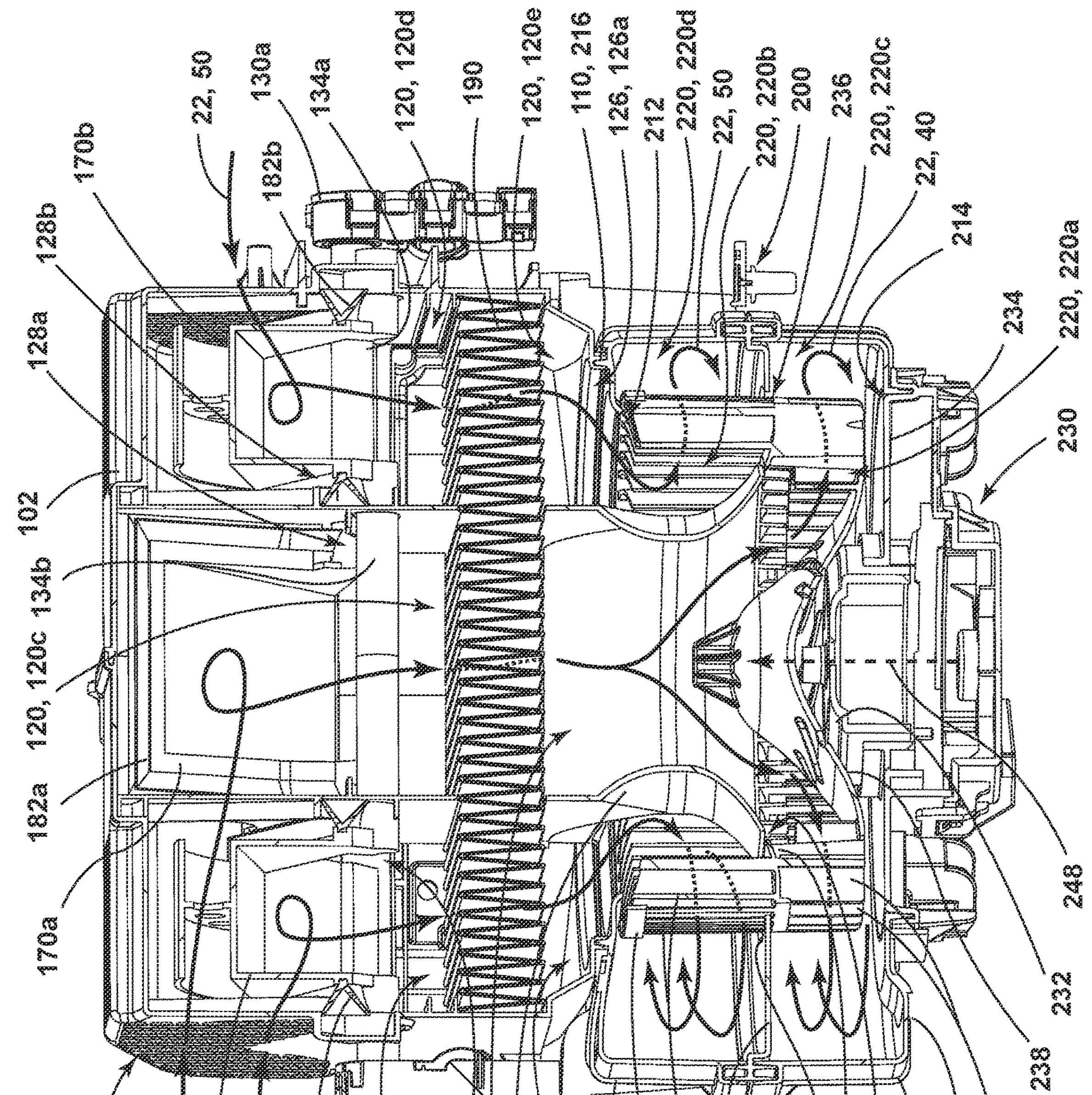
158a'
132b
134b
190
154b'
124, 124a
32
132a
134a
154a'
270
220, 220b
158b'
146'
102
100
170a
128c
120, 120b
10
142
104
120, 120d
126, 126a
200

FIG. 4C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22, 50
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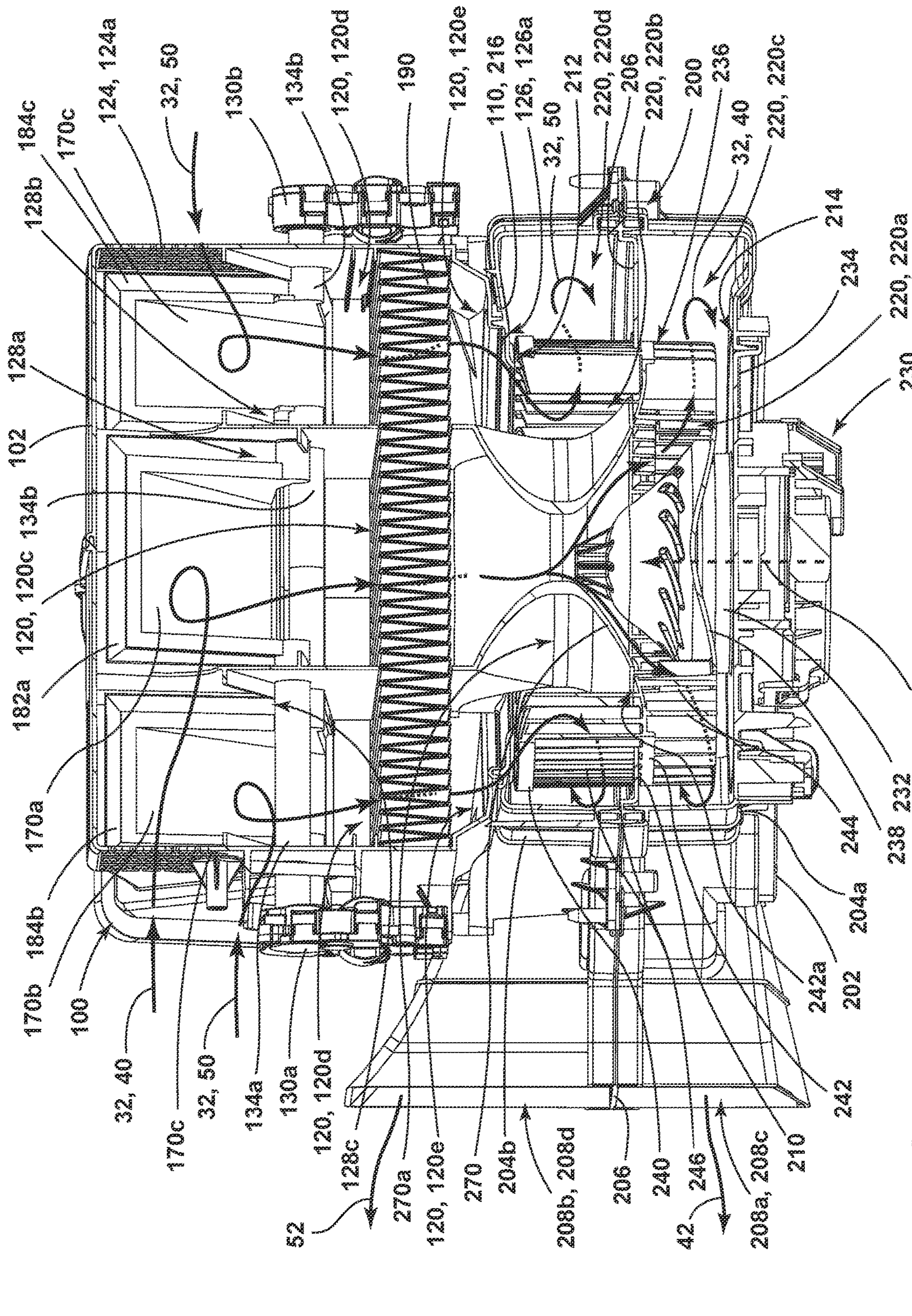
220, 220c
22, 40
214
220, 220a
234
230
170b
128b
128a
102
134b
120, 120c
182a
170a
182b
248
232
238
244
204a
202
242a
242
210
206
246
240
204b
120, 120e
270
270a
128c
120, 120d
130b
182c
22, 50
170c
22, 40
100

FIG. 5A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130b
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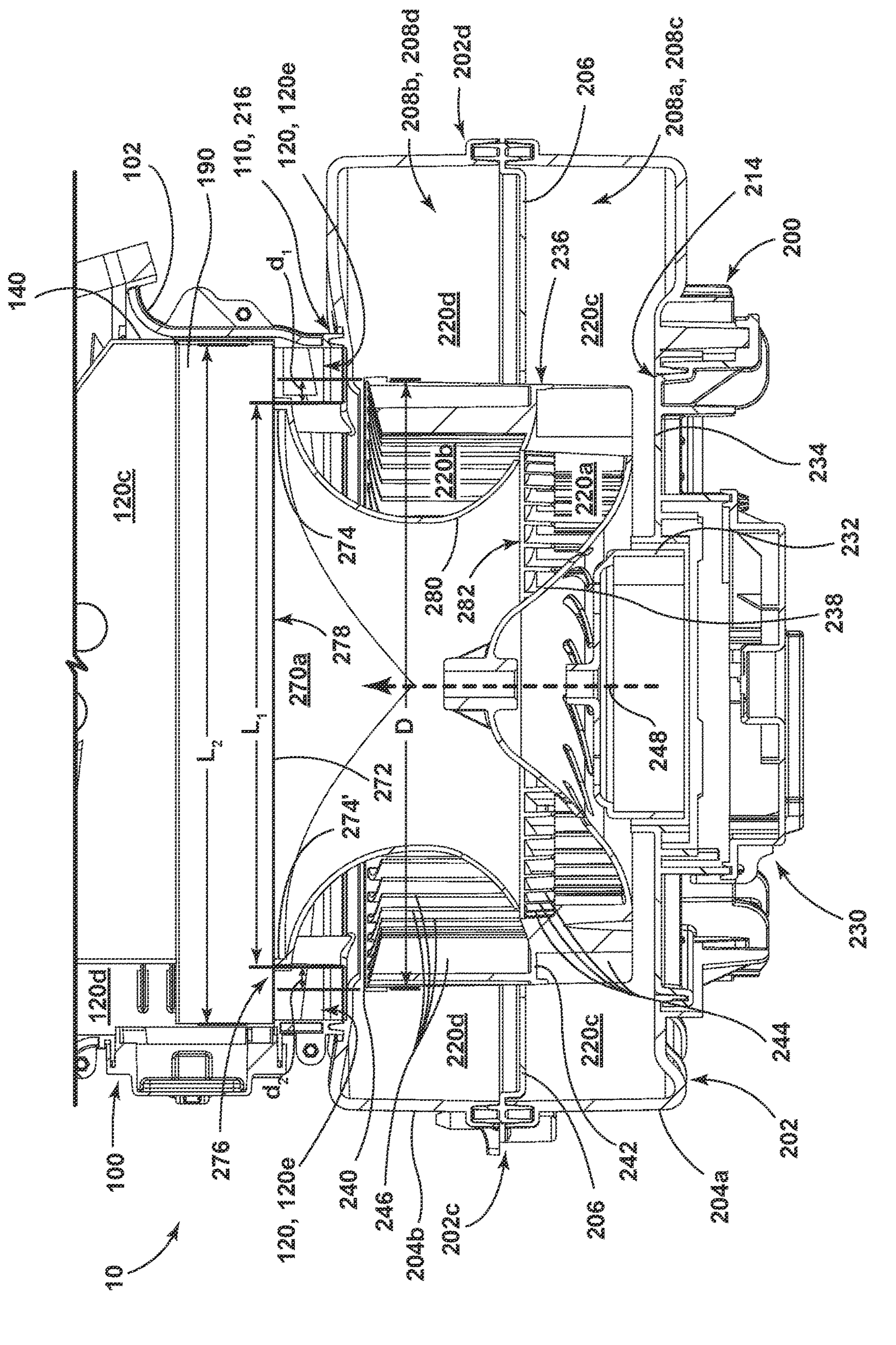
206
220, 220b
200
236
32, 40
220, 220c
214
234
220, 220a
230
128b
128a
102
134b
120, 120c
182a
170a
184b
170b
100
32, 40
170c
32, 50
134a
130a
120, 120d
128c
270a
120, 120e
270
204b
208b, 208d
206
240
246
208a, 208c
210
242
242a
202
204a
238
244
232
248
52
42

FIG. 5B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190
110, 216
120, 120e
120c
120d
d1
d2
L1
L2
D
270a
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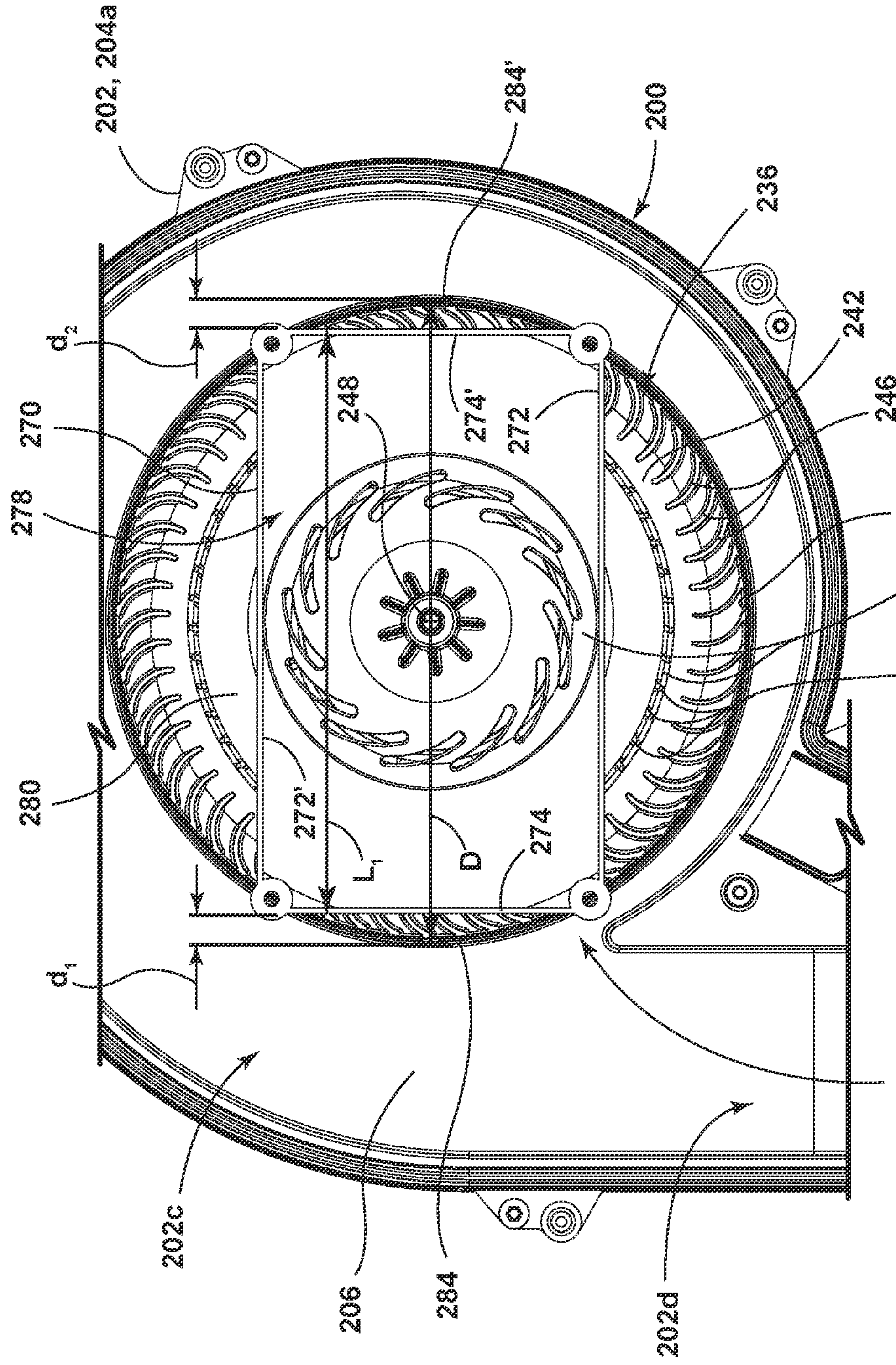
274
274'
276
278
280
282
208b, 208d
208a, 208c
202d
206
236
214
200
220d
220c
220b
220a
234
232
238
248
230
244
202
204a
242
246
240
204b
202c

FIG. 6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200
284'
236
242
246
240
238
244
202e
202d
284
206
202c
280
278
270
d2
d1
248
274'
272
272'
L1
D
274

FIG. 7

HVAC MODULE INCLUDING A FILTER AND AN AIR FUNNEL

TECHNICAL FIELD

[0001] The present disclosure generally relates to heating, ventilation, and air conditioning (HVAC) modules that may, for example, be used in connection with vehicles.

BACKGROUND

[0002] Vehicles commonly have HVAC systems and/or modules for controlling the climate within the vehicle cabin or another internal space and/or area of the vehicle by providing heated air and/or cooled air into the vehicle cabin. Some HVAC system and/or module designs include an air filter and an air funnel. During operation, a first flow of air passes through the air filter and into the air funnel in a vertical direction, while a second flow of air passes through the air filter and into a flow space in the vertical direction. The flow space is disposed outside of the air funnel and adjacent to the air funnel in a width direction extending transversely (e.g., perpendicular) to the vertical direction. A dimension/length of the inlet of the air funnel and a dimension/length of the air filter extending in a length direction, which is transverse (e.g., perpendicular) to the vertical direction and the width direction), are typically the same and/or equal to one another. It was thought that the inlet of the air funnel and the air filter needed to have the same length to ensure adequate sealing between the air filter and the air funnel.

[0003] However, computational fluid dynamics (CFD) has revealed that there are drawbacks and challenges with these HVAC system and/or module designs. For example, when the inlet of the air funnel and the air filter have the same length a restriction of airflow occurs in a region near, adjacent to, and/or at or about a region where air exits from the scroll portion of the housing (e.g., into a branch portion of the housing). This not only reduces efficiency of the HVAC system and/or module and/or efficiency of the fan and/or blower thereof, it also results in the generation of undesirable noise during operation.

[0004] Accordingly, there is a need for an improved HVAC system and/or module that minimizes or eliminates one or more challenges or shortcomings of existing HVAC systems and/or modules.

SUMMARY

[0005] A blower assembly for a heating, ventilation, and air conditioning (HVAC) module may include a blower and an air funnel. The blower may include a blower wheel. The air funnel may include a base portion and a circumferential wall connected to and projecting from the base portion. When viewed in a first direction parallel to a blower axis, a first flow area may be defined by and between a first side of the base portion and an outer perimeter of the blower wheel. When viewed in the first direction, a second flow area may also be defined by and between a second side of the base portion and the outer perimeter of the blower wheel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] While the claims are not limited to a specific illustration, an appreciation of various aspects may be gained through a discussion of various examples. The drawings are not necessarily to scale, and certain features may be exaggerated or hidden to better illustrate and explain an innovative aspect of an example. Further, the exemplary illustrations described herein are not exhaustive or otherwise limiting, and embodiments are not restricted to the precise form and configuration shown in the drawings or disclosed in the following detailed description. Exemplary illustrations are described in detail by referring to the drawings as follows:

[0007] FIG. **1** is a perspective view of an exemplary HVAC module;

[0008] FIG. **2** is a perspective, partially exploded view of the HVAC module of FIG. **1**;

[0009] FIGS. **3**A and **3**B are cross-sectional perspective views through a second valve of the HVAC module of FIG. **1** when the valves are each in a first position (FIG. **3**A) and when the valves are each in a second position (FIG. **3**B), respectively;

[0010] FIGS. **4**A, **4**B, and **4**C are cross-sectional perspective views through a third valve of the HVAC module of FIG. **1** when the valves are each in the first position (FIG. **4**A), when the valves are each in the second position (FIG. **4**B), and when the first valve is in the first position, the second valve is in the second position, and the third valve is in an intermediate position (FIG. **4**C), respectively;

[0011] FIG. **5**A is a cross-sectional perspective front view of the HVAC module of FIG. **1** when the valves are each in the first position;

[0012] FIG. **5**B is a cross-sectional perspective rear view of the HVAC module of FIG. **1** when the valves are each in the second position;

[0013] FIG. **6** is a cross-sectional side view of the HVAC module of FIG. **1**; and

[0014] FIG. **7** is a partial view of the blower assembly of the HVAC module of FIG. **1** with the second housing shell hidden.

DETAILED DESCRIPTION

[0015] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings. In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the various described embodiments. However, it will be apparent to one of ordinary skill in the art that the various described embodiments may be practiced without these specific details. In other instances, well-known methods, procedures, components, circuits, and networks have not been described in detail so as not to unnecessarily obscure aspects of the embodiments.

[0016] FIGS. **1**-**5**B present a heating, ventilation, and air conditioning (HVAC) module **10** configured to receive air from one or more air sources (e.g., first and second air sources) and selectively output the received air, such as to one or more portions, areas (e.g., zones), and/or regions within a vehicle. Air (e.g., external air) from a first air source (e.g., an external space outside of the vehicle) may be considered and/or referred to as first input air **22**. Air (e.g., recirculation air) from a second air source (e.g., an interior space and/or cabin of the vehicle) may be considered and/or referred to as second input air **32**.

[0017] As generally illustrated in FIG. **1**, the HVAC module **10** includes a valve assembly **100**, a blower assembly **200**, and a controller **12**. The valve assembly **100** and the blower assembly **200** are connected to one another and are in fluid communication with one another. The valve assembly **100** is configured to receive air **22**, **32** from one or more air sources and selectively communicate the received air **22**, **32** to the blower assembly **200** (e.g., as a first airflow **40** and/or as a second airflow **50**). The blower assembly **200** is configured to receive air (e.g., the first airflow **40** and/or the second airflow **50**) from the valve assembly **100** and output that air to one or more structures, spaces, and/or destinations (e.g., as a first output air **42** and a second output air **52**). The controller **12** is operatively connected (e.g., communicatively connected, electrically connected, and/or physically connected) to (i) the valve assembly **100** and/or one or portions/parts/elements thereof and (ii) the blower assembly **200** and/or one or portions/parts/elements thereof. The controller **12** is configured to control and/or operate the HVAC module **10**, the valve assembly **100**, and/or the blower assembly **200**.

[0018] As generally illustrated in FIGS. **2**-**5**B and described in further detail below, the blower assembly **200** includes a blower housing **202**, a blower **230**, and an air funnel **270**. The valve assembly **100** includes a valve housing **102**, a plurality of actuators and/or motors (e.g., a first and second actuator **130***a*, **130***b*), a plurality of shafts (e.g., a first and second shaft **134***a*, **134***b*), a plurality of valves (e.g., a first, second, and third valve **170***a*, **170***b*, **170***c*), and a filter **190**. The valve housing **102** includes a plurality of air inlets (e.g., a first and second inlet **122**, **124**), an air outlet **126**, and a plurality of airflow openings (e.g., a first, second, and third airflow opening **128***a*, **128***b*, **128***c*; see FIG. **3**A). The valve housing **102** also includes a valve support **140** for supporting the valves **170***a*-**170***c* and the shafts **134***a*, **134***b* within the valve housing **102**. The valves **170***a*-**170***c* and the filter **190** are arranged in an internal space **120** of the valve housing **102** (also referred to as the 'valve housing internal space' and/or 'VH internal space'). The VH internal space **120** includes a first intake region **120***a*, a second intake region **120***b*, a first unfiltered region **120***c*, a second unfiltered region **120***d*, and a filtered region **120***e*. Air (e.g., first input air **22** and/or external air) from a first air source is flowable into the first intake region **120***a* via the first inlet **122**. Air (e.g., second input air **32** and/or recirculation air) from a second air source is flowable into the second intake region **120***b* via the second inlet **124**. The intake regions **120***a*, **120***b* are in selective fluid communication with (i) the first unfiltered region **120***c* via the first airflow opening **128***a* and (ii) the second unfiltered region **120***d* via the second and third airflow openings **128***b*, **128***c*. The first valve **170***a* is adjustable about a first axis **132***a* to selectively open and close the first airflow opening **128***a* with respect to the intake regions **120***a*, **120***b*. The second and third valves **170***b*, **170***c* are adjustable about a second axis **132***b* to selectively open and close the second and third airflow openings **128***b*, **128***c*, respectively, with respect to the intake regions **120***a*, **120***b*. The filter **190** is disposed between and/or separates (to at least an extent) the first unfiltered region **120***c* and an inner space **270***a* of the air funnel **270**, which projects through the air outlet **126** and into the VH internal space **120**. The filter **190** is also disposed between and/or separates (to at least an extent) the second unfiltered region **120***d* and the filtered region **120***e*. The funnel inner space **270***a* is in fluid communication with a first inner region **220***a* of an internal space **220** of the blower housing **202** (also referred to as the 'blower housing internal space' and/or 'BH internal space'), which is in fluid communication with a first flow region **220***c* of the BH internal space **220** and a first outlet **208***a* of the blower housing **202**. The filtered region **120***e* is in fluid communication with a second inner region **220***b* of the BH internal space **220** via the air outlet **126** of the valve housing **102** and an inflow opening **212** of the blower housing **202**. The second inner region **220***b* is in fluid communication with a second flow region **220***d* of the BH internal space **220** and a second outlet **208***b* of the blower housing **202**.

[0019] As generally illustrated in FIGS. **3**A-**5**B, during operation of the HVAC module **10**, air (e.g., first input air **22**) flows into the first intake region **120***a* via the first inlet **122** and/or air (e.g., second input air **32**) flows into the second intake region **120***b* via the second inlet **124**. The first input air **22** in the first intake region **120***a* and/or the second input air **32** in the second intake region **120***b* flows through one or more of the airflow openings **128***a*-**128***c* based on the positions of the valves **170***a*-**170***c*. Air **22**, **32** flowing through the first airflow opening **128***a*, which may be considered and/or referred to as a first airflow **40**, flows into the first unfiltered region **120***c*, through the filter **190**, and into the funnel inner space **270***a* (i.e., into the blower assembly **200**). The first airflow **40** then flows sequentially through the funnel inner space **270***a*, the first inner region **220***a*, the first flow region **220***c*, and the first outlet **208***a*, at which point the first airflow **40** is output and/or expelled from the blower assembly **200** and/or the HVAC module **10** as first output air **42** that may ultimately be directed to one or more first destinations (e.g., a windshield defrost zone of a vehicle cabin). Air **22**, **32** flowing through the second airflow opening **128***b* and air **22**, **32** flowing through the third airflow opening **128***c* both flow into the second unfiltered region **120***d* and, thus, may be considered and/or referred to as a second airflow **50**. The second airflow **50** then flows into the filtered region **120***e* by flowing through the filter **190**, and subsequently flows into the second inner region **220***b* of the blower assembly **200** via the air outlet **126** of the valve housing **102** and the inflow opening **212** of the blower housing **202**. The second airflow **50** then flows sequentially through the second inner region **220***b*, the second flow region **220***d*, and the second outlet **208***b*, at which point the second airflow **50** is output and/or expelled from the blower assembly **200** and/or the HVAC module **10** as second output air **52** that may ultimately be directed to one or more second destinations (e.g., one or more second/footwell zones of a vehicle cabin).

[0020] As generally illustrated in FIGS. **1**-**4**C, the valve housing **102** defines a VH internal space **120** in which the valves **170***a*-**170***c* and the filter **190** are arranged. The valve housing **102** includes a partition **104**, a first end wall **106***a*, a second end wall **106***b*, and one or more sidewalls **108***a*-**108***d* extending between and connecting the end walls **106***a*, **106***b* (see FIG. **2**). The partition **104** is disposed between the end walls **106***a*, **106***b*. The partition **104** extends transversely to the sidewalls **108***a*-**108***d* and projects from and/or is connected to the sidewalls **108***a*-**108***d*.

[0021] As generally illustrated in FIGS. **1**-**4**C, the valve housing **102** includes a plurality of air inlets via which air is flowable into the VH internal space **120**. The plurality of air inlets includes a first inlet **122** (e.g., a fresh air inlet) via which first input air **22** (e.g., external air) from the first air source is flowable into the first intake region **120***a*. The first inlet **122** includes and/or is defined by a first inlet opening **122***a*, which is disposed in and defined by the valve housing **102**.

[0022] The plurality of air inlets further includes a second inlet **124** (e.g., a recirculation air inlet) via which second input air **32** (e.g., recirculation air) from the second air source is flowable into the second intake region **120***b*. The second inlet **124** includes and/or is defined by a plurality of second inlet openings **124***a*, which are disposed in and/or defined by the valve housing **102** (e.g., the first end wall and/or one or more sidewalls). The valve housing **102** includes several subsets or groups of second inlet openings **124***a*. Each subset or group of second inlet openings **124***a* includes a plurality of second inlet openings **124***a* that are arranged in a closely packed array (e.g., a grid arrangement, a honeycomb arrangement) and defined by a region and/or section of the valve housing **102** that is structured in the manner of a mesh and/or lattice. Conceivably, the second inlet **124** may alternatively include and/or formed by a single second inlet opening **124***a*, a single subset or group of second inlet openings **124***a*, or in other suitable configurations.

[0023] As generally illustrated in FIGS. **2**-**5**B, the valve housing **102** includes an air outlet **126** via which air (i.e., input air **22**, **32** that has passed through the filter **190**, the first airflow **40**, and/or the second airflow **50**) is expelled and/or flowable out of the valve housing **102**. The air outlet **126** includes and/or is defined by an outlet opening **126***a*, which is disposed in and/or defined by the valve housing **102** (e.g., the second end wall **106***b*). The filtered region **120***e* and the second inner region **220***b* are in direct fluid communication with one another via the air outlet **126** and the inflow opening **212**. The air funnel **270** is disposed partially in the air outlet **126** and extends into the VH internal space **120** via the air outlet **126**. As such, the air outlet **126** and the inflow opening **212** enable fluid communication between the first unfiltered region **120***c* and the first inner region **220***a* via the air funnel **270**.

[0024] As generally illustrated in FIGS. **2**-**5**B, the valve housing **102** includes an attachment formation **110** configured to engage a complimentary attachment formation **216** of the blower housing **202** and at least partially attach and/or seal the valve assembly **100** (e.g., the valve housing **102**) and the blower assembly **200** (e.g., the blower housing **202**). The attachment formation **110** includes a plurality of protrusions (e.g., two protrusions) that define a channel that receives a complimentary projection of the attachment formation **216**. The protrusions and the channel of the attachment formation **110** extend substantially parallel to one another and extend around and/or encircle the air outlet **126**.

[0025] As generally illustrated in FIGS. **2**-**5**B, the valve housing **102** further includes a valve support **140** arranged in the VH internal space **120**. The valve support **140** is formed and/or defined by one or more separate components, structures, and/or elements connected to one or more other portions of the valve housing **102**. Conceivably, the valve support **140** and/or one or more portions thereof may alternatively be formed integrally with one or more other portions of the valve housing **102**.

[0026] As generally illustrated in FIG. **2**, the valve support **140** includes a base **142**, an end wall **144**, two support walls **146**, **146'**, and two connecting walls **148**, **148'**. The support walls **146**, **146'** are disposed opposite one another and are connected to one another by the connecting walls **148**, **148'**, which are disposed opposite one another. The base **142** is connected to and extends transversely to the support walls **146**, **146'** and the connecting walls **148**, **148'**. The base **142** is disposed offset from the partition **104** in a first/vertical direction (e.g., to account for and/or accommodate the offset arrangement of the axes **132***a*, **132***b* and shafts **134***a*, **134***b*) as generally shown in FIGS. **3**A and **3**B. The end wall **144** is connected to and extends between the support walls **146**, **146'**, and is disposed spaced apart from the base **142**. The valve support **140** (e.g., the base **142** and/or support walls **146**, **146'**) includes and/or defines the first airflow opening **128***a*. The first unfiltered region **120***c* is disposed in the valve support **140** and is at least partially defined by the valve support **140** (e.g., the base **142** and walls **146**, **146'**, **148**, **148'**), which is shown in FIGS. **5**A and **5**B. As illustrated in FIGS. **3**A-**4**C, the second unfiltered region **120***d* is disposed outside the valve support **140** and extends at least partially around the valve support **140**. The end of the valve support **140** and/or the ends of the walls **146**, **146'**, **148**, **148'** opposite the base **150** are disposed near, directly adjacent to, and/or in contact with the filter **190** such that valve support **140** and/or the walls **146**, **146'**, **148**, **148'** at least partially separate and/or seal the first unfiltered region **120***c* and the second unfiltered region **120***d* from one another.

[0027] As generally illustrated in FIGS. **2**-**4**C, the support walls **146**, **146'** rotatably engage and/or contact the shafts **132***a*, **132***b* and support the shafts **132***a*, **132***b* and the valves **170***a*-**170***c* within the valve housing **102**. The support walls **146**, **146'** each have a first shaft recess **154***a*, **154***a'* for receiving the first shaft **134***a* and a second shaft recess **154***b*, **154***b'* for receiving the second shaft **134***b*. Additionally, the support walls **146**, **146'** each have a plurality of sealing projections **156***a'* **156***b'*, **158***a*-**158***d*, **158***a'*-**158***d'* the project from and extend longitudinal along the support wall **146**, **146'**. The sealing projections includes a first inner sealing projection **156***a'* and a second inner sealing projection **156***b'*, which project toward the other support wall **146**, **146'** and are selectively contacted by the first valve **170***a* to at least partially seal the first airflow opening **128***a*. The sealing projections includes a first, second, third, and fourth outer sealing projection **158***a*-**158***d*, **158***a'*-**158***d'*, which project away the other support wall **146**, **146'** and are selectively contacted by an associated one of the second and third valves **170***b*, **170***c* to at least partially seal an associated one of the second and third airflow openings **128***b*, **128***c*. The valve support **140** (e.g., the first support wall **146** and/or the outer sealing projections **158***a*, **158***b*) at least partially defines the second airflow opening **128***b*. The valve support **140** (e.g., the second support wall **146'** and/or the outer sealing projections **158***a'*, **158***b'*) at least partially defines the third airflow opening **128***c*.

[0028] As generally illustrated in FIGS. **3**A-**4**C, the valve housing **102** includes a plurality of airflow openings, including a first, second, and third airflow opening **128***a*, **128***b*, **128***c*. The first airflow opening **128***a* is disposed in and defined by the valve support **140**. More specifically, the first airflow opening **128***a* is disposed in the base **142** and is at least partially defined by the base **142** and the support walls **146**, **146'**. The first airflow opening **128***a* fluidically connects each of the intake regions **120***a*, **120***b* to the first unfiltered region **120***c*. The first airflow opening **128***a* is selectively openable and closeable with respect to the intake regions **120***a*, **120***b* via the first valve **170***a*. The second airflow opening **128***b* is defined at least partially by the partition **104** and the valve support **140** (e.g., the first support wall **146** and/or the first and second outer sealing projections **158***a*, **158***b*). The third airflow opening **128***c* is defined at least partially by the partition **104** and the valve support **140** (e.g., the second support wall **146'** and/or the first and second outer sealing projections **158***a*', **158***b*'). The second and third airflow openings **128***b*, **128***c* each fluidically connect each of the intake regions **120***a*, **120***b* to the second unfiltered region **120***d*. The second airflow opening **128***b* is selectively openable and closeable with respect to the intake regions **120***a*, **120***b* via the second valve **170***b*. The third airflow opening **128***c* is selectively openable and closeable with respect to the intake regions **120***a*, **120***b* via the third valve **170***c*.

[0029] As generally illustrated in FIGS. **1**-**5**B, the valve assembly **100** includes a plurality of valves **170***a*-**170***c* including a first, second, and third valve **170***a*, **170***b*, **170***c*. The valves **170***a*-**170***c* are arranged in the valve housing **102** (e.g., in the VH internal space **120**) between the first and second intake regions **120***a*, **120***b* and control the flow of air through the HVAC module **10**. Each valve **170***a*-**170***c* includes at least one seal **182***a*-**182***c*, **184***a*-**184***c*. The first seal **182***a*-**182***c* is connected to and projects outward from the valve **170***a*-**170***c* and extends at least partially around a first open end of the valve **170***a*-**170***c*. The second seal **184***a*-**184***c* is connected to and projects outward from valve **170***a*-**170***c* and extends at least partially around a second open end of the valve **170***a*-**170***c*. While the first seal **182***a*-**182***c* and second seal **184***a*-**184***c* are separate and independent elements in the illustrative example herein, the first seal **182***a*-**182***c* and the second seal **184***a*-**184***c* may conceivably be connected to one another and/or formed as a singular seal.

[0030] As generally illustrated in FIGS. **2**-**5**B, the first valve **170***a* is disposed at least partially within the valve support **140**, and is arranged between the second valve **170***b* and the third valve **170***c* relative to the first and second axes **132***a*, **132***b*. The first valve **170***a* is adjustable and/or rotatable about the first axis **132***a* to selectively open and close the first airflow opening **128***a* with respect to the intake regions **120***a*, **120***b*. The first valve **170***a* is connected to the first shaft **134***a*, which extends along and/or defines the first axis **132***a*. The first shaft **134***a* is disposed in and/or extends through (i) a first shaft recess **112** disposed in and defined by the first sidewall **108***a* of the valve housing **102**, (ii) the first shaft recess **154***a* of the first support wall **146**, and (iii) the first shaft recess **154***a*' of the second support wall **146'** (see FIG. **2**). The first shaft **134***a* extends only part way through the valve housing **102** (e.g., does not extend completely through the valve housing **102**, nor contact or engage the second sidewall **108***b* of the valve housing **102**). The first valve **170***a* and the first shaft **134***a* are supported by the valve support **140** and the valve housing **102**. An end of the first shaft **134***a* is connected to the first actuator **130***a* (see FIGS. **1** and **5**B). In other words, the first shaft **134***a* connects the first valve **170***a* and the first actuator **130***a* to one another. The first actuator **130***a* is disposed on a first side of the valve housing **102** and is arranged outside of the valve housing **102** adjacent to the first sidewall **108***a* of the valve housing **102**. The first actuator **130***a* is configured to adjust the first valve **170***a* about the first axis **132***a*. The first actuator **130***a* is connected to the controller **12**. The controller **12** is configured to control, operate, and/or actuate the first actuator **130***a* to rotate the first shaft **134***a*, which in turn adjusts and/or rotates the first valve **170***a* about the first axis **132***a*.

[0031] As generally illustrated in FIGS. **2**-**5**B, the second valve **170***b* and the third valve **170***c* are arranged on opposite sides of the first valve **170***a* relative to the first and second axes **132***a*, **132***b*. The second valve **170***b* and the third valve **170***c* are adjustable and/or rotatable about the second axis **132***b* to selectively open and close the second airflow opening **128***b* and the third airflow opening **128***c*, respectively, with respect to the intake regions **120***a*, **120***b*. The second and third valves **170***b*, **170***c* are connected to the second shaft **134***b*, which extends along and/or defines the second axis **132***b*. The second shaft **134***b* is disposed in and/or extends through (i) a second shaft recess **114***a* disposed in and defined by the first sidewall **108***a* of the valve housing **102**, (ii) a second shaft recess **114***b* disposed in and defined by the second sidewall **108***b* of the valve housing **102**, (iii) the second shaft recess **154***b* of the first support wall **146**, and (iv) the second shaft recess **154***b*' of the second support wall **146'** (see FIG. **2**). The second valve **170***b*, the third valve **170***c*, and the second shaft **134***b* are supported by the valve support **140** and the valve housing **102**. The second shaft **134***b* extends completely through the valve housing **102**. An end of the second shaft **134***b* is connected to the second actuator **130***b* (see FIG. **5**A). In other words, the second shaft **134***b* connects the second and third valves **170***b*, **170***c* and the second actuator **130***b* to one another. The second actuator **130***b* is disposed on a second, opposite side of the valve housing **102** and is arranged outside of the valve housing **102** adjacent to the second sidewall **108***b* of the valve housing **102**. The second actuator **130***b* is configured to adjust the second valve **170***b* and the third valve **170***c* about the second axis **132***b*. The second actuator **130***b* is connected to the controller **12**. The controller **12** is configured to control, operate, and/or actuate the second actuator **130***b* to rotate the second shaft **134***b*, which in turn simultaneously adjusts and/or rotates the second valve **170***b* and the third valve **170***c* about the second axis **132***b*. As such, the controller **12** can control and/or actuate the second and third valves **170**B, **170***c* independently of the first valve **170***a*, and vice versa.

[0032] As generally illustrated in FIGS. **3**A-**4**C, the first axis **132***a* and/or first shaft **134***a* and the second axis **132***b* and/or the second shaft **134***b* are offset from one another in a first/vertical direction and a second/horizontal direction. The first/vertical direction generally extends from the first end wall **106***a* toward the second end wall **106***b* of the valve housing **102** (e.g., generally parallel to the blower axis **248**). The second/horizontal direction generally extends from the first intake region **120***a* toward the second intake region **120***b*. The first/vertical direction and the second/horizontal direction are perpendicular to one another and are perpendicular to the first and second axes **132***a*, **132***b*. While the HVAC module **10** described herein includes two actuators **130***a*, **130***b*, the HVAC module **10** may include a single actuator that is connected to both shafts **134***a*, **134***b* and that controls, actuates, and/or rotates both shafts **134***a*, **134***b* independently of one another.

[0033] The first valve **170***a* is adjustable and/or rotatable about the first axis **132***a* to a variety of positions, including a first position (see FIGS. **3**A, **4**A, **4**C, **5**A), a second position (see FIGS. **1**, **3**B, **4**B, **5**B), and a plurality of intermediate positions between the first and second positions (e.g., an intermediate position similar to that of the third valve **170***c* shown in FIG. **4**C). When in the first position (see FIGS. **3**A, **4**A, **4**C, **5**A), the second seal **184***a* contacts, abuts, and/or presses against the base **142** of the valve support **140** and the first seal **182***a* contacts, abuts, and/or presses against the first inner sealing projection **156*a*'** of each support wall **146**, **146'** and a first end of the end wall **144** of the valve support **140**. Thus, when in the first position, the first valve **170*a*** closes the first airflow opening **128*a*** with respect to the second intake region **120*b*** and does not close the first airflow opening **128*a*** with respect to the first intake region **120*a*** such that the first input air **22** is permitted to flow through the first airflow opening **128*a*** and the second input air **32** is restricted and/or prevented from flowing through the first airflow opening **128*a***. When in the second position (see FIGS. **1**, **3**B, **4**B, **5**B), the first seal **182*a*** contacts, abuts, and/or presses against the base **142** of the valve support **140** and the second seal **184*a*** contacts, abuts, and/or presses against the second inner sealing projection **156*b*'** of each support wall **146**, **146'** and a second end of the end wall **144** of the valve support **140**. Thus, when in the second position, the first valve **170*a*** closes the first airflow opening **128*a*** with respect to the first intake region **120*a*** and does not close the first airflow opening **128*a*** with respect to the second intake region **120*b*** such that the second input air **32** is permitted to flow through the first airflow opening **128*a*** and the first input air **22** is restricted and/or prevented from flowing through the first airflow opening **128*a***. When in one or more intermediate positions, the seals **182*a***, **184*a*** do not contact the base **142**, the inner sealing projections **156*a*'**, **156*b*'**, nor the end wall **144** of the valve support **140**. Thus, when in one or more intermediate positions, the first valve **170*a*** does not close the first airflow opening **128*a*** with respect to the first intake region **120*a*** nor the second intake region **120*b*** such that both the first and second input air **22**, **32** are permitted to flow through the first airflow opening **128*a***.

[0034] The second valve **170*b*** is adjustable and/or rotatable about the second axis **132*b*** to a variety of positions, including a first position (see FIGS. **3**A, **4**A, **5**A), a second position (see FIGS. **1**, **3**B, **4**B, **4**C, **5**B), and a plurality of intermediate positions between the first and second positions (e.g., an intermediate position similar to that of the third valve **170*c*** shown in FIG. **4**C). When in the first position (see FIGS. **3**A, **4**A, **5**A), the first seal **182*b*** contacts, abuts, and/or presses against the first end wall **106*a*** of the valve housing **102** (e.g., a first protrusion thereof), the first sidewall **108*a*** of the valve housing **102** (e.g., a protrusion thereof), and the third outer sealing projection **158*c*** of the first support wall **146** and the second seal **184*b*** contacts, abuts, and/or presses against the partition **104** and the second outer sealing projection **158*b*** of the first support wall **146**. Thus, when in the first position, the second valve **170*b*** closes the second airflow opening **128*b*** with respect to the second intake region **120*b*** and does not close the second airflow opening **128*b*** with respect to the first intake region **120*a*** such that the first input air **22** is permitted to flow through the second airflow opening **128*b*** and the second input air **32** is restricted and/or prevented from flowing through the second airflow opening **128*b***. When in the second position (see FIGS. **1**, **3**B, **4**B, **4**C, **5**B), the first seal **182*b*** contacts, abuts, and/or presses against the partition **104** and the first outer sealing projection **158*a*** of the first support wall **146** and the second seal **184*b*** contacts, abuts, and/or presses against the first end wall **106*a*** of the valve housing **102** (e.g., a first protrusion thereof), the first sidewall **108*a*** of the valve housing **102** (e.g., a protrusion thereof), and the fourth outer sealing projection **158*d*** of the first support wall **146**. Thus, when in the second position, the second valve **170*b*** closes the second airflow opening **128*b*** with respect to the first intake region **120*a*** and does not close the second airflow opening **128*b*** with respect to the second intake region **120*b*** such that the second input air **32** is permitted to flow through the second airflow opening **128*b*** and the first input air **22** is restricted and/or prevented from flowing through the second airflow opening **128*b***. When in one or more intermediate positions, the seals **182*b***, **184*b*** do not contact the partition **104**, the outer sealing projections **158*a*-158*d*** of the first support wall **146**, the first sidewall **108*a*** of the valve housing **102**, nor the first end wall **106*a*** of the valve housing **102**. Thus, when in one or more intermediate positions, the second valve **170*b*** does not close the second airflow opening **128*b*** with respect to the first intake region **120*a*** nor the second intake region **120*b*** such that both the first and second input air **22**, **32** are permitted to flow through the second airflow opening **128*b***.

[0035] The third valve **170*c*** is adjustable and/or rotatable about the second axis **132*b*** to a variety of positions, including a first position (see FIGS. **3**A, **4**A, **5**A), a second position (see FIGS. **1**, **3**B, **4**B, **5**B), and a plurality of intermediate positions between the first and second positions (see FIG. **4**C). When in the first position (see FIGS. **3**A, **4**A, **5**A), the first seal **182*c*** contacts, abuts, and/or presses against the first end wall **106*a*** of the valve housing **102** (e.g., a second protrusion thereof), the second sidewall **108*b*** of the valve housing **102** (e.g., a protrusion thereof), and the third outer sealing projection **158*c*'** of the second support wall **146'** and the second seal **184*c*** contacts, abuts, and/or presses against the partition **104** and the second outer sealing projection **158*b*'** of the second support wall **146'**. Thus, when in the first position, the third valve **170*c*** closes the third airflow opening **128*c*** with respect to the second intake region **120*b*** and does not close the third airflow opening **128*c*** with respect to the first intake region **120*a*** such that the first input air **22** is permitted to flow through the third airflow opening **128*c*** and the second input air **32** is restricted and/or prevented from flowing through the third airflow opening **128*c***. When in the second position (see FIGS. **1**, **3**B, **4**B, **5**B), the first seal **182*c*** contacts, abuts, and/or presses against the partition **104** and the first outer sealing projection **158*a*'** of the second support wall **146'** and the second seal **184*c*** contacts, abuts, and/or presses against the first end wall **106*a*** of the valve housing **102** (e.g., a second protrusion thereof), the second sidewall **108*b*** of the valve housing **102** (e.g., a protrusion thereof), and the fourth outer sealing projection **158*d*'** of the second support wall **146'**. Thus, when in the second position, the third valve **170*c*** closes the third airflow opening **128*c*** with respect to the first intake region **120*a*** and does not close the third airflow opening **128*c*** with respect to the second intake region **120*b*** such that the second input air **32** is permitted to flow through the third airflow opening **128*c*** and the first input air **22** is restricted and/or prevented from flowing through the third airflow opening **128*c***. When in one or more intermediate positions (see FIG. **4**C), the seals **182*c***, **184*c*** do not contact the partition **104**, the outer sealing projections **158*a*'-158*d*'** of the second support wall **146'**, the second sidewall **108*b*** of the valve housing **102**, nor the first end wall **106*a*** of the valve housing **102**. Thus, when in one or more intermediate positions, the third valve **170*c*** does not close the third airflow opening **128*c*** with respect to the first intake region **120*a*** nor the second intake region **120*b*** such that both the first and second input air **22**, **32** are permitted to flow through the third airflow opening **128*c***.

[0036] As generally illustrated in FIGS. **2-5**B, the filter **190** is configured to remove and/or collect impurities from air (e.g., the input air **22**, **33**, the first airflow **40**, and/or the second airflow **50**) flowing through the filter **190**. The filter **190** is arranged in the valve housing **102** (e.g., the VH internal space **120**). The filter **190** is releasably engaged by and/or connected to the valve housing **102** (e.g., one or more sidewalls thereof) enabling the filter **190** to be easily removed and replaced, such as by removing an access panel and/or cover that closes an opening in valve housing **102**. The inlets **122**, **124**, the first end wall **106***a* of the valve housing **102**, the partition **104**, the valve support **140**, the airflow openings **170***a*-**170***c*, and the unfiltered regions **120***c*, **120***d* are disposed on a first side of the filter **190** and the second end wall **106***b* of the valve housing **102**, the air outlet **126**, the air funnel **270**, and the filtered region **120***e* are disposed on a second, opposite side of the filter **190**, at least with respect to a throughflow direction of the HVAC module **10**. The filter **190** is disposed between and/or separates (to at least an extent) the first unfiltered region **120***c* and the funnel inner space **270***a* such that the first airflow **40** is flowable (e.g., exclusively) from the first unfiltered region **120***c* into the funnel inner space **270***a* via flowing through the filter **190**. The filter **190** is also disposed between and/or separates (to at least an extent) the second unfiltered region **120***d* and the filtered region **120***e* such that the second airflow **50** is flowable (e.g., exclusively) from the second unfiltered region **120***d* into the filtered region **120***e* via flowing through the filter **190**.

[0037] As generally illustrated in FIGS. **3**A-**5**B, the VH internal space **120** includes a first intake region **120***a*, a second intake region **120***b*, a first unfiltered region **120***c*, a second unfiltered region **120***d*, and a filtered region **120***e*.

[0038] As generally illustrated in FIGS. **3**A-**4**C, the first intake region **120***a* is defined at least partially by a first section and/or region of the valve housing **102** (e.g., a first portion of the first end wall **106***a*, a first portion of the partition **104**, and a first portion of one or more sidewalls **108***a*-**108***c* disposed on a first side of the valves **170***a*-**170***c* and/or the valve support **140**). The second intake region **120***b* is defined at least partially by a second section and/or region of the valve housing **102** (e.g., a second portion of the first end wall **106***a*, a second portion of the partition **104**, and a second portion of one or more sidewalls disposed **108***a*, **108***b*, **108***d* on a second, opposite side of the valves **170***a*-**170***c* and/or the valve support **140**). In other words, the first intake region **120***a* and the second intake region **120***b* are disposed on opposite sides of the valves **170***a*-**170***c* and/or the valve support **140**.

[0039] The intake regions **120***a*, **120***b* are in selective fluid communication with one another and may be selectively closed off and/or sealed from one another via the valves **170***a*-**170***c*. For example, the intake regions **120***a*, **120***b* are in fluid communication when one another when one or more of the valves **170***a*-**170***c* is disposed in an intermediate position. The intake regions **120***a*, **120***b* are fluidically sealed off from one another via the valves **170***a*-**170***c* when the valves **170***a*-**170***c* are each disposed in one of the first and second positions (e.g., the valves **170***a*-**170***c* are each in the first position; the first valve **170***a* is in the first position and the second and third valves **170***b*, **170***c* are in the second position; etc.). The first intake region **120***a* and the second intake region **120***b* are in selective fluid communication with the unfiltered regions **120***c*, **120***d* via the valve openings **128***a*-**128***c* and may be selectively closed off and/or sealed from one or more of the unfiltered regions **120***c*, **120***d* via the valves **170***a*-**170***c*.

[0040] As generally illustrated in FIGS. **5**A and **5**B, the first unfiltered region **120***c* is disposed in the valve support **140**. The first unfiltered region **120***c* is at least partially defined by the valve support **140** (e.g., the base **142** and walls **146**, **146'**, **148**, **148'**) and the filter **190**. The first unfiltered region **120***c* is in fluid communication with the funnel inner space **270***a* via the filter **190**. The first unfiltered region **120***c* is in selective fluid communication with the intake regions **120***a*, **120***b* via the first airflow opening **128***a* and may be selectively closed off and/or sealed from one or more of the intake regions **120***a*, **120***b* via the first valve **170***a*. The first unfiltered region **120***c* and the first intake region **120***a* are (i) in fluid communication when the first valve **170***a* is the first position or in an intermediate position and (ii) not in fluid communication when the first valve **170***a* is in the second position. The first unfiltered region **120***c* and the second intake region **120***b* are (i) in fluid communication when the first valve **170***a* is the second position or in an intermediate position and (ii) not in fluid communication when the first valve **170***a* is in the first position.

[0041] As generally illustrated in FIGS. **3**A-**5**B, the second unfiltered region **120***d* is defined at least partially by the valve housing **102** (e.g., the partition **104** and one or more of the sidewalls **108***a*-**108***d*), the valve support **140** (e.g., the walls **146**, **146'**, **148**, **148'** and the outer sealing projections **158***a*, **158***b*, **158***a*', **158***b*'), and the filter **190**. The second unfiltered region **120***d* is disposed outside the valve support **140** and extends at least partially around the valve support **140** (e.g., circumferentially). The second unfiltered region **120***d* is in fluid communication with the filtered region **120***e* via the filter **190**. The second unfiltered region **120***d* is in selective fluid communication with the intake regions **120***a*, **120***b* via the second and third airflow openings **128***b*, **128***c*, and may be selectively closed off and/or sealed from one or more of the intake regions **120***a*, **120***b* via the second and third valves **170***b*, **170***c*. The second unfiltered region **120***d* and the first intake region **120***a* are (i) in fluid communication when the second and third valves **170***b*, **170***c* are in the first position or in one or more intermediate positions and (ii) not in fluid communication when the second and third valves **170***b*, **170***c* are in the second position. The second unfiltered region **120***d* and the second intake region **120***b* are (i) in fluid communication when the second and third valves **170***b*, **170***c* are in the second position or in one or more intermediate positions and (ii) not in fluid communication when the second and third valves **170***b*, **170***c* are in the first position.

[0042] As generally illustrated in FIGS. **3**A-**5**B, the filtered region **120***e* is defined at least partially by the filter **190**, the valve housing **102** (e.g., the second end wall **106***b* and one or more of the sidewalls **108***a*-**108***d*), and the air funnel **270**. The filtered region **120***e* is disposed outside of and extends at least partially around the air funnel **270** (e.g., circumferentially). The filtered region **120***e* is in fluid communication with the second unfiltered region **120***d* via the filter **190**. The filtered region **120***e* is in fluid communication with the blower assembly **200** (e.g., the second inner region **220***b*) via the air outlet **126** and the inflow opening **212**.

[0043] As generally illustrated in FIGS. **1**, **2**, **5**A, and **5**B, the blower housing **202** includes two housing shells **204***a*, **204***b*, a separation panel **206** connected to the housing shells **204***a*, **204***b*, and a plurality of outlets (e.g., a first outlet **208***a* and a second outlet **208***b*). The housing shells **204***a*, **204***b* are attached and/or connected to one another and define an internal space **220** (i.e., BH internal space **220**) in which the blower **230** and the air funnel **270** are at least partially arranged. The separation panel **206** is arranged and/or sandwiched between the housing shells **204***a*, **204***b* and is disposed at least partially in the BH internal space **220**. The separation panel **206** includes and/or defines a panel aperture **210** that receives at least a portion of the blower **230** (e.g., the blower wheel **236**) and/or at least a portion of the air funnel **270**.

[0044] As generally illustrated in FIG. **1**, the blower housing **202** may be considered to include and/or be divided into two sections (e.g., a first housing section **202***a* and a second housing section **202***b*) at or about the separation panel **206**. The first housing section **202***a* is the lower portion and/or 'half' of the blower housing **202** defined by and/or including the first housing shell **204***a*, the separation panel **206**, and the first outlet **208***a*. The second housing section **202***b* is the upper portion and/or 'half' of the blower housing **202** defined by and/or including the second housing shell **204***b*, the separation panel **206**, and the second outlet **208***b*.

[0045] As generally illustrated in FIGS. **6** and **7**, the blower housing **202** includes a main and/or scroll portion **202***c* and a branch portion **202***d*. The scroll portion **202***c* is generally cylindrical in shape and at least partially houses the blower **230** (e.g., the blower wheel **236**) and the air funnel **270**. The branch portion **202***d* is connected to and tangentially extends, projects, splits, and/or diverges from the scroll portion **202***c* at or about a scroll exit region **202***e*. The branch portion **202***d* includes the outlets **208***a*, **208***b*. The scroll portion **202***c* and the branch portion **202***d* each partially define a section and/or portion of the first and second flow regions **220***c*, **220***d* of the BH internal space **220**.

[0046] As generally illustrated in FIGS. **1**, **2**, and **5**B, the blower housing **202** includes a plurality of outlets **208***a*, **208***b* via which air (i.e., input air **22**, **32** received from the valve assembly **100** as the first airflow **40** and/or the second airflow **50**) is output, expelled, and/or flowable out of the blower assembly **200** and/or the HVAC module **10**. The first outlet **208***a* outputs and/or expels the first airflow **40** as first output air **42**, which may ultimately be directed to one or more first destinations (e.g., one or more first/defrost zones of a vehicle internal space and/or cabin, one or more upper portions or regions of a vehicle internal space and/or cabin, and/or a windshield of a vehicle). The first outlet **208***a* includes and/or is defined by a first outlet opening **208***c*, which is defined and/or formed by the first housing shell **204***a* and the separation panel **206**. The second outlet **208***b* outputs and/or expels the second airflow **50** as second output air **52**, which may ultimately be directed to one or more second destinations (e.g., one or more second/lower/footwell zones of a vehicle internal space and/or cabin, lower portions or regions of a vehicle internal space and/or cabin, and/or footwells of the vehicle). The second outlet **208***b* includes and/or is defined by a second outlet opening **208***d*, which is defined and/or formed by the second housing shell **204***b* and the separation panel **206**.

[0047] As generally illustrated in FIGS. **2**-**5**B, the second housing shell **204***b* includes and/or defines the inflow opening **212** via which air (i.e., input air **22**, **32** received from the valve assembly **100** as the first airflow **40** and/or the second airflow **50**) is flowable into the blower assembly **200** from the valve assembly **100**. The second inner region **220***b* and the filtered region **120***e* are in direct fluid communication with one another via the inflow opening **212**. The air funnel **270** is disposed partially in the inflow opening **212** and projects from the blower housing **202** (e.g., the BH internal space **220**) via the inflow opening **212**. As such, the air outlet **126** and the inflow opening **212** enable fluid communication between the first unfiltered region **120***c* and the first inner region **220***a* via the air funnel **270**.

[0048] As generally illustrated in FIGS. **3**A, **5**A, and **5**B, the second housing shell **204***b* further includes an attachment formation **216** configured to engage the complimentary attachment formation **110** of the valve housing **102** and at least partially attach and/or seal the valve assembly **100** (e.g., the valve housing **102**) and the blower assembly **200** (e.g., the blower housing **202**). The attachment formation **216** includes a projection that engages and/or is received in the complimentary channel of the attachment formation **110** of the valve housing **102**. The projection of the attachment formation **216** extends around and/or encircles the inflow opening **212**.

[0049] As generally illustrated in FIGS. **5**A and **5**B, the first housing shell **204***a* includes a shell aperture **214** that receives and (e.g., releasably) retains at least a portion of the blower **230** (e.g., the blower motor **232**, motor housing **234**). The shell aperture **214** facilitates insertion and/or arrangement of at least a portion the blower **230** (e.g., the blower wheel **236**) within the blower housing **202** and/or the BH internal space **220**. The shell aperture **214** is closed and/or sealed by one or more portions of the blower **230** (e.g., the motor housing **234**).

[0050] As generally illustrated in FIGS. **5**A-**6**, the blower **230** is at least partially arranged in the blower housing **202** and/or the BH internal space **220**. The blower **230** is partially disposed in and projects through the shell aperture **214** into the BH internal space **220**. The blower **230** includes a blower motor **232**, a motor housing **234**, and a blower wheel **236**. The blower motor **232** is disposed and/or mounted in the motor housing **234**. The motor housing **234** is (e.g., releasably) connected to the blower housing **202** and closes and/or seals the shell aperture **214**. The blower motor **232** and/or the motor housing **234** are disposed at least partially in and/or extend through the shell aperture **214**. The blower motor **232** is connected to the blower wheel **236** (e.g., via a drive shaft). The blower motor **232** is configured to rotate and/or spin the blower wheel **236** about a blower axis **248**. The blower **230** and/or the blower motor **232** is connected to the controller **12**. The controller **12** is configured to control, operate, and/or actuate the blower motor **232** to rotate and/or spin the blower wheel **236**, which in turn generates flow through the HVAC module **10**, the valve assembly **100**, and/or the blower assembly **200** (e.g., draws air **22**, **32** through the inlets **122**, **124** into the valve assembly **100** and through the valve assembly **100** into the blower assembly **200**, and/or drives and/or pushes air through the blower assembly **200** and out the outlets **208***a*, **208***b*).

[0051] As generally illustrated in FIGS. **5**A-**7**, the blower wheel **236** includes a hub **238**, an annular perimeter wall **240**, an annular intermediate wall **242**, a plurality of first blades **244**, and a plurality of second blades **246**. The hub **238** is disposed at or about a first axial end of the blower wheel **236** and is connected to the blower motor **232** (e.g., via a drive shaft). The hub **238** generally extends and/or lies transversely to the blower axis **248**. The perimeter wall **240** extends around an outer circumference and/or perimeter of the blower wheel **236** at a second axial end of the blower wheel **236** opposite the hub **238**. The intermediate wall **242** generally extends and/or lies transversely to the blower axis **248** and is disposed axially between the perimeter wall **240** and at least a portion of the hub **238** (e.g., the portion connected to the first blades **244**). The first blades **244** extend axially between and connect the hub **238** and the intermediate wall **242**, and are disposed circumferentially spaced apart from one another around a radially outer perimeter of the blower wheel **236**. The second blades **246** extend axially between and connect the perimeter wall **240** and the intermediate wall **242**, and are disposed circumferentially spaced apart from one another around the radially outer perimeter of the blower wheel **236**.

[0052] As generally illustrated in FIGS. **5A-6**, the intermediate wall **242** is curved and directs and/or guides the second airflow **50** in the second inner region **220***b* radially outward, where the second airflow **50** passes between the second blades **246** and into the second flow region **220***d*. The intermediate wall **242** includes and/or defines a through opening **242***a* that is disposed at least partially axially aligned with the blower axis **248**, a portion of the hub **238** (i.e., the bell-shaped dome), and the air funnel **270**. An end of the air funnel **270** (e.g., a second end) is disposed near, directly adjacent to, and/or in close proximity to an edge of the intermediate wall **242** defining the through opening **242***a* such that the first airflow **40** flows from the funnel inner space **270***a* into the first inner region **220***a* via the through opening **242***a*. A central region and/or portion of the hub **238** is structured as a bell-shaped dome that, optionally, projects at least partially into the funnel inner space **270***a*. The bell-shaped dome directs and/or guides the first airflow **40** in the first inner region **220***a* radially outward, where the first airflow **40** passes between the first blades **244** and into the first flow region **220***c*.

[0053] The blower wheel **236** may be considered to include and/or be divided into two sections (e.g., a first wheel section and a second wheel section) at or about the intermediate wall **242**. The first wheel section is the lower portion and/or 'half' of the blower wheel **236** defined by and/or including the hub **238**, the intermediate wall **242**, and the first blades **244**. The second wheel section is the upper portion and/or 'half' of the blower wheel **236** defined by and/or including the perimeter wall **240**, the intermediate wall **242**, and the second blades **246**.

[0054] As generally illustrated in FIGS. **2-5**B, the blower assembly **200** includes an air funnel **270** via which the first airflow **40** enters and/or flows into the blower housing **202**. The air funnel **270** defines an inner space **270***a* (also referred to as the 'funnel inner space'). The air funnel **270** is disposed partially in the valve housing **102** (e.g., the VH internal space **120**), the air outlet **126**, the blower housing **202** (e.g., the BH internal space **220**), and the inflow opening **212**. The air funnel **270** projects from the blower housing **202** via the inflow opening **212** and extends into the valve housing **102** via the air outlet **126**. A first axial end of air funnel **270** is connected to the second housing shell **204***b* and is disposed within the valve housing **102** (e.g., the VH internal space **120**) near, directly adjacent to, and/or in contact with the filter **190**. A second axial end of the air funnel **270** is disposed in the blower housing **202** (e.g., the BH internal space **220**) and the blower wheel **236**, near, directly adjacent to, and/or in the through opening **242***a* and/or the intermediate wall **242** of the blower wheel **236**.

[0055] As generally illustrated in FIG. **7**, the air funnel **270** includes two major sidewalls **272**, **272'**and two minor sidewalls **274**, **274'**. The two minor sidewalls **274**, **274'** extend between and connect the two major sidewalls **272**, **272'** to define and/or form a rectangle in which the minor sidewalls **274**, **274'** define and/or form the minor/short sides of the rectangle and the major sidewalls **272**, **272'** define and/or form the major/long sides of the rectangle. The sidewalls **272**, **272'**, **274**, **274'** of the air funnel **270** are part of and/or at least partially define a rectangular base portion **276** of the air funnel **270**, which is connected to the second housing shell **204***b*. The sidewalls **272**, **272'**, **274**, **274'** and/or the base portion **276** are disposed at the first axial end of the air funnel **270** and define a funnel inflow opening **278** via which the first airflow **40** enters and/or flows into the air funnel **270** and/or the funnel inner space **270***a*.

[0056] As generally illustrated in FIG. **6**, the air funnel **270** further includes a circumferential wall **280** that is connected to and projects axially from the base portion **276**. The circumferential wall **280** is configured and/or structured in the manner of and/or similar to a hyperboloid and, thus, may be referred to as a hyperboloid wall **280**. The circumferential wall **280** is disposed at least partially at the second axial end of the air funnel **270** and defines a funnel outflow opening **282** via which the first airflow **40** exits and/or flows out of the air funnel **270** (e.g., into the first inner region **220***a*).

[0057] As generally illustrated in FIGS. **6** and **7**, a dimension/length L_1 of the rectangular base portion **276** extending in the second/horizontal direction (i.e., transversely and/or perpendicular to the axes **132***a*, **132***b* and to the blower axis **248**) is less and/or smaller than a dimension/length L_2 of the filter **190**. The length L_1 of the base portion **276** is defined by and between the external surfaces of the two minor sidewalls **274**, **274'** of the base portion **276**. The two minor sidewalls **274**, **274'** extend substantially parallel to the axes **132***a*, **132***b*, the shafts **134***a*, **134***b*, and/or the branch portion **202***d*. In addition, the first minor sidewall **274** (e.g., a first side of the base portion **276**) is disposed near and/or adjacent to where the branch portion **202***d* of the blower housing **202** extends and/or splits off from the scroll portion **202***c* (i.e., the scroll exit region **202***e*).

[0058] As generally illustrated in FIG. **7**, a longitudinal length of the first minor sidewall **274** (e.g., in a third direction parallel to the axes **132***a*, **132***b*) is equal to or greater than a first chord of the blower wheel **236** that is parallel to and disposed in alignment with the first minor sidewall **274** in the first/vertical direction such that, when viewed in the first/vertical direction, the first minor sidewall **274** intersects the outer perimeter of the blower wheel **236** at two points and a circle segment shaped first flow area **284** is defined by and between the first minor sidewall **274** and the outer perimeter of the blower wheel **236**. The external surface of the first minor sidewall **274** (i.e., a first side of the base portion **276**) is disposed a first distance d_1 in the second/horizontal direction from the outer perimeter of the blower wheel **236** (e.g., from a vertex of the arc of the circle segment shape of the first flow area **284**). In other words, a maximum dimension of the first flow area **284** in the second/horizontal direction is equal to the first distance d_1.

[0059] As generally illustrated in FIG. **7**, a longitudinal length of the second minor sidewall **274'** (e.g., in the third direction parallel to the axes **132**_a_, **132**_b_) is equal to or greater than a second chord of the blower wheel **236** that is parallel to and disposed in alignment with the second minor sidewall **274'** in the first/vertical direction such that, when viewed in the first/vertical direction, the second minor sidewall **274'** intersects the outer perimeter of the blower wheel **236** at two points and a circle segment shaped second flow area **284'** is defined by and between the second minor sidewall **274'** and the outer perimeter of the blower wheel **236**. The external surface of the second minor sidewall **274'** (i.e., a second side of the base portion **276**) is disposed a second distance d_2 in the second/horizontal direction from the outer perimeter of the blower wheel **236** (e.g., from a vertex of the arc of the circle segment shape, or arc vertex, of the second flow area **284'**). In other words, a maximum dimension of the second flow area **284'** in the second/horizontal direction is equal to the second distance d_2.

[0060] As generally illustrated in FIG. **7**, a first distance-diameter ratio R_{d1} of the first distance d_1 to the diameter D of the blower wheel **236** is 0.05 to 0.15 (i.e., $R_{d1}=d_1/D=0.05$ to 0.15), preferably 0.10. The diameter D of the blower wheel **236** is measured at and/or defined by the outer perimeter of the second blades **246** (e.g., at its widest point). For example, the diameter of the blower wheel may be A second distance-diameter ratio R_{d2} of the second distance d_2 to the diameter D of the blower wheel **236** is 0.05 to 0.15 (i.e., $R_{d2}=d_2/D=0.05$ to 0.15), preferably 0.10. An area ratio R_A of the total combined flow area A_{Total} of the flow areas **284**, **284'** to the area A_{Blower} of the blower wheel **236** is 0.05 to 0.25 (i.e., $R_A=A_{Total}/A_{Blower}=0.05$ to 0.25), preferably 0.05 to 0.15. The blower area A_{Blower} can be calculated using the formula

$$A_{Blower} = \pi \times \left(\frac{D}{2}\right)^2,$$

where D is the diameter of the blower wheel **236**. The total combined flow area A_{Total} of the flow areas **284**, **284'** can be calculated by adding/summing the area A_{FA1} of the first flow area **284** and the area A_{FA2} of the second flow area **284'** (i.e., $A_{Total}=A_{FA1}+A_{FA2}$). The area A_{FA1} of the first flow area **284** can be calculated using the formula

$$A_{FA1} = \left(\frac{\theta_1 \times \pi}{360} - \frac{\sin\theta_1}{2}\right) \times \left(\frac{D}{2}\right)^2,$$

where D is the diameter of the blower wheel **236** and θ_1 is the first segment angle in degrees. The first segment angle θ_1 is defined between a first imaginary radial line extending from the blower axis **248** (i.e., the center of the blower wheel **236**) to a first end of the first chord and a second imaginary radial line extending from the blower axis **248** to a second, opposite end of the first chord. The area A_{FA2} of the second flow area **284'** can be calculated using the formula

$$A_{FA2} = \left(\frac{\theta_2 \times \pi}{360} - \frac{\sin\theta_2}{2}\right) \times \left(\frac{D}{2}\right)^2,$$

where D is the diameter of the blower wheel **236** and θ_2 is the second segment angle in degrees. The second segment angle θ_2 is defined between a first imaginary radial line extending from the blower axis **248** to a first end of the second chord and a second imaginary radial line extending from the blower axis **248** to a second, opposite end of the second chord. The first flow area **284**, the area A_{FA1} of the first flow area **284**, the second flow area **284'**, the area A_{FA2} of the second flow area **284'**, and blower area A_{Blower} each lie in a plane perpendicular to the first/vertical direction and/or the blower axis **248**.

[0061] Surprisingly, Applicant has found that providing the rectangular base portion **276** of the air funnel **270** with a length L_1 that is smaller than the length L_2 of the filter **190** did not compromise the sealing and/or separation of the first airflow **40** and the second airflow **50** after passing though the filter **190** (i.e., separation of the first airflow **40** in the air funnel **270** and the second airflow **50** in the filtered region **120**_e_). Applicant also surprisingly found that the difference between L_1 and L_2, as well as the size/area of the first and second flow areas **284**, **284'** relative to one another and to the diameter D of the blower wheel **236**, influenced airflow in the scroll exit region **202**_e_ of the blower housing **202**. Moreover, Applicant was able to achieve reduced airflow restriction and/or improved airflow in the scroll exit region **202**_e_ by providing the rectangular base portion of the air funnel **270** with a length L_1 that is smaller than the length L_2 of the filter **190** and utilizing a first distance-diameter ratio R_{d1}, a second distance-diameter ratio R_{d2}, and an area ratio R_A that were each within the above described ranges. This, in turn, improved efficiency of the blower **230** and/or the HVAC module **10** and eliminated or at least reduced the amount of noise generated during operation of the blower **230** and/or the HVAC module **10**.

[0062] As generally illustrated in FIGS. **5A-6**, the BH internal space **220** includes a first inner region **220**_a_, a second inner region **220**_b_, a first flow region **220**_c_, and a second flow region **220**_d_.

[0063] The first inner region **220**_a_ is at least partially disposed in and/or defined by the first wheel section of the blower wheel **236**. More specifically, the first inner region **220**_a_ is at least partially defined by the hub **238**, the intermediate wall **242**, the first blades **244**, and the second end of the air funnel **270**. The first airflow **40** enters and/or flows into the first inner region **220**_a_ via the air funnel **270**. The first airflow **40** exits and/or flows out of the first inner region **220**_a_ and into the first flow region **220**_c_ by passing between the first blades **244** (e.g., via flowing through the gaps and/or openings defined between the first blades **244**).

[0064] The second inner region **220**_b_ is at least partially disposed in and/or defined by the second wheel section of the blower wheel **236**. More specifically, the second inner region **220**_b_ is at least partially defined by the first housing shell **204**_a_, the inflow opening **212**, the perimeter wall **240**, the intermediate wall **242**, the second blades **246**, and/or the air funnel **270** (e.g., the circumferential wall **280**). The second airflow **50** enters and/or flows into the second inner region **220**_b_ from the filtered region **120**_e_ by way of the air outlet **126** and the inflow opening **212**. The second airflow **50** exits and/or flows out of the second inner region **220**_b_ and into the second flow region **220**_d_ by passing between the second blades **246** (e.g., via flowing through the gaps and/or openings defined between the second blades **246**). The first inner region **220**_a_ and the second inner region **220**_b_ are substantially separated from one another by the intermediate wall **242** of the blower wheel **236** and/or the air funnel **270**.

[0065] The first flow region **220***c* is at least partially disposed in and/or defined by the first housing section **202***a* of the blower housing **202**. More specifically, the first flow region **220***c* is at least partially defined by the first housing shell **204***a*, the separation panel **206**, and the blower wheel **236** (e.g., the first wheel section). The first inner region **220***a*, the funnel inner space **270***a*, and the VH internal space **120** (e.g., the first unfiltered region **120***c*) are in fluid communication with the first outlet **208***a* via the first flow region **220***c*.

[0066] The second flow region **220***d* is at least partially disposed in and/or defined by the second housing section **202***b* of the blower housing **202**. More specifically, the second flow region **220***d* is at least partially defined by the second housing shell **204***b*, the separation panel **206**, and the blower wheel **236** (e.g., the second wheel section). The second inner region **220***b* and the VH internal space **120** (e.g., the second unfiltered region **120***d* and the filtered region **120***e*) are in fluid communication with the second outlet **208***b* via the second flow region **220***d*. The first flow region **220***c* and the second flow region **220***d* are disposed on opposite sides of the separation panel **206** and substantially separated from one another by the separation panel **206**.

[0067] As generally illustrated in FIG. **1**, the controller **12** includes an electronic controller and/or includes an electronic processor, such as a programmable microprocessor and/or microcontroller. The controller **12** may also include an application specific integrated circuit (ASIC), a central processing unit (CPU), a memory (e.g., a non-transitory computer-readable storage medium), and/or an input/output (I/O) interface. The controller **12** is configured to perform various functions, including those described in greater detail herein, with appropriate programming instructions and/or code embodied in software, hardware, and/or other medium. The controller **12** is, optionally, connected to a display, such as a touchscreen display.

[0068] Various examples/embodiments are described herein for various apparatuses, systems, and/or methods. Numerous specific details are set forth to provide a thorough understanding of the overall structure, function, manufacture, and use of the examples/embodiments as described in the specification and illustrated in the accompanying drawings. It will be understood by those skilled in the art, however, that the examples/embodiments may be practiced without such specific details. In other instances, well-known operations, components, and elements have not been described in detail so as not to obscure the examples/embodiments described in the specification. Those of ordinary skill in the art will understand that the examples/embodiments described and illustrated herein are non-limiting examples, and thus it can be appreciated that the specific structural and functional details disclosed herein may be representative and do not necessarily limit the scope of the embodiments.

[0069] Reference throughout the specification to "examples, "in examples," "with examples," "various embodiments," "with embodiments," "in embodiments," or "an embodiment," or the like, means that a particular feature, structure, or characteristic described in connection with the example/embodiment is included in at least one embodiment. Thus, appearances of the phrases "examples, "in examples," "with examples," "in various embodiments," "with embodiments," "in embodiments," or "an embodiment," or the like, in places throughout the specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more examples/embodiments. Thus, the particular features, structures, or characteristics illustrated or described in connection with one embodiment/example may be combined, in whole or in part, with the features, structures, functions, and/or characteristics of one or more other embodiments/examples without limitation given that such combination is not illogical or non-functional. Moreover, many modifications may be made to adapt a particular situation or material to the teachings of the present disclosure without departing from the scope thereof.

[0070] It should be understood that references to a single element are not necessarily so limited and may include one or more of such element. Any directional references (e.g., plus, minus, upper, lower, upward, downward, left, right, leftward, rightward, top, bottom, above, below, vertical, horizontal, clockwise, and counterclockwise) are only used for identification purposes to aid the reader's understanding of the present disclosure, and do not create limitations, particularly as to the position, orientation, or use of examples/embodiments.

[0071] "One or more" includes a function being performed by one element, a function being performed by more than one element, e.g., in a distributed fashion, several functions being performed by one element, several functions being performed by several elements, or any combination of the above.

[0072] It will also be understood that, although the terms first, second, etc. are, in some instances, used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first element could be termed a second element, and, similarly, a second element could be termed a first element, without departing from the scope of the various described embodiments. The first element and the second element are both element, but they are not the same element.

[0073] The terminology used in the description of the various described embodiments herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used in the description of the various described embodiments and the appended claims, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will also be understood that the term "and/or" as used herein refers to and encompasses any and all possible combinations of one or more of the associated listed items. It will be further understood that the terms "includes," "including," "comprises," and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0074] Joinder references (e.g., attached, coupled, connected, and the like) are to be construed broadly and may include intermediate members between a connection of elements, relative movement between elements, direct connections, indirect connections, fixed connections, movable connections, operative connections, indirect contact, and/or direct contact. As such, joinder references do not necessarily imply that two elements are directly connected/coupled and in fixed relation to each other. Connections of electrical components, if any, may include mechanical connections, electrical connections, wired connections, and/or wireless connections, among others. Uses of "e.g." and "such as" in the specification are to be construed broadly and are used to provide non-limiting examples of embodiments of the disclosure, and the disclosure is not limited to such examples.

[0075] While processes, systems, and methods may be described herein in connection with one or more steps in a particular sequence, it should be understood that such methods may be practiced with the steps in a different order, with certain steps performed simultaneously, with additional steps, and/or with certain described steps omitted.

[0076] As used herein, the term "if" is, optionally, construed to mean "when" or "upon" or "in response to determining" or "in response to detecting," depending on the context. Similarly, the phrase "if it is determined" or "if [a stated condition or event] is detected" is, optionally, construed to mean "upon determining" or "in response to determining" or "upon detecting [the stated condition or event]" or "in response to detecting [the stated condition or event]," depending on the context.

[0077] All matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative only and not limiting. Changes in detail or structure may be made without departing from the present disclosure.

[0078] It should be understood that a controller, a system, and/or a processor as described herein may include a conventional processing apparatus known in the art, which may be capable of executing preprogrammed instructions stored in an associated memory, all performing in accordance with the functionality described herein. To the extent that the methods described herein are embodied in software, the resulting software can be stored in an associated memory and can also constitute means for performing such methods. Such a system or processor may further be of the type having ROM, RAM, RAM and ROM, and/or a combination of non-volatile and volatile memory so that any software may be stored and yet allow storage and processing of dynamically produced data and/or signals.

[0079] It should be further understood that an article of manufacture in accordance with this disclosure may include a non-transitory computer-readable storage medium having a computer program encoded thereon for implementing logic and other functionality described herein. The computer program may include code to perform one or more of the methods disclosed herein. Such embodiments may be configured to execute via one or more processors, such as multiple processors that are integrated into a single system or are distributed over and connected together through a communications network, and the communications network may be wired and/or wireless. Code for implementing one or more of the features described in connection with one or more embodiments may, when executed by a processor, cause a plurality of transistors to change from a first state to a second state. A specific pattern of change (e.g., which transistors change state and which transistors do not), may be dictated, at least partially, by the logic and/or code.

What is claimed is:

1. A blower assembly for a heating, ventilation, and air conditioning (HVAC) module, comprising:

a blower including a blower wheel; and

an air funnel including a base portion and a circumferential wall connected to and projecting from the base portion;

wherein, when viewed in a first direction parallel to a blower axis, a first flow area is defined by and between a first side of the base portion and an outer perimeter of the blower wheel and a second flow area is defined by and between a second side of the base portion and the outer perimeter of the blower wheel.

2. The blower assembly of claim **1**, wherein:

the blower wheel has a diameter;

when viewed in the first direction, the first side of the base portion is disposed a distance from the outer perimeter of the blower wheel in a second direction that is perpendicular to the first direction and to the first side of the base portion; and

a ratio of the distance to the diameter is 0.05 to 0.15.

3. The blower assembly of claim **2**, wherein the ratio of the distance to the diameter is 0.10.

4. The blower assembly of claim **2**, wherein a maximum dimension of the first flow area in the second direction is equal to the distance.

5. The blower assembly of claim **2**, wherein:

the first flow area is circle segment shaped; and

the distance extends from the first side of the base portion to an arc vertex of the first flow area.

6. The blower assembly of claim **1**, wherein the first flow area and the second flow area are each circle segment shaped.

7. The blower assembly of claim **1**, wherein a ratio of a total combined flow area of the first flow area and the second flow area to a blower area of the blower wheel is 0.05 to 0.25.

8. The blower assembly of claim **7**, wherein the ratio of the total combined flow area of the first flow area and the second flow area to the blower area is 0.05 to 0.15.

9. The blower assembly of claim **7**, wherein the first flow area, the second flow area, and the blower area each lie in a plane perpendicular to the blower axis.

10. The blower assembly of claim **1**, wherein the base portion of the air funnel is rectangular.

11. The blower assembly of claim **10**, wherein:

the air funnel includes a first minor sidewall, a second minor sidewall, a first major sidewall, and a second major sidewall connected to one another to from the base portion;

the first side of the base portion is defined by the first minor sidewall; and

the second side of the base portion is defined by the second minor sidewall.

12. The blower assembly of claim **1**, wherein:

the blower wheel has a diameter;

when viewed in the first direction, the first side of the base portion is disposed a first distance from the outer perimeter of the blower wheel in a second direction that is perpendicular to the first direction and to the first side of the base portion;

when viewed in the first direction, the second side of the base portion is disposed a second distance from the outer perimeter of the blower wheel in the second direction;

a ratio of the first distance to the diameter is 0.05 to 0.15; and a ratio of the second distance to the diameter is 0.05 to 0.15.

13. The blower assembly of claim **12**, wherein:

a maximum dimension of the first flow area in the second direction is equal to the first distance; and

a maximum dimension of the second flow area in the second direction is equal to the second distance.

14. The blower assembly of claim **13**, wherein the first flow area and the second flow area are each circle segment shaped.

15. The blower assembly of claim **1**, further comprising a blower housing in which the blower and air funnel are at least partially arranged, wherein:

the blower housing includes a scroll portion and a branch portion that extends tangentially from the scroll portion; and

the first side of the base portion of the air funnel is disposed adjacent to a scroll exit region of the blower housing at which the branch portion extends from the scroll portion.

16. The blower assembly of claim **15**, wherein the blower and the air funnel are at least partially housed within the scroll portion of the blower housing.

17. The blower assembly of claim **1**, wherein the base portion of the air filter defines a funnel inflow opening via which air is flowable into an inner space of the air funnel.

18. A heating, ventilation, and air conditioning (HVAC) module, comprising the blower assembly of claim **1**.

19. The HVAC module of claim **18**, further comprising a valve assembly connected to the valve assembly and in fluid communication with the blower assembly, wherein the valve assembly includes a filter through which air is flowable into the air funnel.

20. The HVAC module of claim **19**, wherein a length of the base portion of the in a second direction that is perpendicular to the first direction and to the first side of the base portion is less than a length of the filter in the second direction.

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