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(54) QUIET VACUUM CLEANER

(76) Inventors: **Christopher Wayne Murray**, Boise, ID (US); **Richard William Vinson**, Nampa, ID (US); **Michael Shideler**, Boise, ID (US)

Correspondence Address:
PROCOPIO, CORY, HARGREAVES & SAVITCH LLP
530 B STREET
SUITE 2100
SAN DIEGO, CA 92101 (US)

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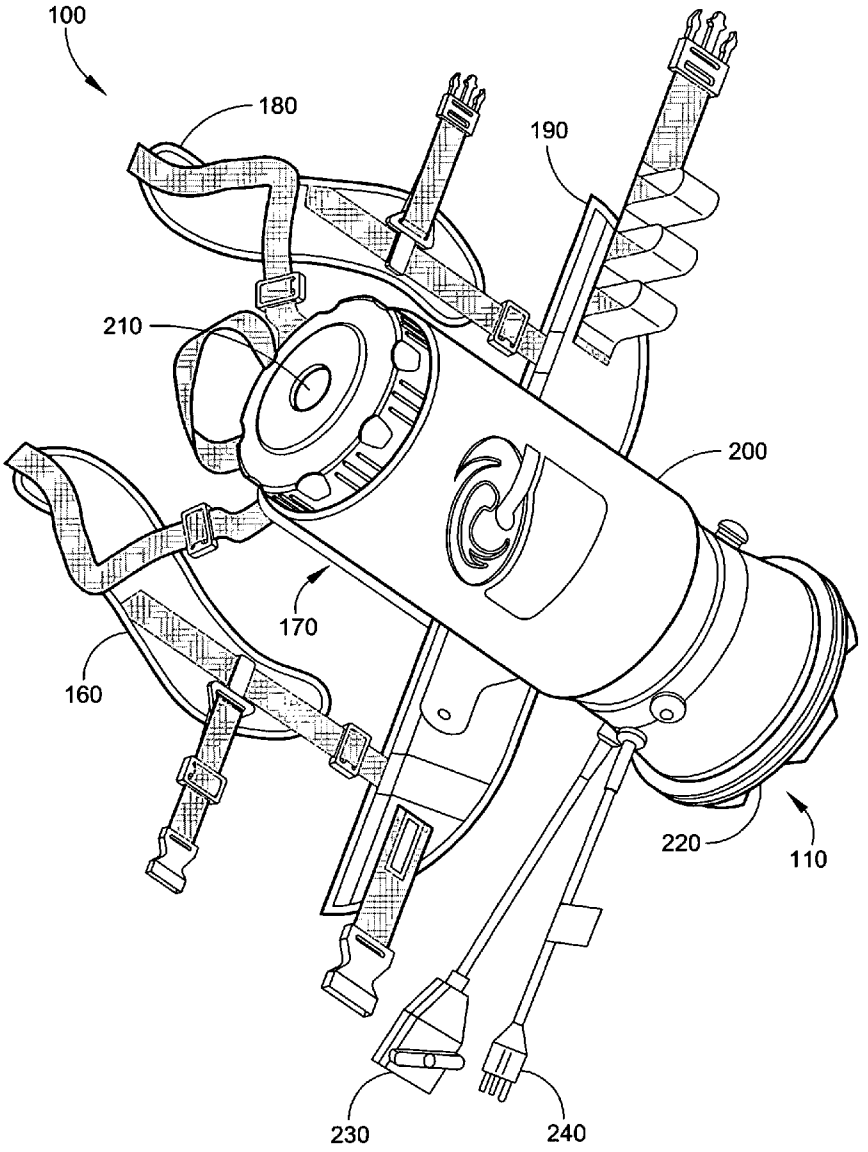
(57) **ABSTRACT**

A light-weight, quiet vacuum cleaner assembly for a back-pack vacuum cleaner includes an air inlet for communicating with a vacuum cleaner hose and a filter; a vacuum motor for drawing air through the vacuum cleaner hose, air inlet, and filter; a quiet exhaust assembly module in communication with the vacuum motor for expelling and quieting exhaust from the vacuum motor, and wherein the vacuum cleaner assembly weighs 2-12 lbs. and includes a flow rate (CFM) to noise (dbA) ratio (flow rate/noise) of at least 0.6.



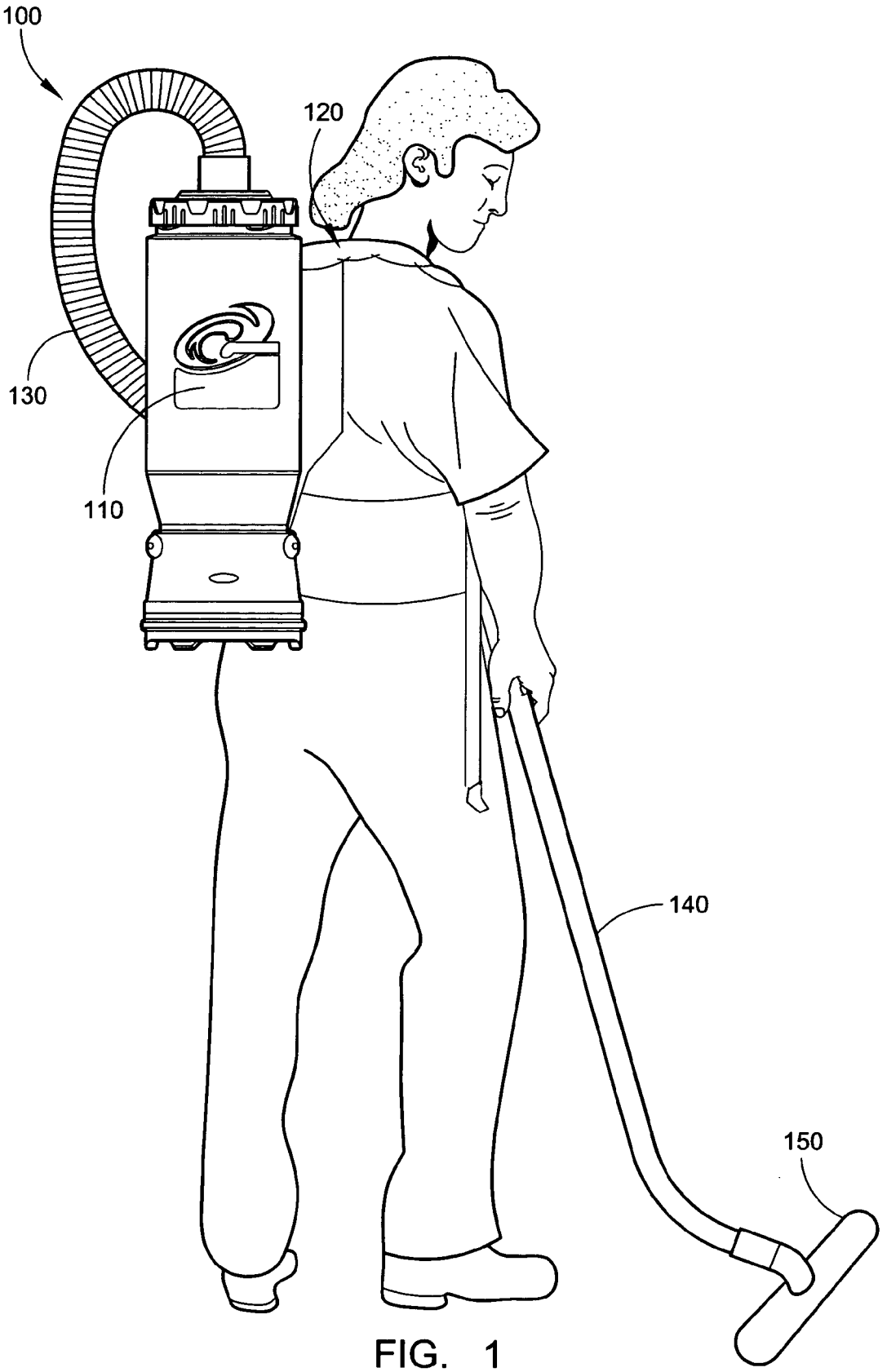


FIG. 1

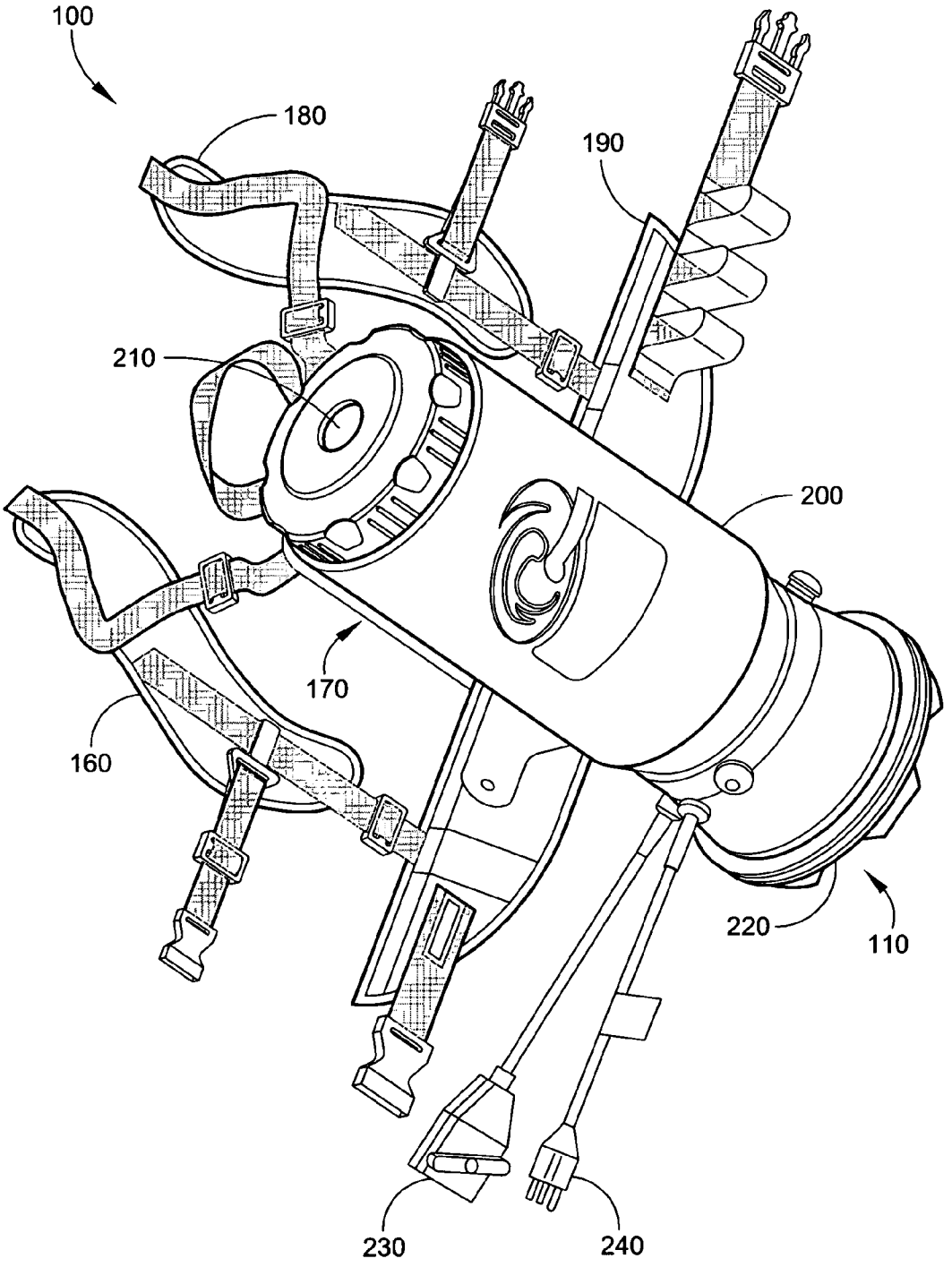


FIG. 2

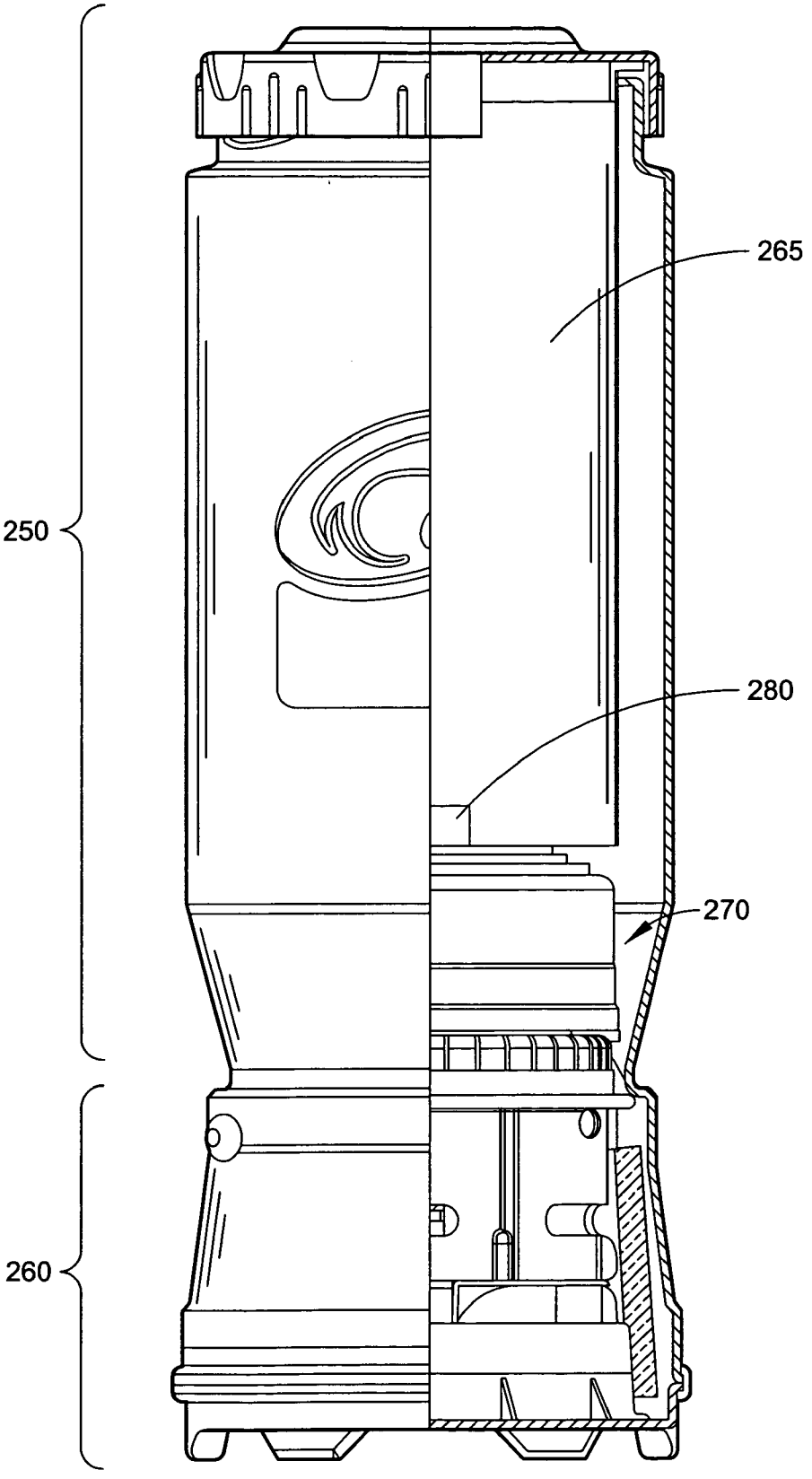


FIG. 3

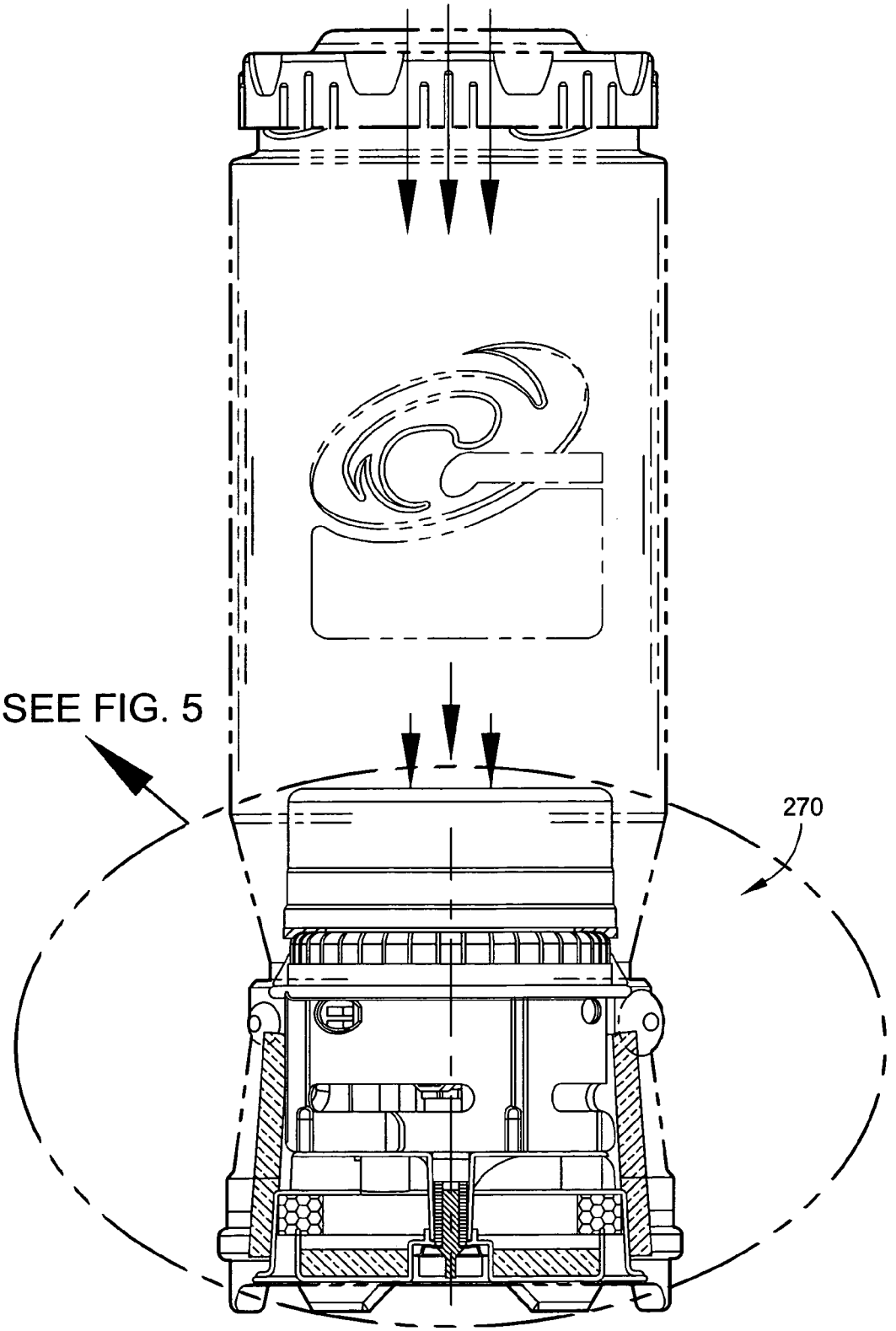


FIG. 4

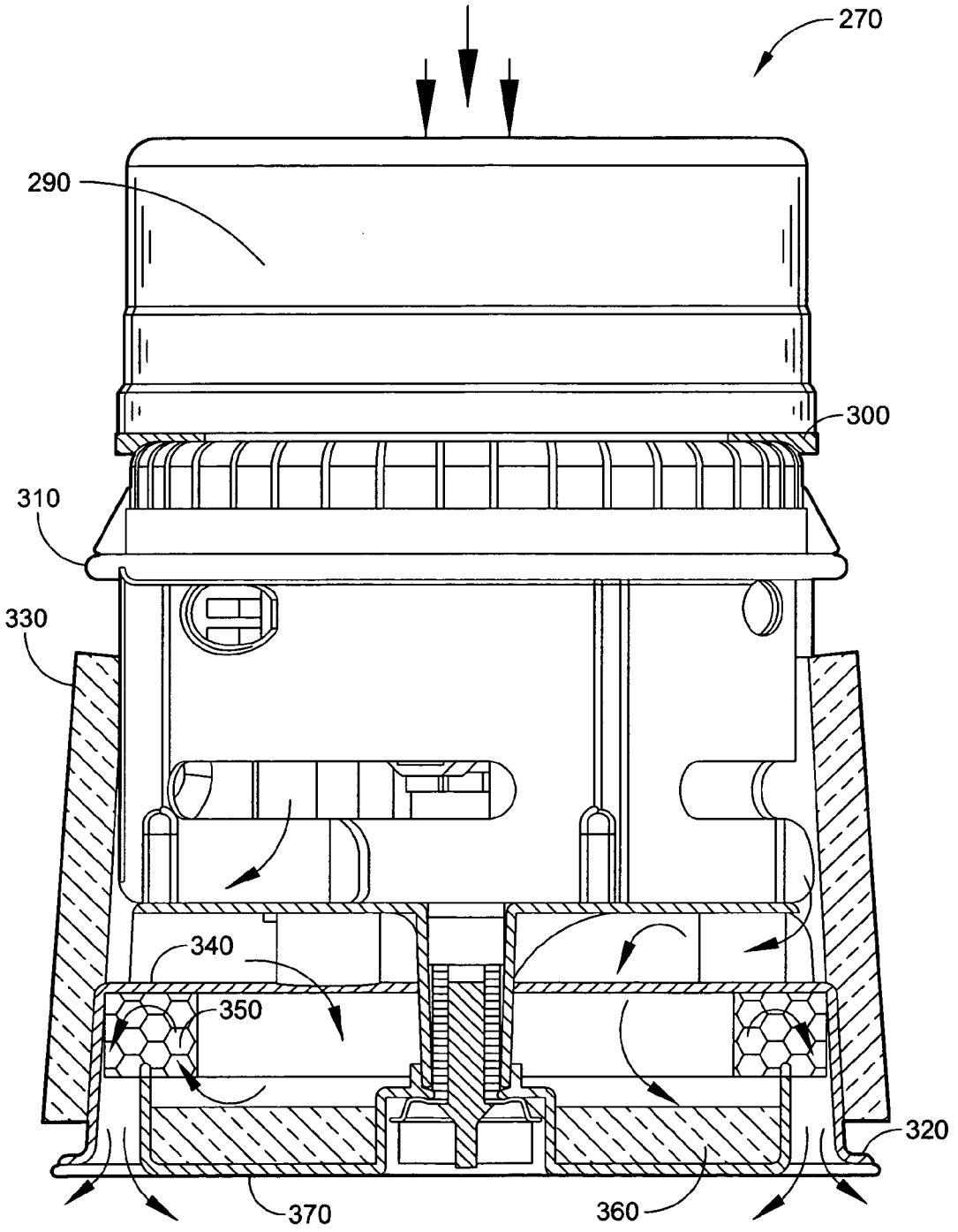


FIG. 5

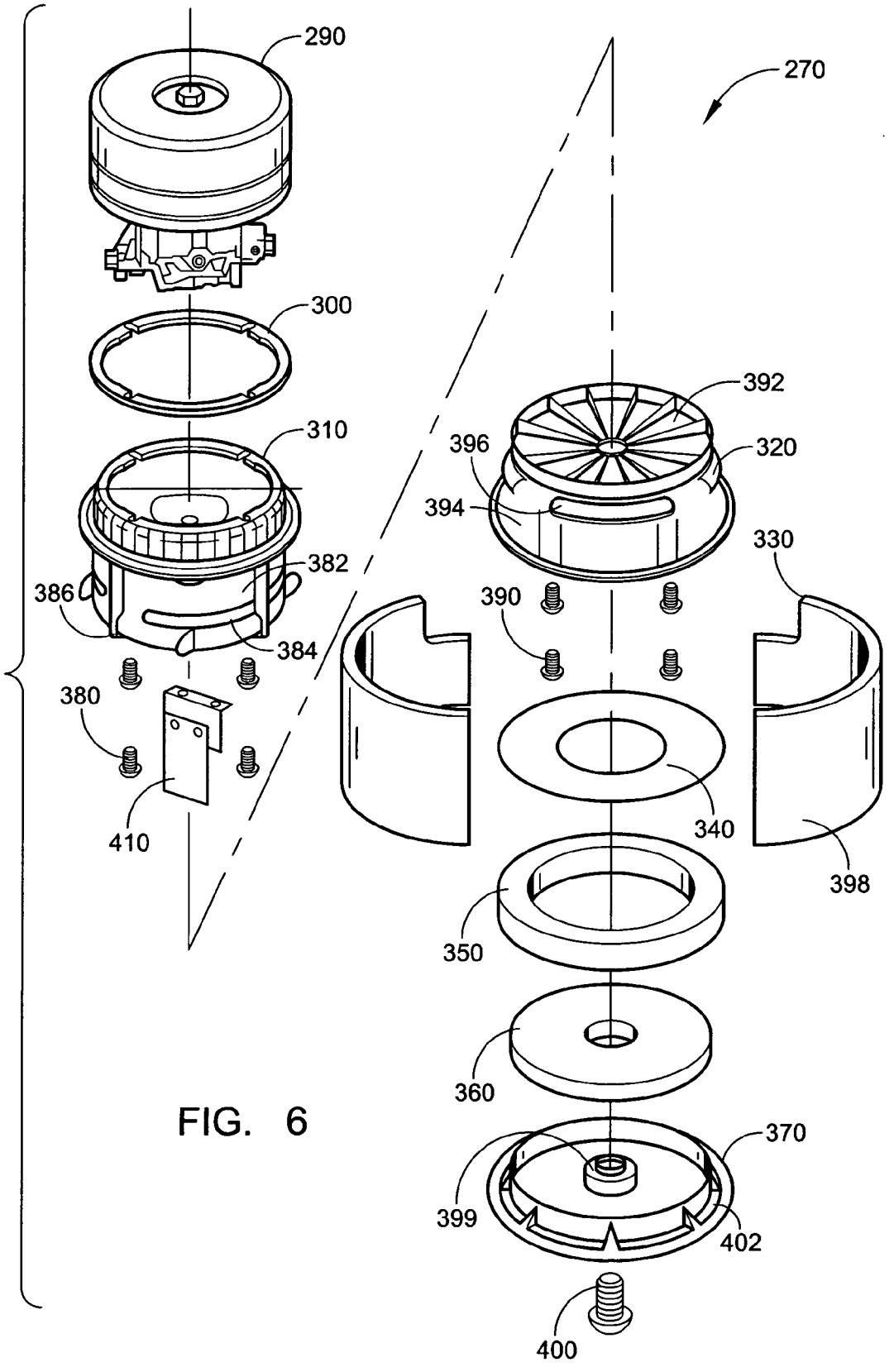

290
270
300
310
392
396
320
394
330
382
386
390
384
380
340
410
398
350
360
370
399
402
400

FIG. 6

QUIET VACUUM CLEANER

BACKGROUND

[0001] 1. Field of the Invention

[0002] The present invention relates, in general, to vacuum cleaners, and, in particular, to backpack vacuum cleaners.

[0003] 2. Background of the Invention

[0004] It is well-known that vacuum cleaning efficiency has been improved through the use of backpack vacuum cleaners. A backpack vacuum cleaner includes a backpack assembly, similar to that used in a hiking backpack, where the vacuum cleaner assembly is carried by a backpack frame of the backpack assembly. A vacuum cleaner hose extends from a top of the vacuum cleaner assembly and is connected to a vacuum cleaner wand. A distal end of the vacuum cleaner wand includes a vacuum cleaner floor tool. In use, the cleaner carries the backpack vacuum cleaner on his or her back using the backpack assembly, and directs the vacuum cleaner tool for cleaning the floor surface through the wand. Historically, much of the cleaning performed using backpack vacuum cleaners such as that done in office buildings or other commercial settings was done at night time, by night-time cleaning personnel and janitors. Noise made by the backpack vacuum cleaners was not that big of an issue because most workers and visitors were not present during the vacuum cleaning, so the noise would not bother workers in the office buildings or other commercial settings. However, more recently, there is a trend to clean during the daytime, when workers and visitors in the office buildings or other commercial settings are present. One of the complaints by workers and visitors in the office buildings or other commercial settings of vacuum cleaning is the noise. The noise sources are noises associated with the motor and air movement noise at the vacuum tools and exhaust.

[0005] Motor noise has been addressed in the past by placing sound absorbing materials in the flow path. This reduces the system performance to an unacceptable level and adds weight to the vacuum cleaner. By restricting the flow path in this manner the motor is susceptible to overheating because it is not getting sufficient air for cooling.

[0006] Therefore, a need exists for a vacuum cleaner, especially a backpack vacuum cleaner, that overcomes the problems with prior art vacuum cleaners, especially the problems with prior art backpack vacuum cleaners.

SUMMARY

[0007] The backpack vacuum cleaner of the present invention is light-weight and significantly reduces the noise levels associated with the motor and air movement noise at the vacuum tools and exhaust while maintaining good system performance. The vacuum cleaner maintains large cross-sectional areas for exhaust flow, allowing sufficient air flow to provide the required cooling for the motor. The vacuum cleaner also directs the air flow to unique foam surfaces to obtain the required sound deadening.

[0008] An aspect of the invention involves a light-weight, quiet vacuum cleaner assembly for a backpack vacuum cleaner including a backpack assembly for carrying the vacuum cleaner assembly on a user's back, a vacuum cleaner hose for vacuuming debris from a surface, and a filter for filtering out vacuumed debris. The light-weight, quiet vacuum cleaner assembly includes an air inlet for communicating with the vacuum cleaner hose and the filter; a vacuum motor for drawing air through the vacuum cleaner hose, air inlet, and filter; a quiet exhaust assembly module in communication with the vacuum motor for expelling and quieting exhaust from the vacuum motor, and wherein the vacuum cleaner assembly weighs 2-12 lbs. and includes a flow rate (CFM) to noise (dbA) ratio (flow rate/noise) of at least 0.6.

[0009] Another aspect of the invention involves a light-weight, quiet vacuum cleaner assembly for a backpack vacuum cleaner including a backpack assembly for carrying the vacuum cleaner assembly on a user's back, a vacuum cleaner hose for vacuuming debris from a surface, and a filter for filtering out vacuumed debris. The light-weight, quiet vacuum cleaner assembly includes an air inlet for communicating with the vacuum cleaner hose and the filter; a vacuum motor for drawing air through the vacuum cleaner hose, air inlet, and filter; a quiet exhaust assembly module in communication with the vacuum motor for expelling and quieting exhaust from the vacuum motor, and wherein the vacuum cleaner assembly weighs 2-12 lbs. and includes a suction (in. (H_2O)) to noise (dbA) ratio (suction/noise) of at least 0.6.

[0010] Another aspect of the invention involves a light-weight, quiet vacuum cleaner assembly for a backpack vacuum cleaner including a backpack assembly for carrying the vacuum cleaner assembly on a user's back, a vacuum cleaner hose for vacuuming debris from a surface, and a filter for filtering out vacuumed debris. The light-weight, quiet vacuum cleaner assembly includes an air inlet for communicating with the vacuum cleaner hose and the filter, the air inlet including an intake area; a vacuum motor for drawing air through the vacuum cleaner hose, air inlet, and filter; a quiet exhaust assembly module in communication with the vacuum motor for expelling and quieting exhaust from the vacuum motor, and wherein the quiet exhaust assembly module includes a stage of exhaust openings having a total area and the ratio of the total area of the stage of exhaust openings to the intake area of the air inlet is at least 3:1.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The details of the present invention, both as to its structure and operation, may be gleaned in part by the accompanying drawings, in which like reference numerals refer to like parts, and in which:

[0012] FIG. **1** is a perspective view of an embodiment of a quiet backpack vacuum cleaner with a vacuum cleaner hose, vacuum cleaner wand, and vacuum cleaner floor tool attached and the quiet backpack vacuum cleaner shown in use on the back of a user;

[0013] FIG. **2** is perspective view of the backpack vacuum cleaner of FIG. **1**;

[0014] FIG. **3** is front elevational view of the backpack vacuum cleaner of FIG. **1** with the back strap system, power cord assembly, two-speed switch assembly, and paper filter bag hidden for clarity;

[0015] FIG. **4** is a front elevational view of a quiet exhaust assembly of the backpack vacuum cleaner with the rest of the backpack vacuum cleaner shown in phantom;

[0016] FIG. **5** is an enlarged front elevational view of the quiet exhaust assembly module of FIG. **4** with the exhaust air flow path shown; and

[0017] FIG. **6** is an exploded perspective view of the quiet exhaust assembly module of FIGS. **4** and **5**.

DETAILED DESCRIPTION

[0018] With reference to FIGS. **1-6**, and initially FIGS. **1-3**, an embodiment of a quiet backpack vacuum cleaner **100** will be described.

[0019] Although the quiet vacuum cleaner **100** is shown and described as a backpack vacuum cleaner, the features of the vacuum cleaner **100** that make it a quiet, high-performance vacuum cleaner may be applied to additional types of vacuum cleaners such as, but not by way of limitation, canister vacuum cleaners and upright vacuum cleaners.

[0020] After reading this description it will become apparent to one skilled in the art how to implement the invention in various alternative embodiments and alternative applications. However, although various embodiments of the present invention will be described herein, it is understood that these embodiments are presented by way of example only, and not limitation. As such, this detailed description of various alternative embodiments should not be construed to limit the scope or breadth of the present invention as set forth in the appended claims.

[0021] With reference to FIG. **1**, the quiet backpack vacuum cleaner **100** includes a vacuum cleaner assembly **110** that is carried on a user's back via a backpack assembly **120**. A vacuum cleaner hose **130** extends from a top of the vacuum cleaner assembly **110** and is connected to a vacuum cleaner wand **140**. A distal end of the vacuum cleaner wand **140** includes a vacuum cleaner floor tool **150**, which engages the carpet or other floor surface for cleaning the same.

[0022] With reference additionally to FIG. **2**, the backpack assembly **120** includes a backpack strap system **160** connected to a vacuum cleaner support **170**, which carries the vacuum cleaner assembly **110**. The backpack strap system **160** includes shoulder straps **180** and a waist belt **190**.

[0023] The vacuum cleaner assembly **110** includes a main housing assembly **200**, a top cap hose and air inlet **210** at a top end, and an opposite exhaust end **220**. A two-speed switch assembly with switch box **230** and a power cord assembly **240** are connected to a lower electrical section **260** (FIG. **3**) of the vacuum cleaner assembly **110** through respective cords.

[0024] With reference additionally to FIG. **3**, the vacuum cleaner assembly **110** includes an upper filter section **250** and a lower electrical section **260**. The upper filter section **250** includes an intake filter and refuse bag **265**, and a motor intake filter **280**. A lower portion of the upper filter section **250** and the lower electrical section **260** carry a quiet exhaust assembly module **270**.

[0025] With reference to FIGS. **4-6**, an embodiment of the quiet exhaust assembly module **270** will be described in more detail. The quiet exhaust assembly module **270** includes a vacuum motor **290**, an annular gasket **300**, a motor housing **310**, a quiet module housing **320**, acoustic panel **330**, an annular director plate **340**, an annular foam air diffuser **350**, an annular acoustic panel **360**, and a quiet module cap **370**. Each of these quiet exhaust assembly module components will now be described in turn below.

[0026] The vacuum motor **290** is a two-stage vacuum motor having a cylindrical head with an underside.

[0027] The annular gasket **300** is a neoprene gasket with an adhesive on one side. The annular gasket **300** is disposed between the underside of the cylindrical head of the vacuum motor **290** and an upper surface of the motor housing **310**.

[0028] Threaded fasteners **380** are used to attach the vacuum motor **290** to the motor housing **310**.

[0029] The motor housing **310** has a generally cylindrical wall **382** with Stage 1 elongated lateral slots **384** near a bottom of the motor housing **310**. In the embodiment shown, the motor housing **310** includes four (4) Stage 1 slots **384** with three (3) of the slots having a dimension of 3.25 in.×0.5 in. (3 Slots @ 3.25"×0.5"=4.875 sq. in.), and the last slot having a dimension of 2.25 in.×1.0 in. (1 Slot @ 2.25"×1.0"=2.25 sq. in.). Stage 1 air flow occurs through these slots **384**. The total area of the Stage 1 slots **384** is 4.875 sq. in.+2.25 sq. in.=7.125 sq. in. The bottom of the motor housing **310** includes a plurality of ribs **386** extending outwardly from the wall **382**. The ribs **386** include threaded bosses.

[0030] Threaded fasteners **390** threadably engage the threaded bosses of the ribs **386** to attach the quiet module housing **320** to the motor housing **310**.

[0031] The quiet module housing **320** includes a top surface **392** with star-shaped, radiating ridges extending therefrom. The top surface **392** of the quiet module housing **320** forms the bottom or floor of the motor housing **310** when the quiet module housing **320** is connected to the motor housing **310**. The quiet module housing **320** has a frustoconical wall **394** with Stage 2 elongated lateral slots **396** near a top of the quiet module housing **320**. In the embodiment shown, the quiet module housing **320** includes four (4) Stage 2 slots **396** having a dimension of 3.00 in.×0.5 in. (4 Slots @ 3.00"×0.5"=6.0 sq. in.). Stage 2 air flow occurs through these slots **396**. As indicated above, the total area of the Stage 2 slots **396** is 6.0 sq. in.

[0032] The acoustic panel **330** includes two half-cylindrical members with an outer surface **398**. The acoustic panel **330** is made of a unique, light-weight, high-temperature, fire-retardant foam material. The foam material is produced in flat sheets. An adhesive is added to a side of a flat 0.032 in. polycarbonate sheet, and the polycarbonate sheet is laminated to a side of the flat sheet of foam material. Two flat sheets of foam material and polycarbonate are bent into the half-cylinder configuration shown, with the polycarbonate sheet on the outer side of the acoustic panel **330**. The two half-cylindrical members are placed together to form a cylinder around the quiet exhaust assembly module **270**, as shown in FIG. **5**. The hoop stress in the polycarbonate sheet and acoustic panel **330** cause the acoustic panel **330** to be held in place over the motor housing **310**, quiet module housing **320**, annular director plate **340**, annular foam air diffuser **350**, annular acoustic panel **360**, and quiet module cap **370** without any adhesive. The unique, light-weight, high-temperature, fire-retardant foam material of the acoustic panel **330** provides maximum attenuation of the sound waves in the quiet exhaust assembly module **270**. The foam material used in the acoustic panels **330** is a high-perfor-

mance polyimide foam sold as type HT-**340** under the name Solimide® by INSPEC FOAMS, INC. of Plano, Tex. For mechanical properties, the foam material has a density (ASTM D 3574, Test A) of 0.4 lb/ft^3, and a tensile strength (ASTM D 3574, Test E) of 7 lb/in^2. For thermal properties, the foam material has a thermal conductivity (ASTM C 518 at mean temperature of 75° F.) of 0.32 (BTU·in)/(hr·ft^3·° F.), and a continuous use temperature (recommended maximum) of 575° F. For flammability properties, the foam material has a radiant panel flame spread index (ASTM E 162) of 1, a non-flaming specific optical density (ASTM E 662) of smoke of 1, a flaming specific optical density of smoke (ASTM E 662) of 3, a flame spread index (ASTM E 84-95, Tested at a thickness of 22 mm (0.9 in.)) of 0, a smoke developed index (ASTM E 84-95, Tested at a thickness of 22 mm (0.9 in.)) of 10. For steam autoclave aging properties (ASTM D 3574, Test J, Procedure J, and Test E), the foam material has a tensile strength retained of greater than 85% and a change in weight and dimensions of less than 3%. For acoustic properties, the foam material has the following acoustical absorption coefficients (sabins/ft^2; ASTM C 423 and E 795, Type A Mounting) at 1 in.: 0.08 at 125 Hz, 0.22 at 250 Hz, 0.58 at 500 Hz, 0.93 at 1000 Hz, 0.94 at 2000 Hz, 0.81 at 4000 Hz. The foam material has the following acoustical absorption coefficients (sabins/ft^2; ASTM C 423 and E 795, Type A Mounting) at 2 in.: 0.34 at 125 Hz, 0.52 at 250 Hz, 0.86 at 500 Hz, 1.06 at 1000 Hz, 0.85 at 2000 Hz, 0.94 at 4000 Hz.

[**0033**] The annular director plate **340** is a thin, annular sheet of polycarbonate material that serves as a barrier and directs air flow towards the center of the quiet exhaust assembly module **270**.

[**0034**] The annular foam air diffuser **350** serves to break up some line of sight in the quiet exhaust assembly module **270** and attenuate the air flow sound waves. The annular foam air diffuser **350** is made of a reticulated flexible polyester urethane foam that has a completely open cell, three-dimensional structure of skeletal strands which give them special filtering properties. The foam material used in the diffuser **350** is sold as 20 PPI, SIF Z under the name FOAMEX® by Foamex Technical Products of Eddystone, Pa. The homogeneous structure of the diffuser **350** helps minimize the possibility of open channels which could drastically affect filter efficiency. Each cell in the medium is completely interconnected with all surrounding cells. This allows for free passage of air and at the same time provides high surface-area contact for impingement of dust particles. The resilience and strength of the diffuser **350** helps prevent and strand displacement under normal operating conditions. In the embodiment shown, the diffuser **350** includes a 20 pore size (average number of pores-per-linear-inch). At this porosity, the diffuser **350** includes a density of 1.9 lb/ft3, a tensile strength of 25 psi, an ultimate elongation of 320%, a tear strength of 5.5 lb/in., a 50% compression set of 7, a 25% compression deflection of 0.42 psi, and a 65% compression deflection of 0.67 psi. The diffuser **350** has excellent high-temperature characteristics. It can withstand intermittent temperatures as high as 225° F. At temperatures above 500° F., the material beings to melt with decomposition and vaporization.

[**0035**] The annular acoustic panel **360** is made of the same material as the acoustic panel **330** described. The above description of the material used in the acoustic panel **330** is incorporated by reference here as though set forth in full.

[**0036**] The quiet module cap **370** includes a circular dish-like configuration with an annular recess that receives the acoustic panel **360**. A central boss **399** receives threaded fastener **400** to mount the quiet module cap **370** and hold the intermittent components of the quiet module housing **320** together. The quiet module cap **370** is made of a polycarbonate material and includes eight (8) Stage 3 slots **402** having a dimension of 2.0 in.×0.36 in. (8 Slots @ 2.00"×0.36 in =5.76 sq. in.). Stage 3 air flow occurs through these slots **402**. As indicated above, the total area of the Stage 3 slots **402** is 5.76 sq. in. The quiet module cap **370** and threaded fastener **400** allow the quiet exhaust assembly module **270** to be easily field serviced. To service the quiet exhaust assembly module **270**, a user simply unscrews the threaded fastener **400**, and removes the quiet module cap **370**. This provides easy access to the components of the quiet exhaust assembly module **270** for repair or replacement of the components. The entire quiet exhaust assembly module **270** can also be easily replaced in this manner. As a result, the backpack vacuum cleaner **100** is never down because of something in the quiet exhaust assembly module **270** of the backpack vacuum cleaner **100**.

[**0037**] A motor control module **410** is electrically coupled to the vacuum motor **290**, two-speed switch assembly with switch box **230**, and power cord assembly **240**. The motor control module **410** provides two-speed control of the vacuum motor **290**. The motor control module **410** also includes a thermal protection device for shutting off the vacuum motor **290** when the temperature exceeds approximately 95° C.

[**0038**] The backpack vacuum cleaner **100** will now be described in use. When the user is in the area desired for vacuuming, the user dons the backpack vacuum cleaner **100** using the backpack strap system **160** in the same manner as putting on a backpack for hiking. This is easily performed because the backpack vacuum cleaner **100** is light-weight (2-12 lbs.). In the embodiment shown, the vacuum cleaner assembly **110** weighs 11 lbs., 3 oz. The user's arms are placed through the shoulder straps **180** and the shoulder straps **180** are tightened to a snug, yet comfortable condition on the user's shoulders. The waist belt **190** is clipped together, and tightened to a snug, yet comfortable condition around the user's waist. Prior to or after donning the backpack vacuum cleaner **100**, the plug of the power cord assembly **240** is plugged into an electrical outlet. In an embodiment of the backpack vacuum cleaner **100** where the backpack vacuum cleaner **100** has an onboard power source (e.g., one or more batteries, fuel cells), plugging the power cord assembly **240** into an electrical outlet to power the backpack vacuum cleaner **100** may not be necessary. The backpack vacuum cleaner **100** is switched on using the two-speed switch assembly **230**. The two-speed switch assembly **230** is also used to control the speed of the vacuum motor **290** between a high setting and low setting. In alternative embodiments, the backpack vacuum cleaner **100** may have a number of settings other than two settings (e.g., 1, 3, 4, etc.).

[**0039**] In the embodiment shown, the backpack vacuum cleaner **100** performs (about 70 CFM with about 70 in. (H_2O) of lift @ about 65 dbA on a high-speed motor setting,

and about 40 CFM with about 40 in. (H_2O) of lift @ about 61 dbA on a low-speed motor setting. In a preferred embodiment, the backpack vacuum cleaner **100** includes a flow rate (CFM) to noise (dbA) ratio (flow rate/noise) of at least 0.6 and a suction (in. (H_2O)) to noise (dbA) ratio (suction/noise) of at least 0.6. In a more preferred embodiment, the backpack vacuum cleaner **100** includes a flow rate (CFM) to noise (dbA) ratio (flow rate/noise) of at least 1.0 and a suction (in. (H_2O)) to noise (dbA) ratio (suction/noise) of at least 1.0.

[**0040**] With the vacuum motor **290** activated, air, dirt, and debris are drawn through the vacuum cleaner floor tool **150**, vacuum cleaner wand **140**, vacuum cleaner hose **130**, and air inlet **210** into the intake filter/refuse bag **265** (FIG. **3**). The dirt and debris is collected by the intake filter/refuse bag **265** and air is drawn through the motor intake filter **280** and the vacuum motor **290**. Exhaust air is expelled out of the bottom of the vacuum motor **290**, and into the motor housing **310**. The exhaust air reflects off of and is directed radially outward along the star-shaped, radiating ridges on the top surface **392**. The exhaust air exits the motor housing **310** through the Stage 1 slots **396**. The exhaust air reflects off of the acoustic panel **330**, dampening the sound level, around the bottom of the motor housing **310** and top of the quiet module housing **320**, and into/through the Stage 2 slots **396** of the quiet module housing **320**. The air then flows downward towards the director plate **340**, and the director plate **340** directs the air flow radially inward and down towards the acoustic panel **360**. Air flow reflects off of the acoustic panel **360**, further dampening the sound level, and outward through the air diffuser foam **350**. The air diffuser foam **350** filters out exhaust particulates in the exhaust air flow and further dampens the sound levels without significantly impeding air flow. The exhaust air impinges the acoustic panel **410** as it exits the air diffuser foam. The exhaust air then flows downward, through the stage 3 slots **402**, and out of the quiet exhaust assembly module **270**.

[**0041**] With reference to FIGS. **2**, **5**, and **6**, the air inlet **210** has a 1.5 in. intake diameter and an intake area of 1.77 sq. in. As indicated above, the total bypass area for the Stage 1 slots **384** is 7.125 sq. in., the total bypass area for the Stage 2 slots **396** is 6.0 sq. in., and the total bypass area for the Stage 3 slots **402** is 5.76 sq. in. The inventors have determined that it is desirable for the bypass areas in each stage of the quiet exhaust assembly module **270** to be at least 3 times that of the area of the air inlet **210**. This reduces friction and, thus, minimizes flow loss.

[**0042**] The exhaust assembly module **270** incorporates the principles of "Line of Sight" and non-reflective surfaces to diminish sound levels (db). In the quiet exhaust assembly module **270**, the vacuum motor **290** is encapsulated in a housing, and air flow is directed to high-temperature acoustic foam covered surfaces and through a condensed labyrinth of passages.

[**0043**] The above features minimize the weight of the backpack vacuum cleaner **100**, maximize dissipation of sound levels in the backpack vacuum cleaner **100**, and maximize air flow in the backpack vacuum cleaner **100**.

[**0044**] The above description of the disclosed embodiments is provided to enable any person skilled in the art to make or use the invention. Various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles described herein can be applied to other embodiments without departing from the spirit or scope of the invention. Thus, it is to be understood that the description and drawings presented herein represent a presently preferred embodiment of the invention and are therefore representative of the subject matter which is broadly contemplated by the present invention. It is further understood that the scope of the present invention fully encompasses other embodiments that may become obvious to those skilled in the art and that the scope of the present invention is accordingly limited by nothing other than the appended claims.

What is claimed is:

1. A light-weight, quiet vacuum cleaner assembly for a backpack vacuum cleaner including a backpack assembly for carrying the vacuum cleaner assembly on a user's back, a vacuum cleaner hose for vacuuming debris from a surface, and a filter for filtering out vacuumed debris, comprising:

an air inlet for communicating with the vacuum cleaner hose and the filter;

a vacuum motor for drawing air through the vacuum cleaner hose, air inlet, and filter;

a quiet exhaust assembly module in communication with the vacuum motor for expelling and quieting exhaust from the vacuum motor,

wherein the vacuum cleaner assembly weighs 2-12 lbs. and includes a flow rate (CFM) to noise (dbA) ratio (flow rate/noise) of at least 0.6.

2. The light-weight, quiet vacuum cleaner assembly of claim 1, wherein the vacuum cleaner assembly includes a flow rate (CFM) to noise (dbA) ratio (flow rate/noise) of at least 1.0.

3. The light-weight, quiet vacuum cleaner assembly of claim 1, wherein the vacuum cleaner assembly includes a suction (in. (H_2O)) to noise (dbA) ratio (suction/noise) of at least 0.6.

4. The light-weight, quiet vacuum cleaner assembly of claim 3, wherein the vacuum cleaner assembly includes a suction (in. (H_2O)) to noise (dbA) ratio (suction/noise) of at least 1.0.

5. A light-weight, quiet vacuum cleaner assembly for a backpack vacuum cleaner including a backpack assembly for carrying the vacuum cleaner assembly on a user's back, a vacuum cleaner hose for vacuuming debris from a surface, and a filter for filtering out vacuumed debris, comprising:

an air inlet for communicating with the vacuum cleaner hose and the filter, the air inlet including an intake area;

a vacuum motor for drawing air through the vacuum cleaner hose, air inlet, and filter;

a quiet exhaust assembly module in communication with the vacuum motor for expelling and quieting exhaust from the vacuum motor,

wherein the quiet exhaust assembly module includes a stage of exhaust openings having a total area and the ratio of the total area of the stage of exhaust openings to the intake area of the air inlet is at least 3:1.

6. The light-weight, quiet vacuum cleaner assembly of claim 5, wherein the quiet exhaust assembly module includes a motor housing with the stage of exhaust openings therein.

7. The light-weight, quiet vacuum cleaner assembly of claim 5, wherein the quiet exhaust assembly module includes a second stage of exhaust openings having a total area and the ratio of the total area of the second stage of exhaust openings to the intake area of the air inlet is at least 3:1.

8. The light-weight, quiet vacuum cleaner assembly of claim 7, wherein the quiet exhaust assembly module includes a quiet module housing with the second stage of exhaust openings therein.

9. The light-weight, quiet vacuum cleaner assembly of claim 5, wherein the quiet exhaust assembly module includes a third stage of exhaust openings having a total area and the ratio of the total area of the third stage of exhaust openings to the intake area of the air inlet is at least 3:1.

10. The light-weight, quiet vacuum cleaner assembly of claim 9, wherein the quiet exhaust assembly module includes a quiet module cap with the third stage of exhaust openings therein.

11. The light-weight, quiet vacuum cleaner assembly of claim 5, wherein the vacuum cleaner assembly weighs 2-12 lbs. and includes a flow rate (CFM) to noise (dbA) ratio (flow rate/noise) of at least 0.6.

12. The light-weight, quiet vacuum cleaner assembly of claim 5, wherein the vacuum cleaner assembly weighs 2-12 lbs. and includes a flow rate (CFM) to noise (dbA) ratio (flow rate/noise) of at least 1.0.

13. The light-weight, quiet vacuum cleaner assembly of claim 5, wherein the vacuum cleaner assembly weighs 2-12 lbs. and includes a suction (in. (H_2O)) to noise (dbA) ratio (suction/noise) of at least 0.6.

14. The light-weight, quiet vacuum cleaner assembly of claim 5, wherein the vacuum cleaner assembly weighs 2-12 lbs. and includes a suction (in. (H_2O)) to noise (dbA) ratio (suction/noise) of at least 1.0.

15. The light-weight, quiet vacuum cleaner assembly of claim 5, wherein the quiet exhaust assembly module includes a light-weight, high-temperature, fire retardant foam material having a density no greater than 0.4 lb/ft^3 to attenuate the exhaust sound.

16. The light-weight, quiet vacuum cleaner assembly of claim 15, wherein the light-weight, high-temperature, fire retardant foam material is a high-performance polyimide foam.

17. The light-weight, quiet vacuum cleaner assembly of claim 5, wherein the quiet exhaust assembly module includes a light-weight foam air diffuser having a density no greater than 1.9 lb/ft^3 to attenuate the exhaust sound and filter out exhaust particles.

18. The light-weight, quiet vacuum cleaner assembly of claim 17, wherein the light-weight foam air diffuser is a reticulated flexible polyester urethane foam.

19. The light-weight, quiet vacuum cleaner assembly of claim 5, wherein the quiet exhaust assembly module includes an outer acoustic panel surrounding substantially all of the quiet exhaust assembly module, the acoustic panel including an outer surface with a polycarbonate sheet laminated thereto, and the polycarbonate sheet including hoop stress therein that causes the acoustic panel to be held in place, surrounding substantially all of the quiet exhaust assembly module, without any adhesive.

20. A light-weight, quiet vacuum cleaner assembly for a backpack vacuum cleaner including a backpack assembly for carrying the vacuum cleaner assembly on a user's back, a vacuum cleaner hose for vacuuming debris from a surface, and a filter for filtering out vacuumed debris, comprising:

an air inlet for communicating with the vacuum cleaner hose and the filter;

a vacuum motor for drawing air through the vacuum cleaner hose, air inlet, and filter;

a quiet exhaust assembly module in communication with the vacuum motor for expelling and quieting exhaust from the vacuum motor,

wherein the vacuum cleaner assembly weighs 2-12 lbs. and includes a suction (in. (H_2O)) to noise (dbA) ratio (suction/noise) of at least 0.6.

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