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[54] CENTRAL VACUUM WITH ACOUSTICAL DAMPING

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[51] **Int. Cl.**^{6} **A47L 5/38**

[52] **U.S. Cl.** **15/326**; 15/314; 15/413; 55/276

[58] **Field of Search** 15/326, 314, 327.1, 15/413; 55/276

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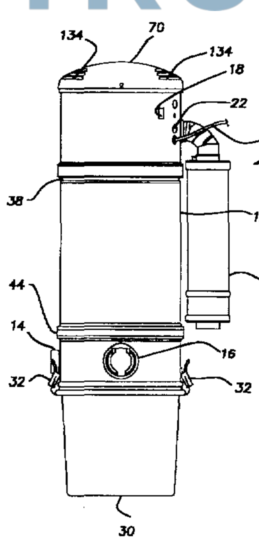
Primary Examiner—Chris K. Moore

Attorney, Agent, or Firm—Pearne, Gordon, McCoy & Granger LLP

[57] **ABSTRACT**

A central vacuum unit having an acoustic damping system is provided. The central vacuum unit includes a canister having a sidewall forming a hollow interior and a lid closing an end of the sidewall, a vacuum motor within the canister which emits noise during operation, at least one cooling air inlet for admitting cooling air into the hollow interior, and at least one cooling air outlet in the sidewall for exhausting the cooling air from the hollow interior. Additionally, the sidewall has an exhaust port and the motor has an exhaust pipe extending through the exhaust port. The acoustic damping system includes an acoustic damping tunnel, an acoustic damping canopy, and an exhaust port seal. The acoustic damping tunnel is within the hollow interior and forms a pathway between the hollow interior and the cooling air outlet. The pathway is lined with a sound absorbing material so that the tunnel reduces noise emitted from the hollow interior through the cooling outlet. The acoustic damping canopy is attached to the canopy over the cooling air inlet. The canopy has an inlet and forms a serpentine pathway between the canister cooling air inlet and said canopy inlet to reduce noise emitted from the hollow interior through the canister cooling air inlet. The exhaust port seal covers the exhaust port to reduce noise emitted from the hollow interior through the exhaust port. The exhaust port seal preferably includes flexible foam bonded to the canister sidewall.

27 Claims, 4 Drawing Sheets



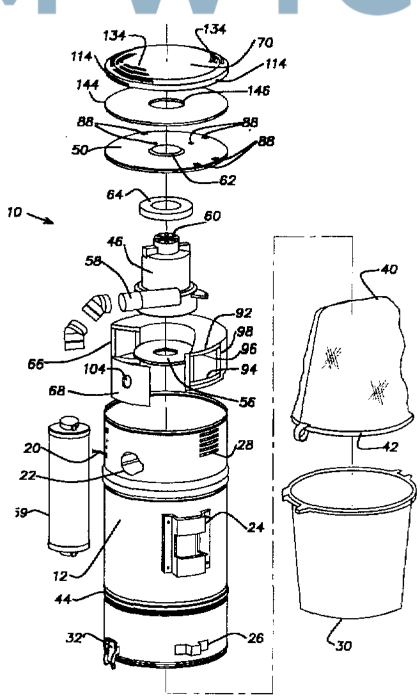


Fig.1

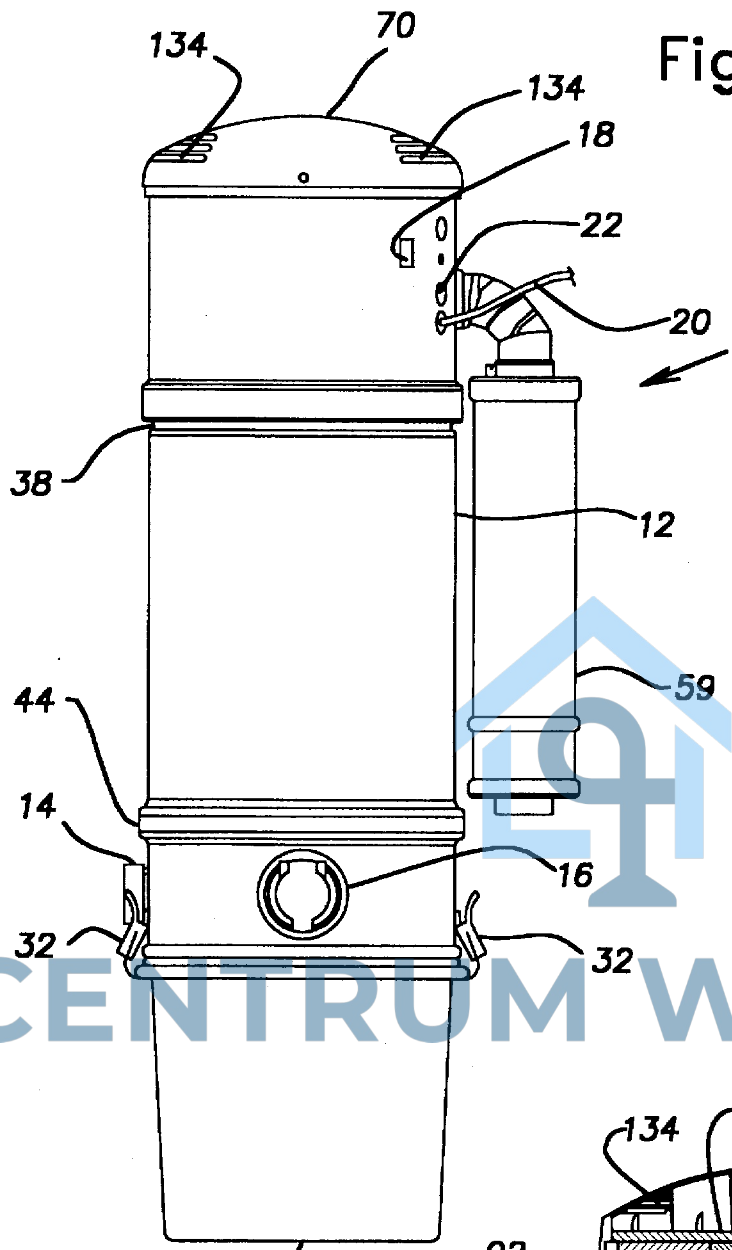

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Fig.2

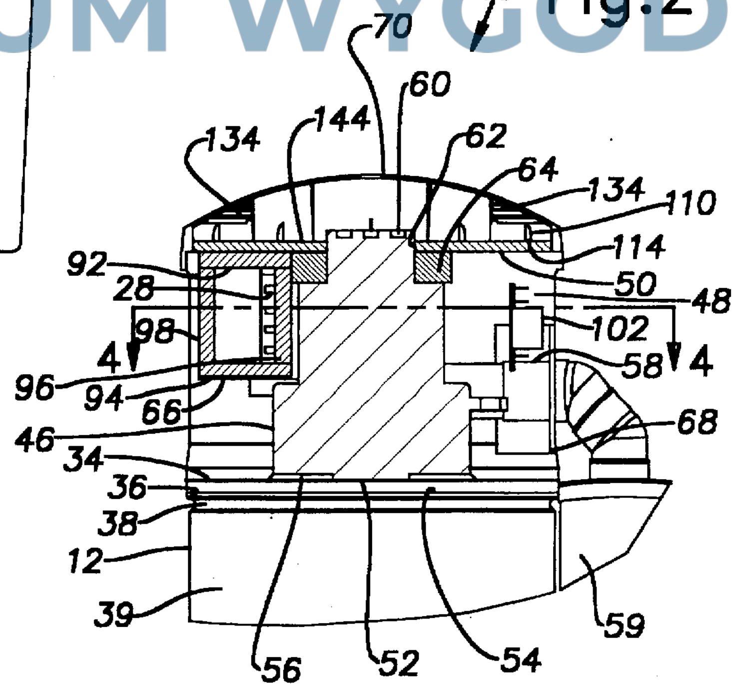
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Fig.3

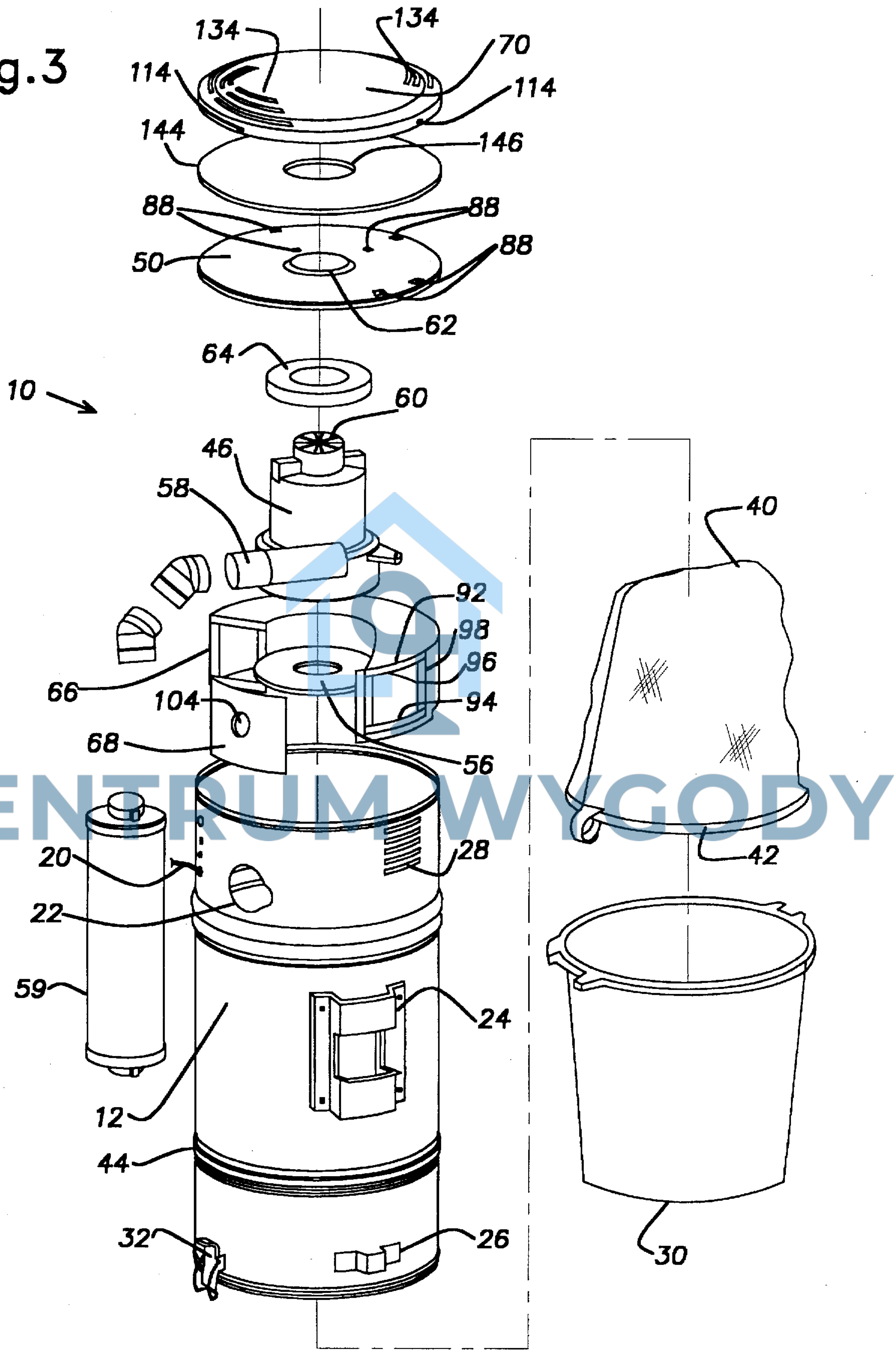
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Fig.4

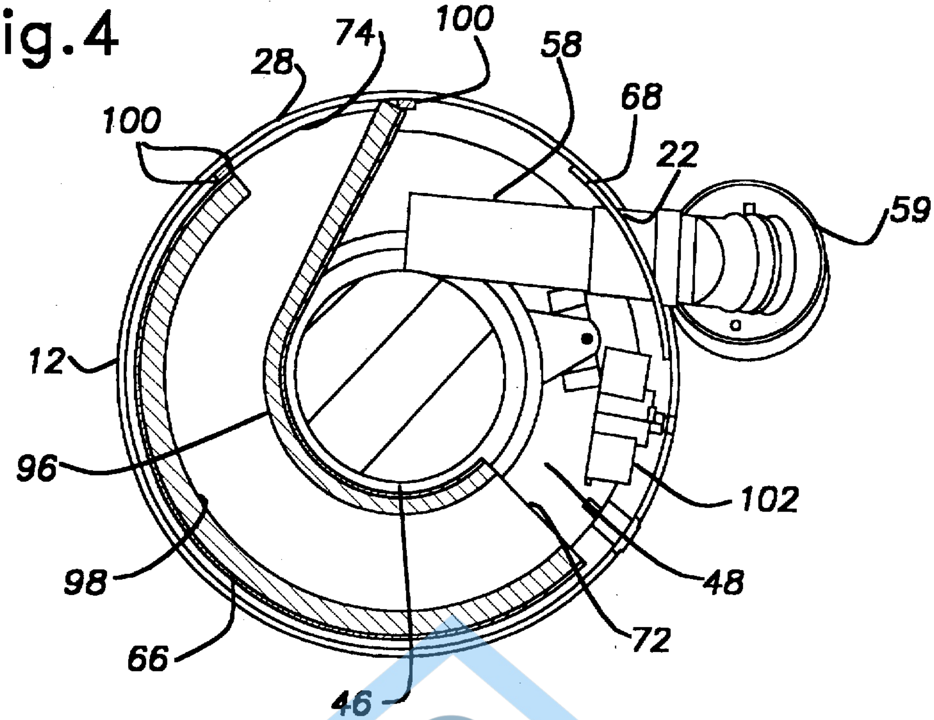

Fig.5

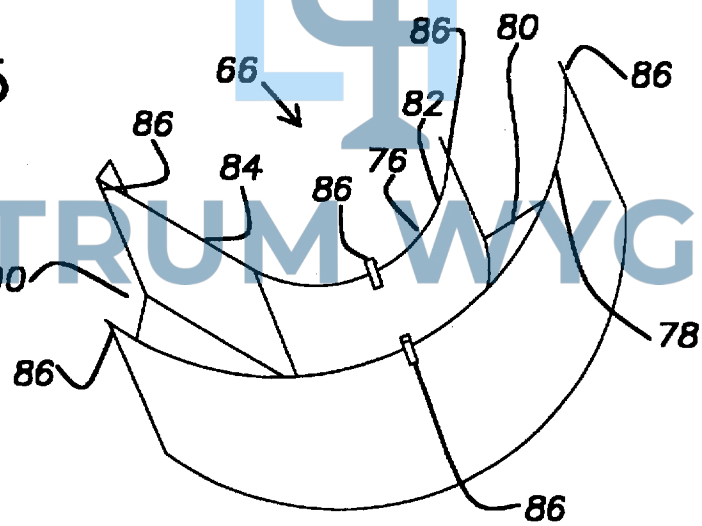

Fig.6

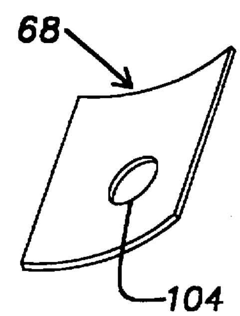

Fig.7

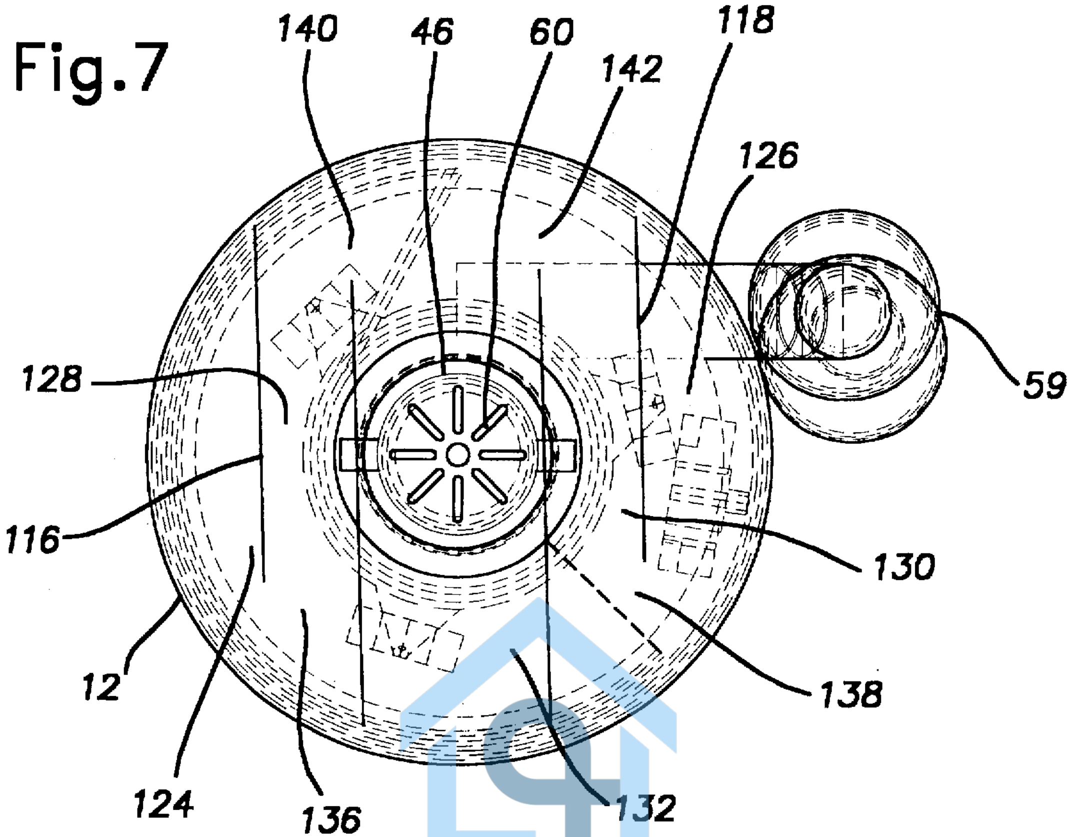
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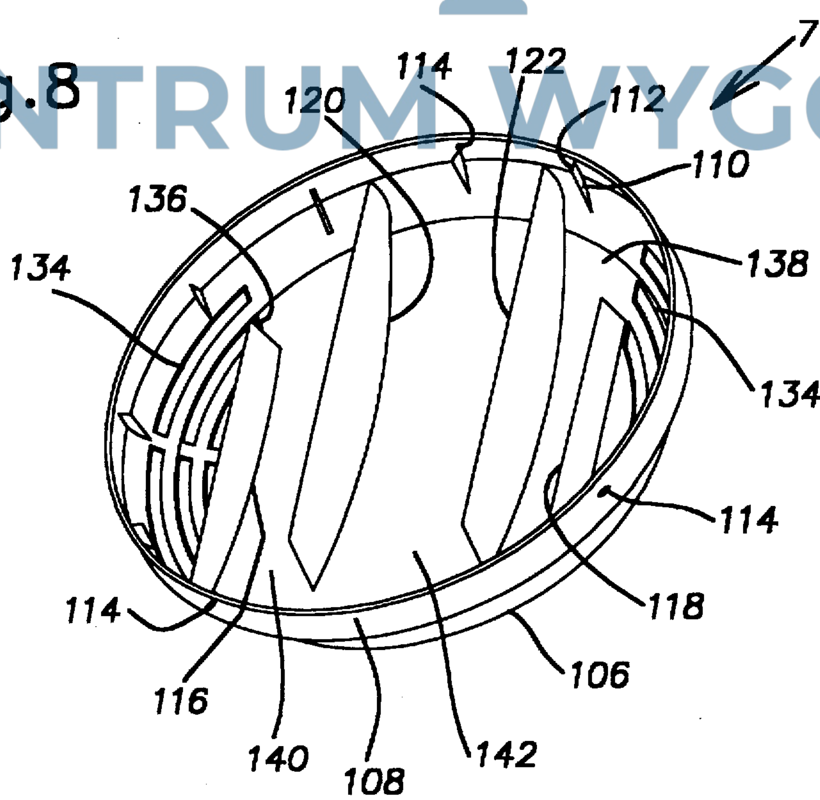
Fig.8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CENTRAL VACUUM WITH ACOUSTICAL DAMPING

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates in general to a central vacuum unit and, more particularly, to an acoustical damping system which substantially reduces the level of noise emitted from the central vacuum unit.

2. Description of Related Art

Built in vacuum systems typically have a central vacuum unit and a system of vacuum ducts which extend into various rooms of the house. Vacuum inlets are located in walls of selected rooms so that a vacuum hose can be connected to the central vacuum unit. When not in use, the vacuum inlets are covered by plates. To use the central vacuum system, one of the vacuum inlets is opened and the vacuum hose is plugged into the inlet. The central vacuum unit is automatically activated and a suction force draws in dirt and dust through a nozzle attached to the end of the vacuum hose. The central vacuum system provides more cleaning power than conventional portable vacuum cleaners and reduces the necessity of carrying portable vacuum cleaners from room to room. Additionally, the central vacuum system vents exhaust air out of the living area to eliminate the recirculation of unhealthy air.

One major disadvantage of built in vacuum systems known in the prior art, however, is the creation of a substantial amount of noise by the central vacuum unit. In most conventional units known in the prior art, the noise level generated from the central vacuum unit lies in the range of about 75 to about 95 decibels. Even though the central vacuum unit is typically located in a remote area such as the basement or garage of the home, many people use such locations as playrooms, workshops, etc. It is almost impossible to comfortably work in such locations when the central power and suction unit is operating, because the high noise level is sometimes deafening and at best extremely irritating.

U.S. Pat. No. 4,938,309, the disclosure of which is expressly incorporated herein in its entirety by reference, discloses a built-in vacuum cleaning system with an acoustic damping design. The motors of the unit are enclosed within an interior chamber which includes at its lower end a baffle covered with acoustic foam and is vented through exhaust ports. Tips of the motor armatures are separated from the remainder of the armatures and motor by the baffle. The tips of the armatures extend into a separate acoustic damping chamber which is also covered at a lower end with acoustic foam and includes openings for cooling air. While this acoustic damping design may reduce the noise level emitted from the unit while sufficiently cooling the motor, the noise level remains relatively high. Accordingly., there is a need in the art for a built-in vacuum cleaning system with an improved acoustical damping system to significantly lower the noise level emitted from the central vacuum unit.

SUMMARY OF THE INVENTION

The present invention provides a central vacuum unit with an improved acoustic damping system which overcomes at least some of the above-noted problems. The central vacuum unit includes a canister which forms a hollow interior, a vacuum motor within the canister which emits noise during operation, at least one opening in the canister, and an acoustic damping tunnel within the hollow interior and forming a pathway between the hollow interior and the opening. The pathway is lined with a sound absorbing material so that the tunnel reduces noise emitted from the hollow interior through the opening.

According to another aspect of the invention, an acoustic damping canopy is attached to the outside of the canister and covers an opening in the canister. The canopy has at least one inlet and forms a serpentine pathway between the inlet and the opening in the canister to reduce noise emitted from the hollow interior through the opening in the canister.

According to yet another aspect of the invention the canister has an exhaust port and the motor has an exhaust pipe extending through the exhaust port. An exhaust port seal is provided which completely covers the exhaust port to reduce noise emitted from the hollow interior through the exhaust port. The exhaust port seal is preferably formed from flexible foam.

BRIEF DESCRIPTION OF THE DRAWINGS

These and further features of the present invention will be apparent with reference to the following description and drawings, wherein:

FIG. **1** is a front elevational view of a central vacuum unit according to the invention;

FIG. **2** is a fragmented and enlarged view, partially in cross-section, of a portion of the central vacuum unit of FIG. **1**;

FIG. **3** is an exploded view of the central vacuum unit of FIG. **1**;

FIG. **4** is a cross-sectional plan view taken along line **4—4** of FIG. **2**;

FIG. **5** is a perspective view of a tunnel of the central vacuum unit of FIG. **1**;

FIG. **6** is a perspective view of an exhaust port seal of the central vacuum unit of FIG. **1**;

FIG. **7** is a cross-sectional plan view taken along line **7—7** of FIG. **2**; and

FIG. **8** is a perspective view of an acoustic damping canopy of the central vacuum unit of FIG. **1**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. **1–3** illustrate a central vacuum unit **10** with an acoustical damping system according to the present invention. The illustrated unit **10** is a model 189 manufactured by Beam Industries of Webster City, Iowa. It is noted, however, that while the model 189 central vacuum unit is utilized herein to illustrate the present invention, any conventional central vacuum unit can include the present invention to reduce the amount of noise emitted therefrom.

The central vacuum unit **10** has a cylindrically-shaped housing or canister **12** of rolled steel which forms a hollow interior space. The canister has a side wall with an air intake port **14** and a vacuum hose port **16** located near the bottom of the canister **12**. An on-off switch **18** is located near the top of the canister **12**. A power cord **20** is provided for connecting the central vacuum unit **10** to a conventional electrical power source (not shown). An exhaust port **22** is also located near the top of the canister **12**. Upper and lower mounting brackets **24**, **26** are vertically aligned along a rear face of the sidewall and provide means for mounting the canister **12** on a wall. Located in the sidewall near the top of the canister **12** is a cooling air exhaust or outlet **28** such as the illustrated plurality of slots.

A hollow bucket **30** is removably attached to the bottom of the canister **12** by means such as quick-release clips **32**.

Within the canister **12** is a partition wall **34** which is supported by a ledge **36** formed by an inwardly extending recess **38** formed in the sidewall of the canister **12**. Together the sidewall of the canister **12**, the bucket **30**, and the partition wall **34** form a first or lower interior compartment or chamber **39** within the hollow interior of the canister **12**. A removable dirt and dust collection bag **40** which is air permeable and is housed within the lower interior chamber **39**. The bag **40** has a flexible rim **42** which rests within an outwardly extending recess **44** formed in the side wall of the canister **12**.

A vacuum motor **46** is housed within a second or upper interior compartment or chamber **48** which is located above the lower interior chamber **39** and is separated from the lower interior chamber **39** by the partition wall **34**. The upper interior chamber **48** is formed by the side wall of the canister **12**, the partition wall **34**, and a steel lid **50** which closes the upper end of the canister **12**. A vacuum inlet **52** of the vacuum motor **46** is in fluid flow communication with the lower interior chamber **39** through an opening **54** in the partition wall **34**. A gasket **56** is provided between the vacuum motor **46** and the partition wall **34** so that a seal is maintained between the lower and upper interior chambers **39**, **48**.

A vacuum exhaust pipe **58** of the vacuum motor **46** provides an exit for hot exhaust coming from the vacuum motor **46** and extends through the exhaust port **22** in the sidewall of the canister **12**. The vacuum exhaust pipe **58** is connected to a muffler **59** which is located outside the canister **12**. The muffler **59** is preferably of the type disclosed in co-pending application No. 08/546,116, filed on Oct. 20, 1995, for a "CENTRAL VACUUM CLEANER MUFFLER", by Steven P. Rittmueller, Douglas E. Johnson, J. Adin Mann III, and David K. Holger, Docket No. ISURF #01877I the disclosure of which is expressly incorporated in its entirety herein by reference.

Suction created by the vacuum motor **46** causes a flow of air into the air intakes **14**, **16** of the canister **12**, through the collection bag **40** within lower interior chamber **39** of the canister **12**, and into the vacuum inlet **52** of the vacuum motor **46**. The air is exhausted from the motor **46** through the exhaust pipe **58** and the muffler **59**. Dirt, dust and other debris entrained within the flow of air is blocked by the collection bag **40** and settles in the bucket **30**. When the bucket **30** is full of dirt, the snap clips **32** are opened and the bucket **30** is removed so that the bucket **30** can be emptied.

A cooling air inlet **60** of the vacuum motor **46** extends through an opening **62** in the lid **50** so that the cooling air inlet **60** of the vacuum motor **46** is in fluid flow communication with the exterior of the canister **12**. A gasket **64** is provided between the vacuum motor **46** and the lid **50** to seal the opening **62** and also thermally isolate the vacuum motor **46** from the lid **50**. Preferably, the gasket **64** comprises an open cell foam. A cooling air fan (not shown) of the vacuum motor **46** draws cooling air through the cooling air inlet **60** of the vacuum motor **46** and over the armatures of the vacuum motor **46**. The cooling air flows over the armatures of the vacuum motor **46**, into the upper interior chamber **48**, and out the cooling air outlet **28**.

The acoustic damping system reduces the amount of noise emitted from the upper interior chamber **48** through the cooling air outlet **28**, the exhaust port **22**, and the cooling air inlet **60**. The acoustic damping system includes an acoustic damping tunnel **66**, an exhaust port seal **68**, and an acoustic damping canopy **70**.

As best shown in FIGS. **2** and **4**, the tunnel **66** is located within the upper interior chamber **48** for the purpose of reducing the amount of noise emitted from the cooling air outlet **28**. The tunnel **66** has a first or inlet end **72** in fluid flow communication with upper interior chamber **48** and a second or outlet end **74** in fluid flow communication with the cooling air outlet **28**.

As shown in FIG. **5**, the tunnel **66** of the illustrated embodiment is generally U-shaped in cross-section having an inner wall **76**, an outer wall **78**, and a bottom wall **80** connecting the inner and outer walls **76**, **78**. The tunnel **66** is preferably molded from a plastic material such as, for example ABS plastic. The outer wall **78** is arcuate having a radius slightly less than the sidewall of the canister **12** and extends for approximately 180 degrees. The inner wall **76** has an arcuate portion **82** and a tangential portion **84**. The arcuate portion **82** has a radius slightly greater than the outer surface of the vacuum motor **46** and extends for approximately 180 degrees. The tangential portion **84** is generally straight and extends from the arcuate portion **82** to the sidewall of the canister **12**. The inner and outer walls **76**, **78** are provided with resilient snap clips **86** which extend **4** through openings **88** (FIG. 3) in the lid **50** to secure the tunnel **66** to the lid **50** which both supports the tunnel **66** within the upper interior chamber **48** and closes the open top **90** of the tunnel **66**.

The interior pathway formed by the tunnel **66** and the lid **50** is covered with sound absorbing material such as an open cell foam. As best shown in FIG. **2**, a top foam element **92**, a bottom element **94**, and side elements **96**, **98** are provided to surround the pathway defined within the tunnel **66**. The foam elements **92**, **94**, **96**, **98** are preferably at least ½ inch thick and preferably comprise a combustion modified polyether polyurethane material such as, for example, Char Hyfonic 1 which is available from Stephenson & Lawyer of Grand Rapids, Mich. As best shown in FIG. **4**, foam elements **100** surround the outlet end **74** of the tunnel **66** to seal the outlet end **74** to the sidewall of the canister **12** so that sound is forced to follow the designed pathway through the tunnel **66** to exit through the cooling air outlet **28**. As the noise passes through the tunnel **66**, the noise is absorbed by the sound absorbing material.

The tunnel **66** is most effective at reducing emitted noise if the tunnel **66** has the greatest length and width allowed by the available space within the upper interior chamber **48** and allowed by heat restrictions. A longer tunnel **66** forces the noise to travel a longer path past the sound absorbing material so that more sound can be absorbed and a wider tunnel **66** allows the use of a thicker layer of sound absorbing material which yield more noise reduction. Therefore, various electrical components **102** within the upper interior chamber **48** are preferably located near the exhaust port **22** so that the tunnel **66** can circumferentially extend for substantially the entire distance around the vacuum motor **46** except for the space occupied by the exhaust pipe **58** and the electrical components **102** as best shown in FIG. **4**. It can also be seen in FIG. **4** that the width of the tunnel **66** extends substantially from the sidewall of the canister **12** to the exterior surface of the vacuum motor **46**. It is noted that while the pathway formed by the illustrated tunnel **66** is generally arcuate or curved, other tunnels can form effective sound absorbing pathways of other shapes. The pathways should, however, include curves or turns so that the pathway's not entirely straight or linear. The pathway of the illustrated tunnel **66** includes a curve which extends for approximately 180 degrees.

The exhaust port seal **68** reduces the amount of noise emitted from the exhaust port **22**. As shown in FIG. **6**, the exhaust port seal **68** is formed from a rectangular sheet of material which is generally arcuate to conform with the sidewall of the canister **12**. The exhaust port seal **68** is preferably formed of a material with either a high transmission loss or a high absorption rate to either block or absorb sound that would otherwise be emitted from the upper interior chamber **48** through the exhaust port **22**. The exhaust port seal preferably comprises a flexible foam such as, for example, 8443 Neoprene blend which is available from Lundell Manufacturing of Minneapolis, Minn. The exhaust port seal **68** forms a circular opening **104** for the exhaust pipe **46**. The opening **104** is sized for an interference fit with the exhaust pipe **58** to provide a seal between the exhaust pipe **58** and the exhaust port seal **68**. As best shown in FIG. **6**, the exhaust port seal **68** is attached to the sidewall of the canister **12** with an adhesive to completely close the exhaust port **22**.

As best shown in FIGS. **2** and **7**, the canopy **70** is attached to the top of the central vacuum unit **10** and encloses the cooling air inlet **60** of the vacuum motor **46** to reduce the noise emitted from the cooling air inlet **60**. The canopy **70** is preferably molded of a plastic material such as, for example, an ABS plastic. As best shown in FIG. **8**, the canopy **70** has a dome portion **106** and a cylindrically-shaped side portion **108**. A plurality of ribs **110** extend inwardly from the side portion **108** and provide a plurality of abutments **112** for engaging the lid **50** to support the canopy **70** on the lid **50**. Additionally, a plurality of fastener openings **114** are provided in the side portion for accepting fasteners which attach the canopy **70** to the canister **12**.

Parallel and spaced-apart dividing walls **116**, **118**, **120**, **122** extend from the dome portion **106** and the side portion **108** within the canopy **70**. When the canopy **70** is attached to the canister **12**, the lid and canopy **12** forms a pair of outer chambers or sections **124**, **126**, a pair of intermediate chambers or sections or **128**, **130**, and a central chamber or section **132**, as best shown in FIG. **7**. Openings or slots **134** are provided in the dome portion **106** at each of the outer sections **124**, **126** so that the outer sections **124**, **126** are in fluid communication with the exterior of the canopy **70** when the canopy **70** is attached to the canister **12**. The outer walls **116**, **118** each form a passage **136**, **138** at a first end so that the outer sections **124**, **126** are in fluid communication with the intermediate chambers **128**, **130** at the first end. The inner walls **120**, **122** each form a passage **140**, **142** at a second end, opposite the passages **136**, **138** of the outer walls **116**, **188**, so that the intermediate sections **128**, **130** are in fluid communication with the central chamber **132**. The central chamber **132** is in fluid communication with the cooling air inlet **60** of the vacuum motor **46** as best shown in FIG. **7**.

As best shown in FIG. **2**, a layer of sound absorbing foam **144** is located between the canopy **70** and the lid **50**. The layer of foam **144** includes a central opening **146** (FIG. **3**) for the cooling air inlet **60** of the vacuum motor **46**. The foam layer **144** is preferably at least ½ inch thick and preferably comprises a combustion modified polyether polyurethane material such as, for example, Char Hyfonic 1 which is available from Stephenson & Lawyer of Grand Rapids, Mich. The layer of sound absorbing foam **144** both absorbs sound and seals the pathway between the sections **124**, **126**, **128**, **130** of the canopy **70** so that sound is forced to follow the designed serpentine-shaped pathway of the canopy **70**. Each of the serpentine pathways of the illustrated canopy **70** includes two 180 degree turns. The canopy **70** is designed so that noise from the motor cooling fan must travel through the serpentine-shape pathway of the canopy **70** past the layer of foam **144** before exiting through the slots **134**. It is noted that additional sound absorbing foam can be added to the top and/or sides of the serpentine passageway. However, the additional foam only increases the noise reduction of the canopy **70** by about 1 db. It is noted that the serpentine pathway formed by the canopy **70** can form effective sound absorbing pathways of other shapes. A serpentine pathway is defined herein as a pathway including at least one curve or at least one turn so that the pathway not entirely straight or linear.

The acoustic damping system described hereabove is effective to substantially reduce the noise level of the central vacuum unit **10**. For example, in the embodiment described hereabove, the overall noise level of the central vacuum unit **10** was reduced about 10 db with the most significant reductions of about 13 db, about 12 db, and about 12 db occurring in the 1,000 Hz, 2,000 Hz, and the 4,000 Hz octave bands respectively.

Although particular embodiments of the invention have been described in detail, it will be understood that the invention is not limited correspondingly in scope, but includes all changes and modifications coming within the spirit and terms of the claims appended hereto.

What is claimed is:

1. A central vacuum unit comprising:

a canister having a sidewall forming a hollow interior;

a vacuum motor within said canister which emits noise during operation;

at least one opening in said sidewall of said canister; and

an acoustic damping tunnel within said hollow interior and forming a pathway between said hollow interior and said opening, said tunnel having an inlet end in fluid flow communication with said hollow interior and an outlet end surrounding said opening and sealed to said sidewall around said opening, said pathway being lined with a sound absorbing material, whereby said tunnel reduces noise emitted from said hollow interior through said opening.

2. The central vacuum unit according to claim **1**, wherein said at least one opening is a plurality of slots.

3. The central vacuum unit according to claim **2**, wherein said opening is a cooling air outlet for said motor.

4. The central vacuum unit according to claim **1**, further comprising a lid closing one end of the sidewall and wherein said tunnel is U-shaped in cross-section having an inner wall adjacent said vacuum motor, an outer wall adjacent said sidewall of said canister, and a bottom wall integrally connecting said inner wall and said outer wall, said lid supporting said tunnel and closing a top end of said tunnel opposite said bottom wall.

5. The central vacuum unit according to claim **4**, wherein said tunnel is secured to said lid with resilient snap clips.

6. The central vacuum according to claim **1**, wherein said sound absorbing material is an open cell foam.

7. The central vacuum according to claim **6**, wherein said open cell foam comprises combustion modified polyether polyurethane foam.

8. A central vacuum unit comprising:

a canister forming a hollow interior;

a vacuum motor within said canister which emits noise during operation;

at least one opening in said canister; and

an acoustic damping canopy outside said canister and covering said opening, said canopy having at least one inlet and parallel and spaced-apart dividing walls forming a serpentine pathway between said opening and said inlet to reduce noise emitted from said hollow interior through said opening and said inlet.

9. The central vacuum unit according to claim **8**, wherein said canister has a side wall and a lid closing an end of the canister, and said at least one opening is a cooling air inlet of said motor formed in said lid, said dividing walls cooperating with said lid to form said serpentine pathway.

10. The central vacuum unit according to claim **9**, wherein a layer of sound absorbing material is provided between said lid and said canopy.

11. The central vacuum according to claim **10**, wherein said sound absorbing material is an open cell foam.

12. The central vacuum according to claim **11**, wherein said open cell foam comprises combustion modified polyether polyurethane foam.

13. The central vacuum unit according to claim **8**, wherein said canopy comprises molded plastic.

14. A central vacuum unit comprising:

a canister having a sidewall forming a hollow interior and a lid closing one end of the sidewall;

a vacuum motor within said canister which emits noise during operation;

at least one cooling air inlet for admitting cooling air into said hollow interior;

at least one cooling air outlet in said sidewall for exhausting the cooling air from said hollow interior; and

an acoustic damping tunnel within said hollow interior and forming a pathway between said hollow interior and said cooling air outlet, said tunnel having an inlet end in fluid flow communication with said hollow interior and an outlet end surrounding said cooling air outlet and sealed around said sidewall, said pathway being lined with a sound absorbing material, whereby said tunnel reduces noise emitted from said hollow interior through said cooling air outlet.

15. The central vacuum unit according to claim **14**, wherein said tunnel is U-shaped in cross-section having an inner wall adjacent said vacuum motor, an outer wall adjacent said sidewall of said canister, and a bottom wall integrally connecting said inner wall and said outer wall, said lid supporting said tunnel and closing a top end of said tunnel opposite said bottom wall.

16. The central vacuum unit according to claim **15**, wherein said tunnel is secured to said lid with resilient snap clips.

17. The central vacuum according to claim **14**, wherein said sound absorbing material is an open cell foam.

18. A central vacuum unit comprising:

a canister having a sidewall forming a hollow interior and a lid closing one end of the sidewall;

a vacuum motor within said canister which emits noise during operation;

at least one cooling air inlet for admitting cooling air into said hollow interior;

at least one cooling air outlet in said sidewall for exhausting the cooling air from said hollow interior;

an acoustic damping tunnel within said hollow interior and forming a pathway between said hollow interior and said cooling air outlet, said pathway being lined with a sound absorbing material, whereby said tunnel reduces noise emitted from said hollow interior through said cooling air outlet; and

an acoustic damping canopy over said lid and covering said cooling air inlet, said canopy having at least one inlet and forming a serpentine pathway between said cooling air inlet and said canopy inlet to reduce noise emitted from said hollow interior through said cooling air inlet and said canopy inlet.

19. The central vacuum unit according to claim **18**, wherein sound absorbing material is provided along at least a portion of said serpentine pathway of said canopy.

20. The central vacuum unit according to claim **19**, wherein said sound absorbing material along said serpentine pathway is an open cell foam.

21. A central vacuum unit comprising:

a canister having a sidewall forming a hollow interior and a lid closing one end of the sidewall, wherein said canister has an exhaust pipe port;

a vacuum motor within said canister which emits noise during operation and has an exhaust pipe extending through said exhaust pipe port;

at least one cooling air inlet for admitting cooling air into said hollow interior;

at least one cooling air outlet in said sidewall for exhausting the cooling air from said hollow interior; and

an acoustic damping tunnel within said hollow interior and forming a pathway between said hollow interior and said cooling air outlet, said pathway being lined with a sound absorbing material, whereby said tunnel reduces noise emitted from said hollow interior through said cooling air outlet; and

a seal which seals the exhaust pipe port to reduce noise emitted from the hollow interior through the exhaust pipe port.

22. The central vacuum unit according to claim **21**, wherein said seal which seals said exhaust pipe port comprises flexible foam.

23. The central vacuum unit according to claim **1**, wherein said tunnel circumferentially extends around said vacuum motor for less than the entire distance around said vacuum motor.

24. The central vacuum unit according to claim **23**, wherein said inlet end of said tunnel is about 180 degrees from said outlet end of said tunnel.

25. The central vacuum unit according to claim **14**, wherein said tunnel circumferentially extends around said vacuum motor for less than the entire distance around said vacuum motor.

26. The central vacuum unit according to claim **25**, wherein said inlet end of said tunnel is about 180 degrees from said outlet end of said tunnel.

27. The central vacuum unit according to claim **14**, further comprising at least one opening in said sidewall separate from said cooling air outlet for vacuum exhaust from said vacuum motor.

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