(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 659 484 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
03.06.2020 Bulletin 2020/23

(21) Application number: **19219117.9**

(22) Date of filing: **08.11.2017**

(51) Int Cl.:
A47L 9/12 *(2006.01)* ***A47L 9/16*** *(2006.01)*
A47L 5/16 *(2006.01)* ***A47L 9/14*** *(2006.01)*
A47L 5/28 *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **08.11.2016 US 201662419231 P**

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
17801267.0 / 3 537 943

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Remarks:
This application was filed on 20-12-2019 as a divisional application to the application mentioned under INID code 62.

(54) VACUUM CLEANER

(57) A vacuum cleaner including a separator assembly having a container that defines a cyclonic separator about a separator axis. The container having a dirty air inlet that receives the airflow and debris to rotate around the separator axis in a first direction. A clean air outlet discharges the airflow from the separator assembly. A shroud forming an airflow passageway is between the dirty air inlet and the clean air outlet. The airflow passageway is formed by a plurality of vanes defining openings between adjacent vanes positioned to direct the airflow and debris in a second direction at least partially opposed to the first direction redirecting airflow into the shroud. A mesh screen is positioned on the shroud covering the airflow passageway and a filter at least partially within the shroud extends around the separator axis positioned in an airflow path between the plurality of vanes and the clean air outlet.

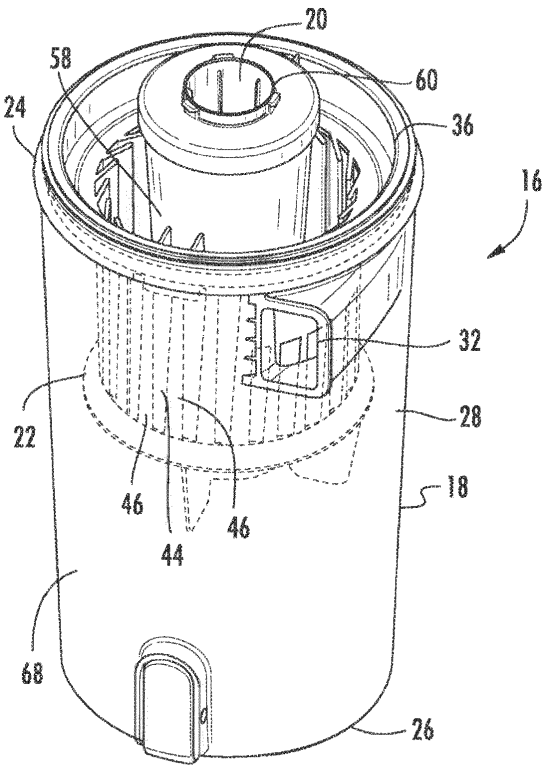

FIG. 2

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 62/419,231, filed November 8, 2016, the entire contents of which are hereby incorporated by reference herein.

BACKGROUND

[0002] The present invention relates to vacuum cleaners and more particularly to cyclonic vacuum cleaners.

SUMMARY

[0003] In one embodiment, the invention provides a vacuum cleaner including a suction inlet and a suction source configured to generate an airflow through the suction inlet to draw debris with the airflow through the suction inlet. The vacuum cleaner further includes a separator assembly downstream from the suction inlet including a container that defines a cyclonic separator about a separator axis. The container has a dirty air inlet positioned to receive the airflow and debris to rotate around the separator axis in a first direction within the container. The separator assembly further includes a clean air outlet that discharges the airflow from the separator assembly and a shroud forming an airflow passageway between the dirty air inlet and the clean air outlet. The airflow passageway is formed by a plurality of vanes defining openings between adjacent vanes positioned to direct the airflow and debris in a second direction at least partially opposed to the first direction redirecting airflow into the shroud. The separator assembly further includes a mesh screen positioned on the shroud covering the airflow passageway and a filter at least partially within the shroud extending around the separator axis positioned in an airflow path between the plurality of vanes and the clean air outlet.

[0004] Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005]

Fig. 1 is a perspective view of a vacuum cleaner according to an embodiment of the invention.

Fig. 2 is a perspective view of a separator assembly of the vacuum cleaner of Fig. 1.

Fig. 3 is a side view of the separator assembly of Fig. 2.

Fig. 4 is a cross-sectional view of the separator assembly of Fig. 3 taken along line 4 - 4 in Fig. 3.

Fig. 5 is a side view of a portion of the separator assembly of Fig. 2.

Fig. 6 is a perspective view of the portion of the separator assembly of Fig. 5.

Fig. 7 is a cross-sectional view of the portion of the separator assembly of Fig. 5.

Fig. 8 is a perspective view of a portion of the separator assembly of Fig. 2.

[0006] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways.

DETAILED DESCRIPTION

[0007] Fig. 1 illustrates a vacuum cleaner 10 according to one embodiment. Although the illustrated vacuum cleaner 10 is an upright style vacuum cleaner, in other embodiments, other types of vacuum cleaners can be used (e.g., handheld, canister, etc.). The vacuum cleaner 10 includes a suction inlet 12, a suction source 14, and a separator assembly 16. The suction source 14 is operable to generate an airflow through the suction inlet 12 to draw debris with the airflow through the suction inlet 12. The separator assembly 16 is downstream from the suction inlet 12 and separates the debris from the airflow.

[0008] Referring to Figs. 2-4, the separator assembly 16 includes a container 18, a clean air outlet 20, and a shroud 22. The container 18 includes an upper end 24 and a lower end 26. The container 18 defines a cyclonic separator 28 about a separator axis 30. The separator axis 30 extends centrally through the container 18 and centrally through the ends 24, 26 in the illustrated embodiment. The container 18 further includes a dirty air inlet 32 that is positioned to receive the airflow and debris. The dirty air inlet 32 is configured to rotate the airflow and debris around the separator axis 30 around the shroud 22 within the container 18 in a first direction of arrow 34 in Fig. 4, viewed from above the separator assembly for convenience. The clean air outlet 20 discharges the airflow from the separator assembly 16. The illustrated clean air outlet 20 extends through and from the upper end 24 of the container 18. In various embodiments, the cyclonic separator may be a first stage separator or a second or subsequent stage separator.

[0009] The shroud 22 forms an airflow passageway 44 between the dirty air inlet 32 and the clean air outlet 20. The shroud 22 is located within the container 18 between the upper end 24 and the lower end 26 of the container

18. The shroud 22 includes an upper end 36 having an upper opening 38 (Fig. 7) and the shroud 22 includes a lower end 40 having a lower opening 42. The upper end 36 of the shroud 22 is releasably connected to the upper end 24 of the container 18.

[0010] The shroud 22 includes the airflow passageway 44. The airflow passageway 44 is formed by a plurality of vanes 46 defining openings 48 between adjacent vanes 46. The openings 48 and the vanes 46 are positioned to direct the airflow (and any debris not yet separated from the airflow) from the outside of the shroud to the inside of the shroud in the direction of arrows 50 in Fig. 4, viewed from above the separator assembly for convenience. Generally, the openings 48 open toward or face in a direction that is opposed to the flow direction (arrow 34) outside of the shroud in the cyclonic separator 28. The flow direction (arrows 50) through the openings 48 between the vanes 46 is in a direction partially opposed to the flow direction (arrow 34) in the cyclonic separator 28. When the airflow travels from the cyclonic separator 28 and through the shroud 22, the airflow is redirected in somewhat of an opposite direction to form a rotational flow inside the shroud opposite direction of the flow direction in the cyclonic separator 28. This redirection of airflow further helps to separate the debris from the airflow and minimizes the debris that travels through the openings 48 between the vanes 46. Referring to Fig. 4, sidewalls 71 of adjacent vanes 46 converge to define openings between vanes having a decreasing area in the direction of airflow into the shroud. This causes air to increase in speed as the air travels through the vanes 46 to further encourage the rotational flow inside the shroud.

[0011] A shown in Fig. 7, a mesh screen 54 is positioned on the shroud 22, outside the vanes 46. The screen 54 extends around the separator axis 30 and covers the openings 48 between the vanes 46 so that the airflow must travel through the mesh screen 54 before traveling through the openings 48 between the vanes 46. The mesh screen 54 further inhibits debris from traveling with the airflow through the shroud 22. Additionally, the mesh screen introduces radial flow from the rotational flow in the cyclonic separator 28 to the entrance to the openings 48 in the shroud. There is a gap 70 between the mesh screen 54 and vanes 46. In one embodiment, the gap 70 is 5 millimeters (mm). In other embodiments, the gap is between 2 and 7 mm. In other embodiments the gap is greater than zero (i.e., the mesh screen does not press directly against the vanes 46). The mesh screen may be a perforated metal mesh with punched or etched pores. Alternatively, the mesh screen may be a wire or fiber mesh. The surface area of the openings in the mesh screen is in a range from 20% to 50% of the total surface area of the mesh screen surface. In one embodiment, the mesh screen 54 has pores each having a pore size in a range from 450 micrometers to 100 micrometers. In other embodiments, the pore size is in a range from 400 micrometers to 150 micrometers. In another embodiment, the pore size is in a range from 400 micrometers to 220 micrometers. In yet other embodiments, the pore size is in a range from 350 micrometers to 200 micrometers. In one alternative, the pore size is in a range from 300 micrometers to 220 micrometers.

[0012] A filter 58 is located within the shroud 22. In the illustrated embodiment, the filter 58 extends from the lower end 40 of the shroud 22 and through the upper opening 38 of the shroud 22. The filter 58 extends around the separator axis 30 and the filter 58 is positioned in the airflow path between the vanes 46 and the cleaner air outlet 20. The filter 58 further separates debris from the airflow. The filter 58 includes an open upper end 60 and a closed lower end 62. The illustrated filter 58 is generally cylindrical and includes an open central portion 63 that is in fluid communication with the clean air outlet 22. The closed lower end 62 of the filter 58 contacts the shroud 22 adjacent the lower end 40 of the shroud 22. The contact between the filter 58 and the shroud 22 closes the lower opening 42 of the shroud 22 to define a filter dirt collection chamber 64 within the shroud 22 between the vanes 46 and the filter 58. The filter 58 can be made from any suitable filter media, including pleated media, open cell foam media, natural fiber media, synthetic media, or any combination thereof.

[0013] The separator assembly 16 further includes a lid 66 and a debris collection chamber 68 below the shroud 22. The debris collection chamber 68 is defined by the container 18 at the lower end 26 of the container 18. The filter 58 is removably coupled to the lid 66 and the lid 66 and the filter 58 are together removably coupled to the container 18 adjacent the upper end 24 of the container 18. Therefore, the filter 58 is removable through the upper opening 38 of the shroud 22 when the lid 66 is uncoupled from the container 18 leaving the shroud in the upper end 24 of the container 18. When the filter is removed from the shroud 22, the closed lower end of the filter is removed from the lower opening in the shroud enabling dirt and debris to empty from the filter dirt collection chamber 64 into the debris collection chamber 68 below the shroud 22. The filter 58 can then be uncoupled from the lid 66 to clean or replace the filter 58. In an alternative embodiment, the shroud 22 is coupled to the lid 66 so that the shroud 22 is removable with the lid 66 and the filter 58 from the container 18. In yet another embodiment, the shroud and filter may remain with the container 18 when the lid 66 is removed from the container 18. In such an embodiment, debris in the chamber 64 falls through the lower opening 42 of the shroud and into the debris collection chamber 68 when the filter is removed from the shroud.

[0014] In an alternative embodiment, the vacuum cleaner includes a separator assembly downstream from the suction inlet and a debris collection chamber, where the separator assembly includes a container that defines a cyclonic separator about a separator axis, with a dirty air inlet positioned to receive the airflow and debris so that the airflow and debris rotates around the separator

axis in a first direction within the container. The separator includes a clean air outlet that discharges the airflow from the separator assembly. The separator assembly further includes a shroud located in the container having apertures forming an airflow passageway between the dirty air inlet and the clean air outlet, the shroud having an upper end and a lower end having a lower opening. A filter is positioned at least partially within the shroud extending around the separator axis positioned in an airflow path between the shroud and the clean air outlet, where a closed end of the filter contacts the shroud adjacent the lower end closing the lower opening defining a filter dirt collection chamber within the shroud between the plurality of vanes and the filter.

[0015] The apertures in the shroud in this embodiment may be longitudinal slots, openings between vanes, holes of any shape, or other apertures.

[0016] In operation, the vacuum cleaner 10 is used to remove debris from a surface (e.g., carpet, hard flooring, upholstery, etc.). The suction source 14 generates an airflow that draws the debris and airflow through the suction inlet 12. The airflow and debris travels into the cyclonic separator 28 through the dirty air inlet 32. The airflow and debris rotate around the separator axis 30 in the direction of arrow 34 in Fig. 4. Debris is separated from the airflow and the debris falls down into the debris collection chamber 68. The airflow travels through the mesh screen 54 that further separates debris from the airflow. After traveling through the mesh screen 54, the airflow travels in the direction of arrows 50 through the openings 48 between the vanes 46. The redirection of the airflow by the vanes 46 (discussed above) may further separate debris from the airflow. Separated debris can fall into the filter dirt collection chamber 64. The airflow then passes through the filter 58 to further remove relatively fine debris from the airflow. The debris separated by the filter 58 may collect on the filter or fall into the filter dirt collection chamber 64. The airflow travels through the filter 58 and into the open central portion 63 of the filter 58. From the open central potion 63 of the filter 58, the airflow passes through the clean air outlet 20, which can include an aperture in the lid 66, before being exhausted from the vacuum cleaner 10.

[0017] The user can empty the filter dirt collection chamber 64 by removing the lid 66 from the container 18. In the illustrated embodiment, the shroud 22 and filter dirt collection chamber 64 are removed from the container 18 with the lid 66. Therefore, the user uncouples the shroud 22 from the lid 66 to empty the chamber 64. The debris collection chamber 68 can be emptied through the upper end 24 of the container 18. In other embodiments, the container 18 includes a door or a lid adjacent the lower end 26 of the container 18 to empty the chamber 68.

[0018] Various features and advantages of the invention are set forth in the claims appended hereto.

[0019] Various aspects of the inventions described above are set out in the following clauses.

1. A vacuum cleaner comprising:

a suction inlet;
a suction source configured to generate an airflow through the suction inlet to draw debris with the airflow through the suction inlet; and
a separator assembly downstream from the suction inlet and a debris collection chamber, the separator assembly including

a container that defines a cyclonic separator about a separator axis, the container having a dirty air inlet positioned to receive the airflow and debris to rotate around the separator axis in a first direction within the container,
a clean air outlet that discharges the airflow from the separator assembly,
a shroud located in the container forming an airflow passageway between the dirty air inlet and the clean air outlet, the airflow passageway formed by a plurality of vanes defining openings between adjacent vanes positioned to direct the airflow and debris in a second direction at least partially opposed to the first direction redirecting airflow into the shroud,
a mesh screen positioned on the shroud covering the airflow passageway, and
a filter at least partially within the shroud extending around the separator axis positioned in an airflow path between the plurality of vanes and the clean air outlet.

2. The vacuum cleaner of clause 1, wherein the mesh screen includes a plurality of pores each having a pore size in a range from 450 micrometers to 100 micrometers.

3. The vacuum cleaner of clause 1, wherein the debris collection chamber is below the shroud.

4. The vacuum cleaner of clause 1, wherein the container includes an upper end and a lower end and the separator axis extends centrally through the upper end and the lower end.

5. The vacuum cleaner of clause 4, wherein the shroud is between the upper end and the lower end of the container.

6. The vacuum cleaner of clause 1, wherein the shroud includes an upper end and a lower end, the shroud upper end being releasably connected to the container upper end.

7. The vacuum cleaner of clause 1, wherein the shroud includes an upper end and a lower end having

a lower opening.

8. The vacuum cleaner of clause 7, wherein a closed end of the filter contacts the shroud adjacent the lower end closing the lower opening defining a filter dirt collection chamber within the shroud between the plurality of vanes and the filter.

9. The vacuum cleaner of clause 7, where the filter is removable from the shroud through the shroud upper end.

10. The vacuum cleaner of clause 1, wherein the separator assembly further includes a lid removably coupled to the container, the filter being coupled to the lid and removable with the lid from the container.

11. The vacuum cleaner of clause 10, wherein the shroud is coupled to the lid and removable with the lid from the container.

12. The vacuum cleaner of clause 1, wherein the separator assembly further includes a lid removably coupled to the container, wherein the clean air outlet includes an aperture through the lid.

13. The vacuum cleaner of clause 1, where the filter is a cylindrical filter forming a central portion in fluid communication with the clean air outlet.

14. The vacuum cleaner of clause 1, where the filter includes a media selected from the group consisting of pleated media, open cell foam media, natural fiber media, and synthetic media.

15. The vacuum cleaner of clause 12, wherein the shroud includes an upper end having an upper opening removably coupled to the container and a lower end having a lower opening, wherein the filter is removably attached to the lid in fluid communication with the clean air outlet, wherein a closed end of the filter contacts the shroud adjacent the lower end closing the lower opening to define a dirt collection chamber within the shroud between the plurality of vanes and the filter, and wherein the filter is removable through the upper opening to empty the dirt collection chamber when the lid is uncoupled from the container.

16. The vacuum cleaner of clause 1, wherein sidewalls of adjacent vanes converge defining the openings between adjacent vanes having a decreasing area in the direction of airflow into the shroud.

17. The vacuum cleaner of clause 1, wherein the plurality of vanes defining openings between adjacent vanes are positioned to direct the airflow and debris to rotate between the shroud and filter in the second direction being opposite of the first direction.

18. A vacuum cleaner comprising:

a suction inlet;
a suction source configured to generate an airflow through the suction inlet to draw debris with the airflow through the suction inlet; and
a separator assembly downstream from the suction inlet including

a container that defines a cyclonic separator about a separator axis, the container having a dirty air inlet positioned to receive the airflow and debris to rotate around the separator axis in a first direction within the container,
a clean air outlet that discharges the airflow from the separator assembly,
a shroud located in the container having apertures forming an airflow passageway between the dirty air inlet and the clean air outlet, the shroud having an upper end and a lower end having a lower opening,
a filter at least partially within the shroud extending around the separator axis positioned in an airflow path between the shroud and the clean air outlet,
wherein a closed end of the filter contacts the shroud adjacent the lower end closing the lower opening defining a filter dirt collection chamber within the shroud between the apertures and the filter.

19. The vacuum cleaner of clause 18, where the filter is removable from the shroud through the shroud upper end.

20. The vacuum cleaner of clause 18, where the shroud airflow passageway is formed by a plurality of vanes defining openings between adjacent vanes positioned to direct the airflow and debris in a second direction at least partially opposed to the first direction redirecting airflow into the shroud.

21. The vacuum cleaner of clause 20, wherein sidewalls of adjacent vanes converge defining the openings between adjacent vanes having a decreasing area in the direction of airflow into the shroud.

22. The vacuum cleaner of clause 20, wherein the plurality of vanes defining openings between adjacent vanes are positioned to direct the airflow and debris to rotate between the shroud and filter in the second direction being opposite of the first direction.

23. The vacuum cleaner of clause 20, further comprising a mesh screen positioned on the shroud cov-

ering the airflow passageway, wherein the mesh screen includes a plurality of pores each having a pore size in a range from 450 micrometers to 100 micrometers.

24. The vacuum cleaner of clause 18, wherein the container includes an upper end and a lower end, the shroud upper end being releasably connected to the container upper end.

25. The vacuum cleaner of clause 18, wherein the separator assembly further includes a lid removably coupled to the container, the filter is coupled to the lid and removable with the lid from the container.

26. The vacuum cleaner of clause 25, wherein the shroud is coupled to the lid and removable with the lid from the container.

27. The vacuum cleaner of clause 25, where the filter is removable from the shroud through the shroud upper end to empty the filter dirt collection chamber when the lid is uncoupled from the container.

Claims

1. A vacuum cleaner (10) comprising:

a suction inlet (12);
a suction source (14) configured to generate an airflow through the suction inlet (12) to draw debris with the airflow through the suction inlet (12); and
a separator assembly (16) downstream from the suction inlet (12) including

a container (18) that defines a cyclonic separator (28) about a separator axis (30), the container (18) having a dirty air inlet (32) positioned to receive the airflow and debris to rotate around the separator axis (30) in a first direction within the container (18),
a clean air outlet (20) that discharges the airflow from the separator assembly (16),
a shroud (22) located in the container (18) having apertures forming an airflow passageway (44) between the dirty air inlet (32) and the clean air outlet (20), the shroud (22) having an upper end (24) and a lower end (26) having a lower opening (42),
a filter (58) at least partially within the shroud (22) extending around the separator axis (30) positioned in an airflow path between the shroud (22) and the clean air outlet (20), wherein a closed end of the filter (58) contacts the shroud (22) adjacent the lower end (22) closing the lower opening defining a filter dirt collection chamber within the shroud between the apertures and the filter.

2. The vacuum cleaner (10) of claim 1, where the filter (58) is removable from the shroud (22) through the shroud (22) upper end (24).

3. The vacuum cleaner (10) of claim 1, where the shroud (22) airflow passageway (44) is formed by a plurality of vanes (46) defining openings (48) between adjacent vanes (46) positioned to direct the airflow and debris in a second direction at least partially opposed to the first direction redirecting airflow into the shroud (22).

4. The vacuum cleaner (10) of claim 3, wherein sidewalls (71) of adjacent vanes (46) converge defining the openings (48) between adjacent vanes (46) having a decreasing area in the direction of airflow into the shroud (22).

5. The vacuum cleaner (10) of claim 3, wherein the plurality of vanes (46) defining openings (48) between adjacent vanes (46) are positioned to direct the airflow and debris to rotate between the shroud (22) and filter (58) in the second direction being opposite of the first direction.

6. The vacuum cleaner (10) of claim 3, further comprising a mesh screen (54) positioned on the shroud (22) covering the airflow passageway (44), wherein the mesh screen (54) includes a plurality of pores each having a pore size in a range from 450 micrometers to 100 micrometers.

7. The vacuum cleaner (10) of claim 1, wherein the container (18) includes an upper end (24) and a lower end (26), the shroud (22) upper end (24) being releasably connected to the container (18) upper end (24).

8. The vacuum cleaner (10) of claim 1, wherein the separator assembly (16) further includes a lid (66) removably coupled to the container (18), the filter (58) is coupled to the lid (66) and removable with the lid (66) from the container (18).

9. The vacuum cleaner (10) of claim 8, wherein the shroud (22) is coupled to the lid (66) and removable with the lid (66) from the container (18).

10. The vacuum cleaner (10) of claim 8, where the filter (58) is removable from the shroud (22) through the shroud (22) upper end (24) to empty the filter dirt collection chamber when the lid is uncoupled from the container.

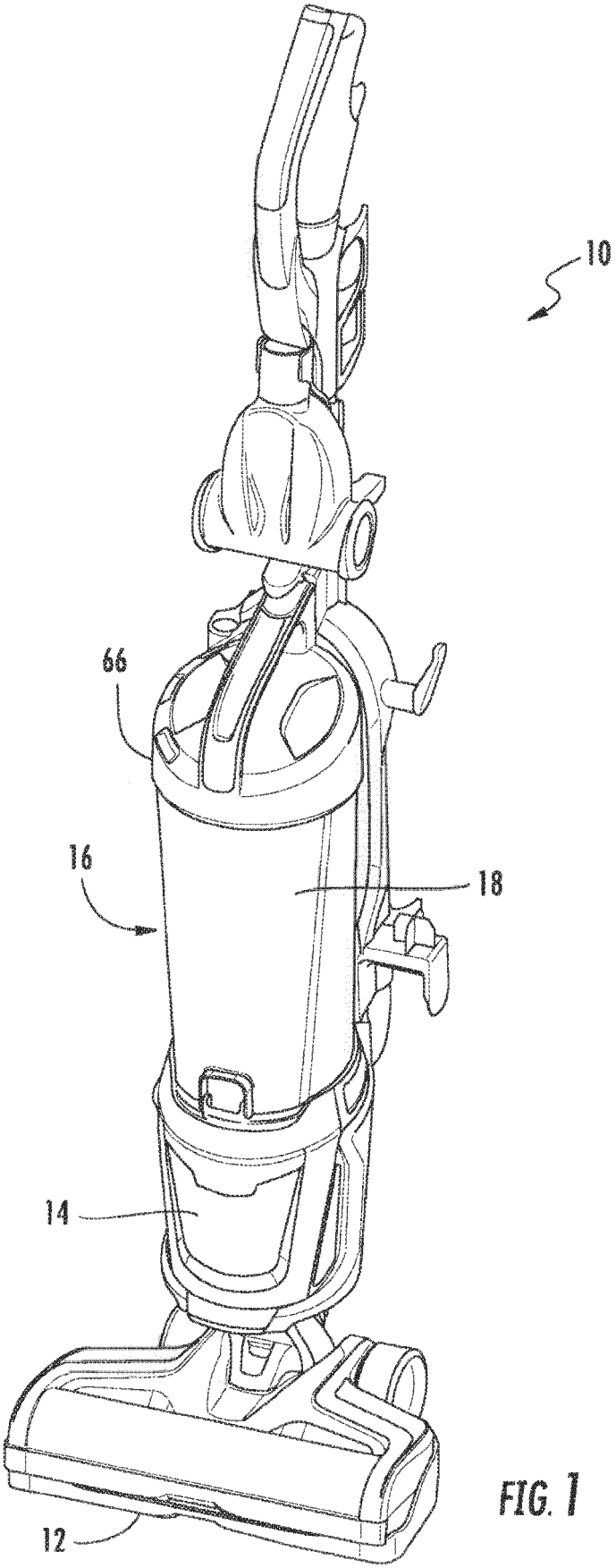

FIG. 1

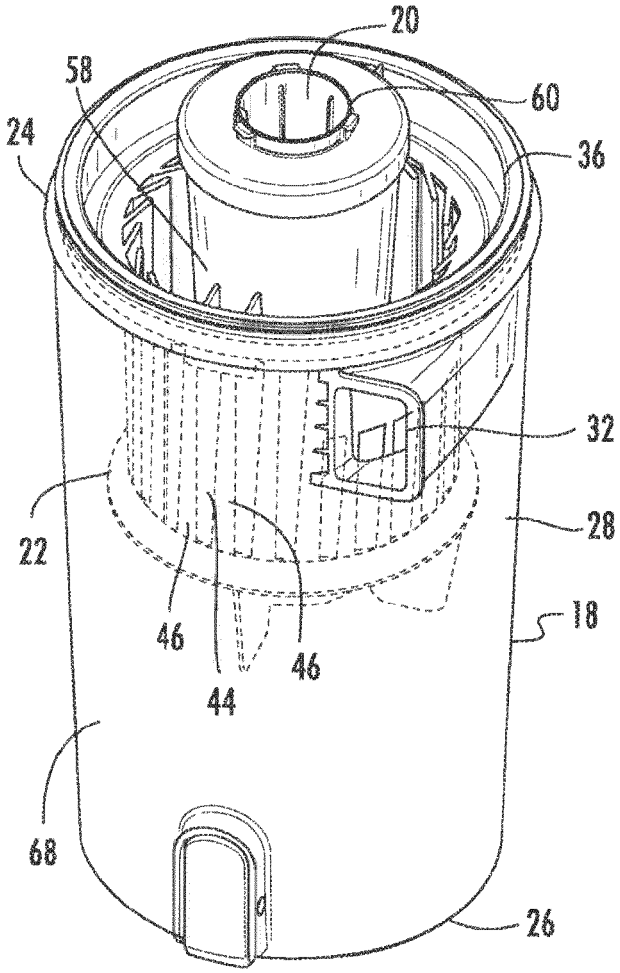
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FIG. 2

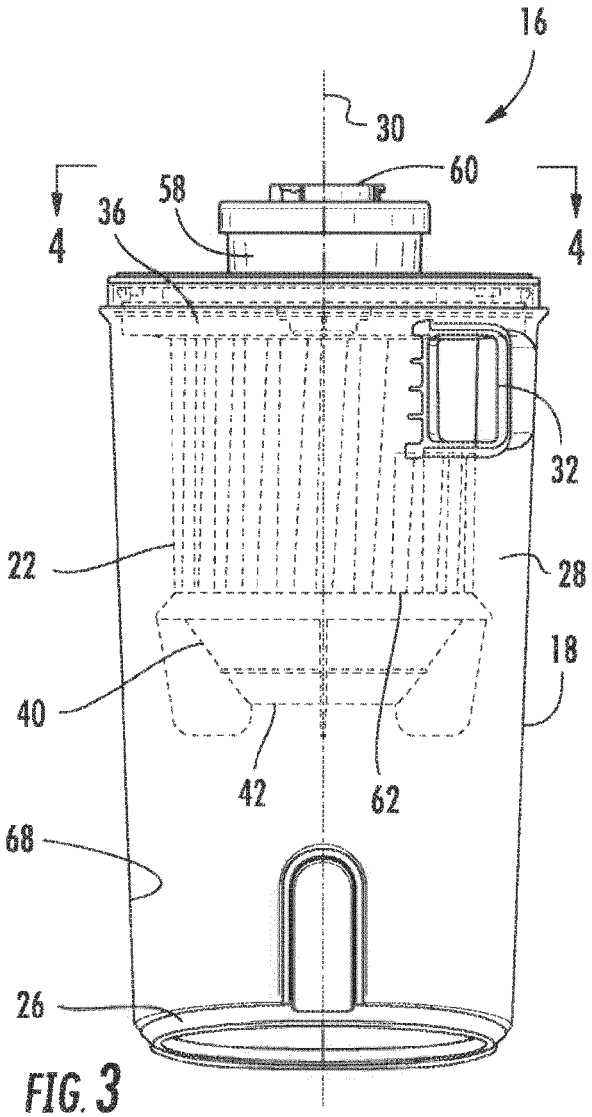
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FIG. 3

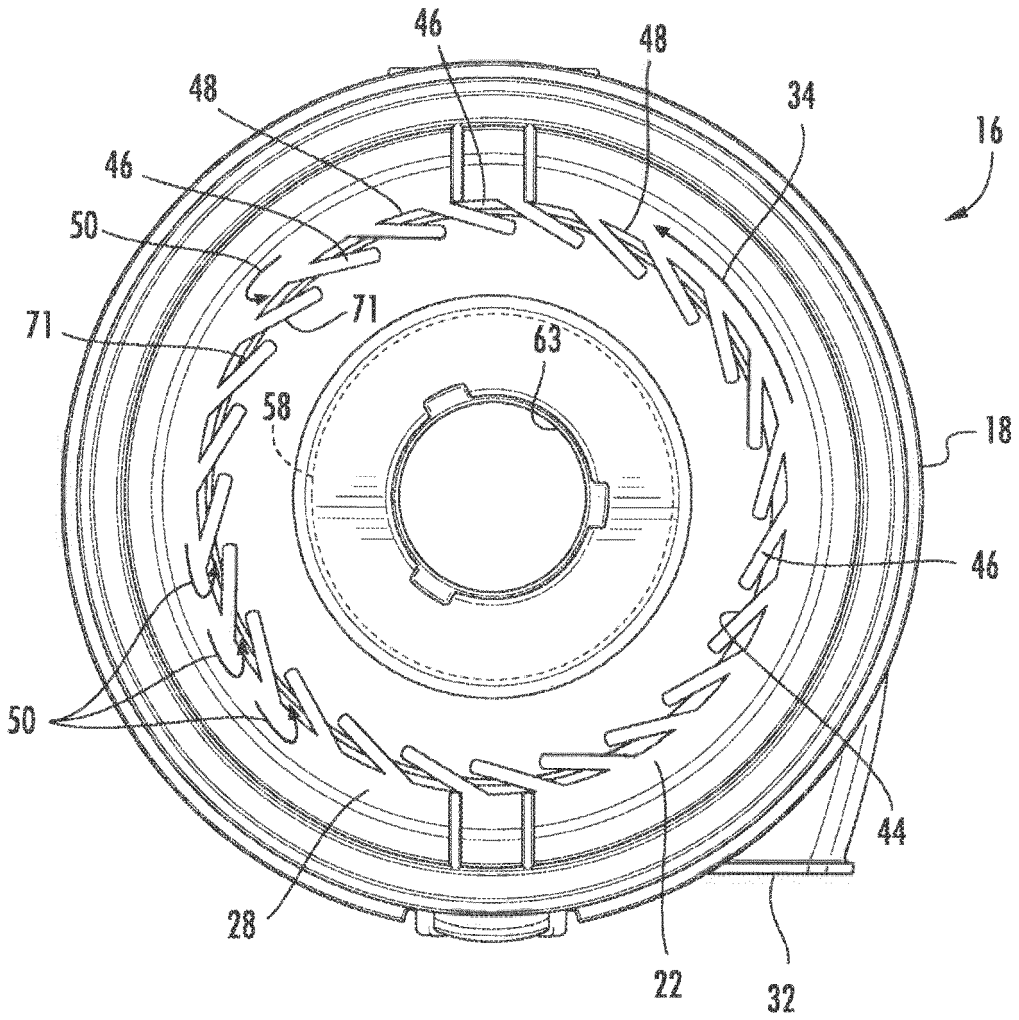

FIG. 4

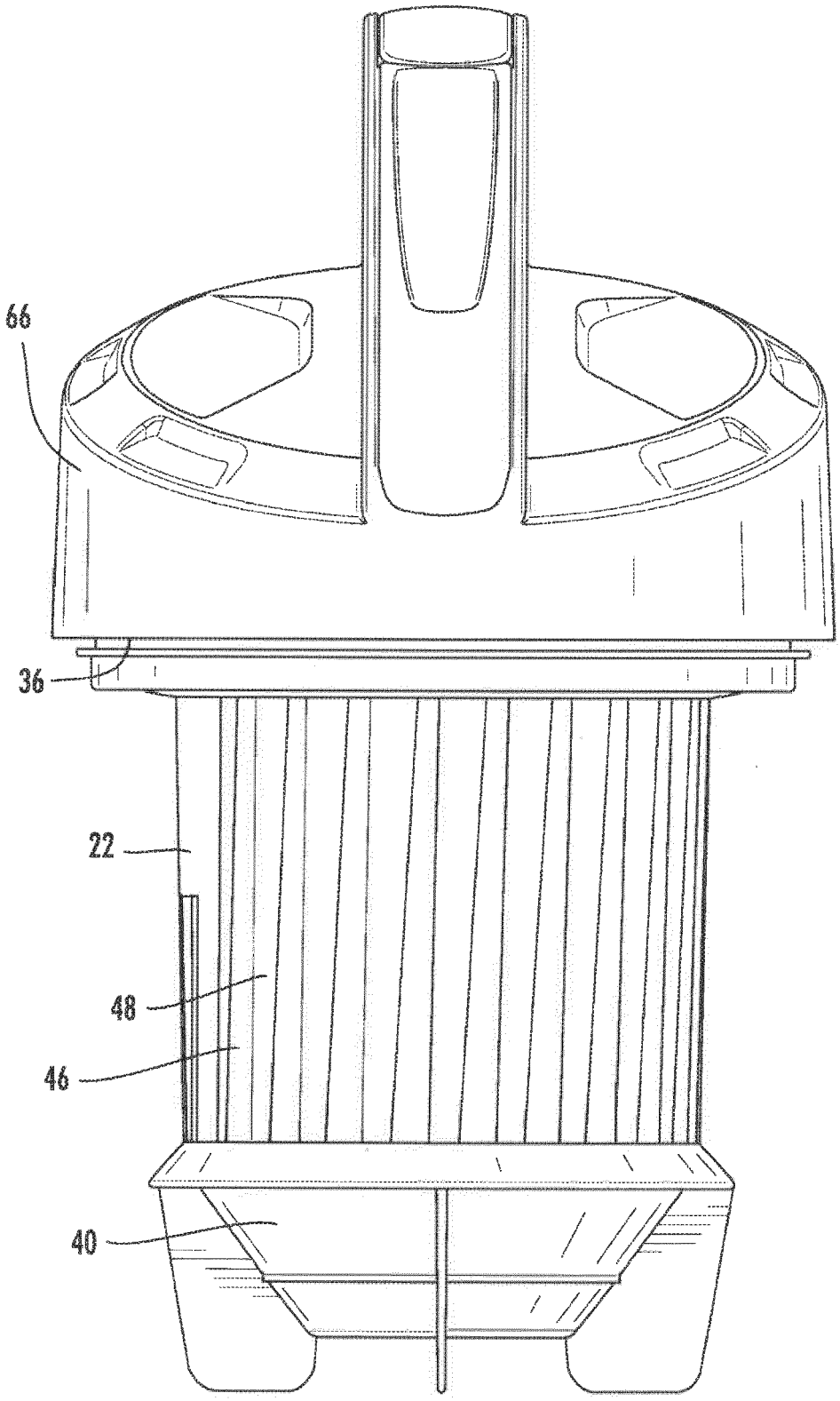

FIG. 5

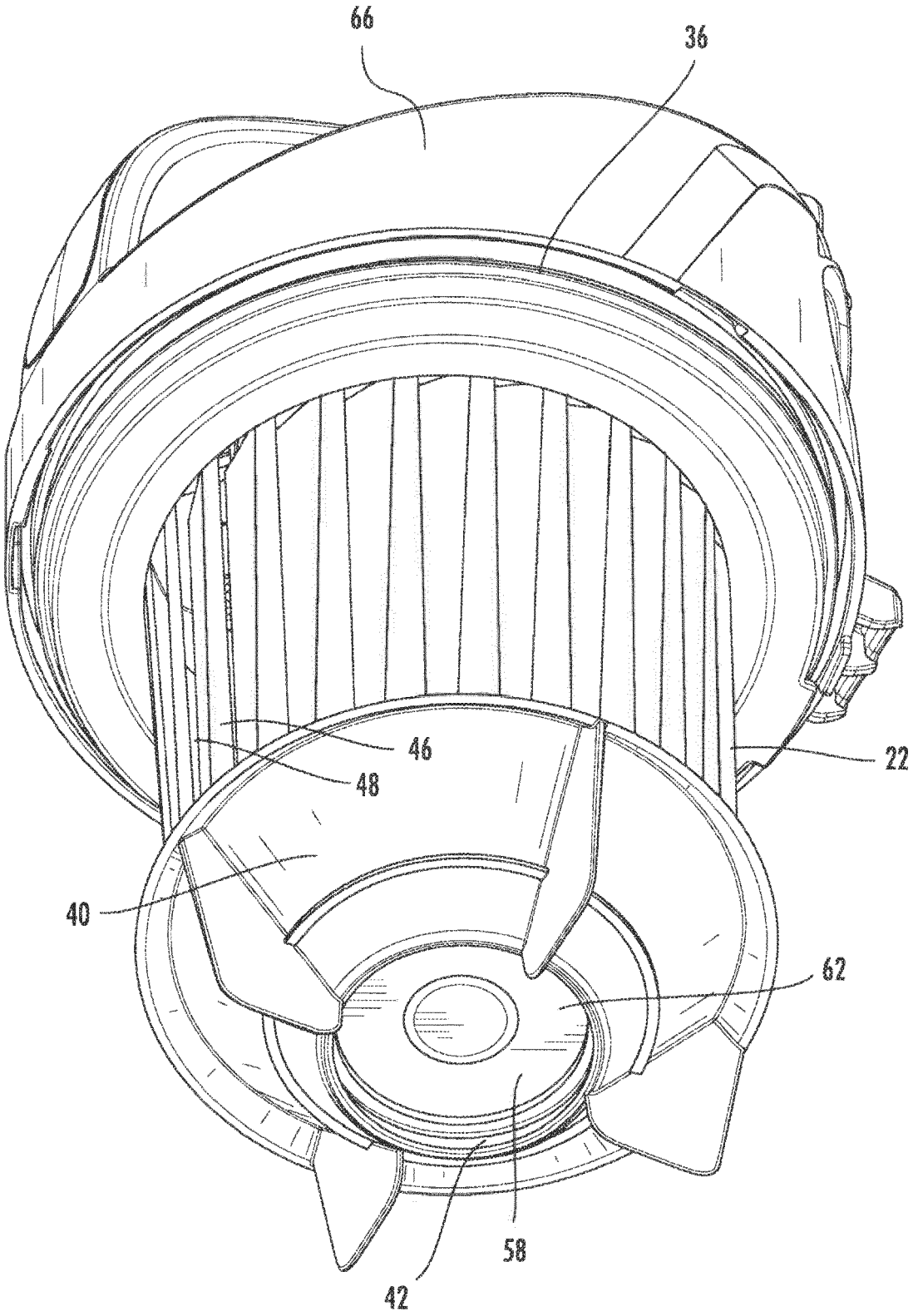

FIG. 6

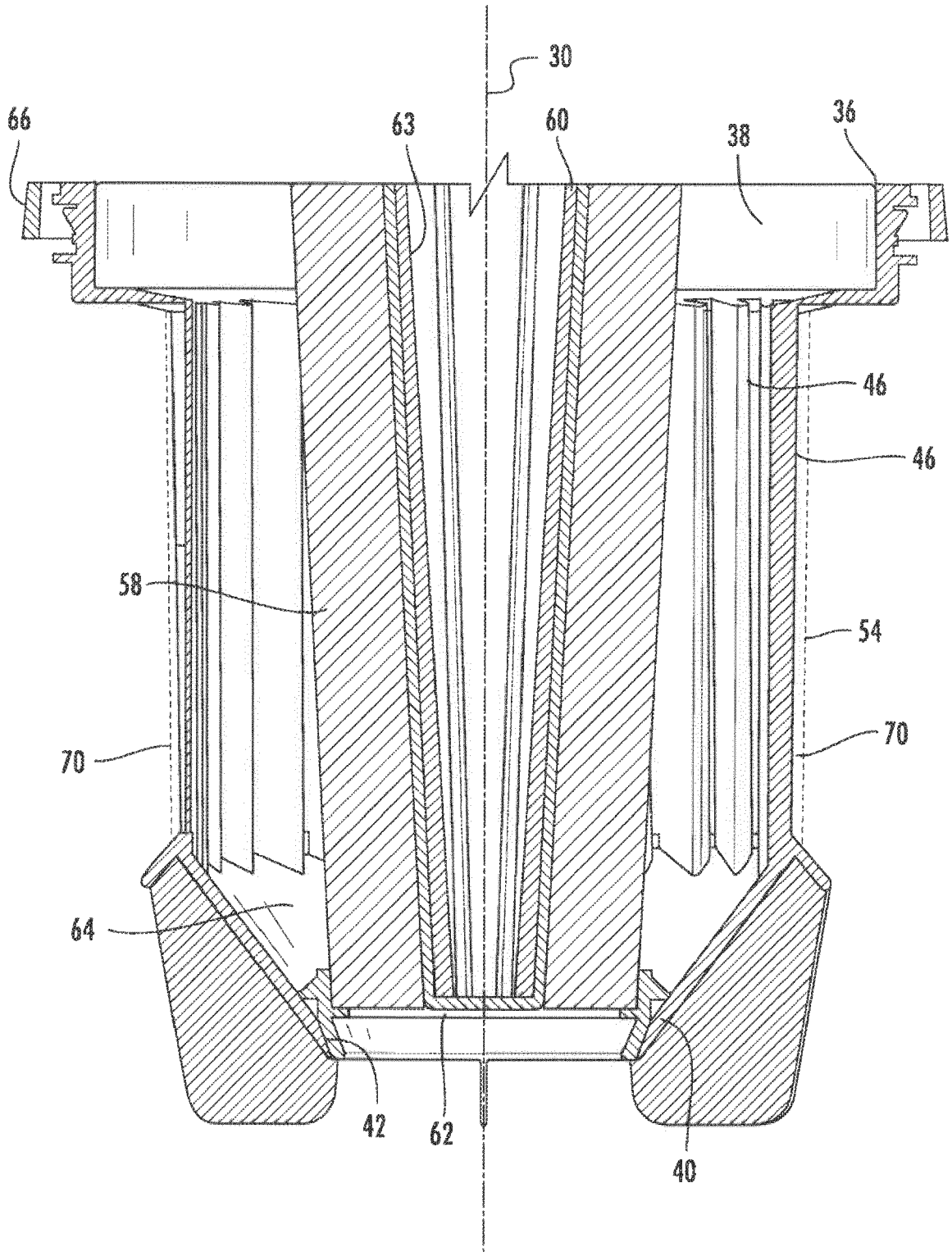

FIG. 7

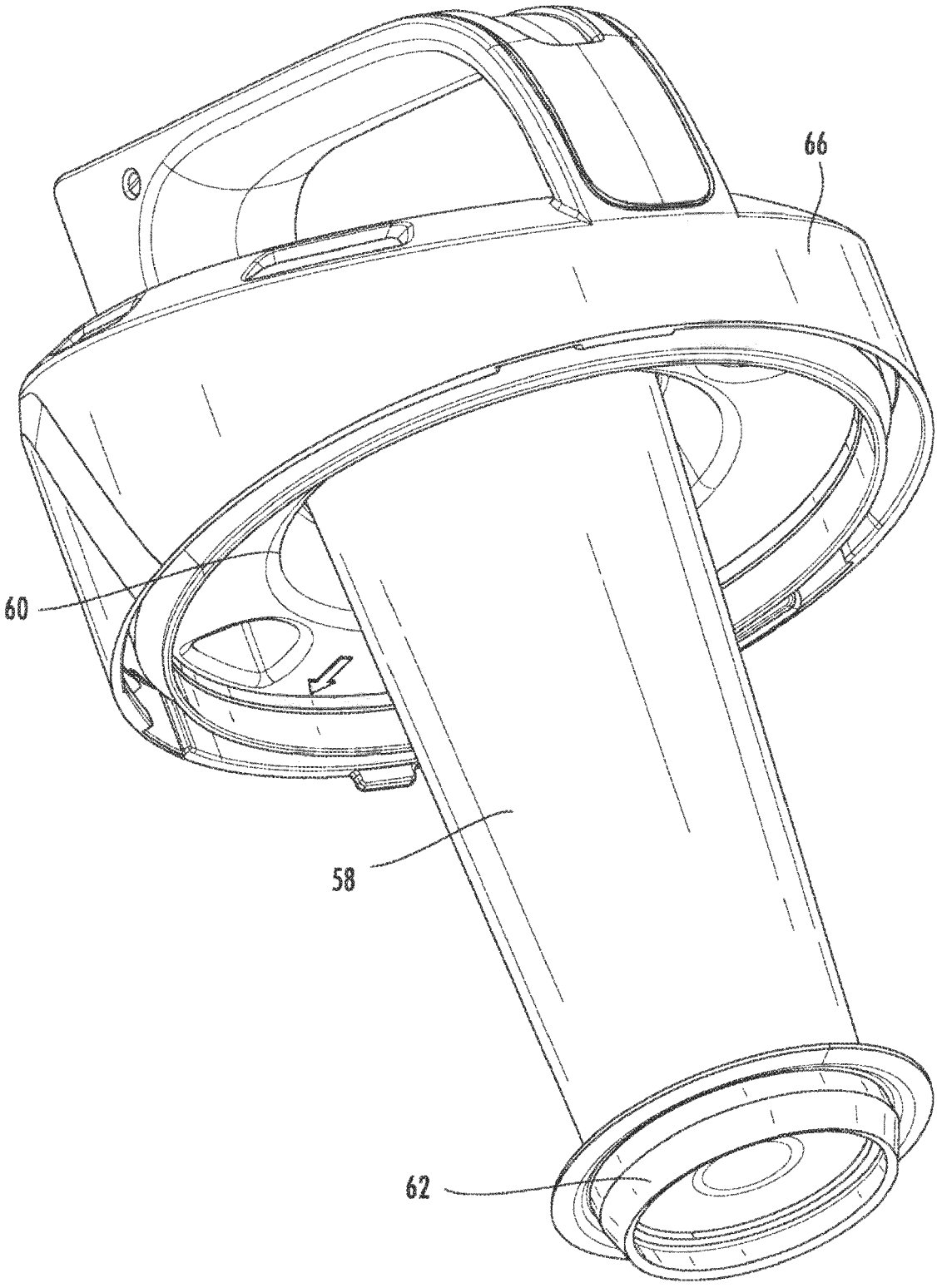

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 19 21 9117

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 7 651 544 B1 (FESTER JOSEPH A [US] ET AL) 26 January 2010 (2010-01-26) * figure 5 * -----	1-10	INV. A47L9/12 A47L9/16 A47L5/16 A47L9/14 A47L5/28
A	US 7 770 256 B1 (FESTER JOSEPH A [US]) 10 August 2010 (2010-08-10) * column 4, line 43 - column 6, line 62; figures 1-3,6 * -----	1-10	
A	WO 2012/127242 A2 (VAX LTD; WILLIAMS THOMAS [GB]; WATERS RICHARD DAVID [GB]) 27 September 2012 (2012-09-27) * page 7, line 28 - page 10, line 16; figure 6b * -----	1-10	
A	US 2010/139033 A1 (MAKAROV SERGEY [US] ET AL) 10 June 2010 (2010-06-10) * paragraph [0050]; figure 11 * -----	1-10	
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TECHNICAL FIELDS SEARCHED (IPC)

A47L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 March 2020	Trimarchi, Roberto

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 21 9117

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30-03-2020

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