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(54) **AIR FILTER CONFIGURED IN A ROLL**

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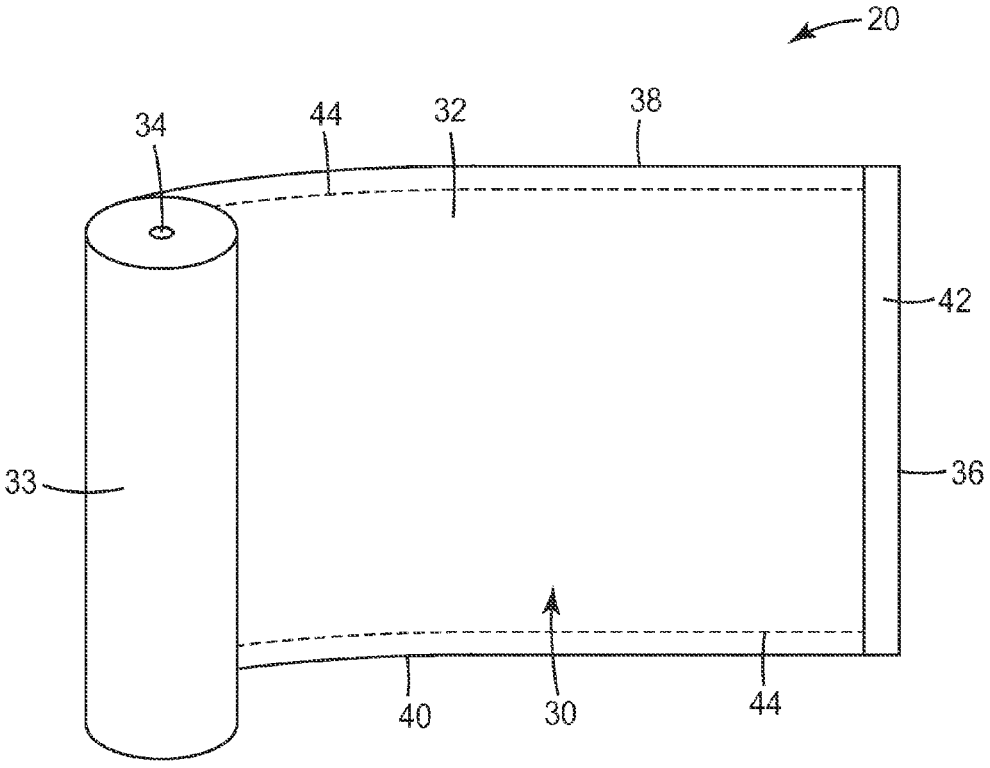
(57) **ABSTRACT**

The present disclosure relates to air filters. More particularly, it relates to adjustably sized air filter systems capable of use in a window opening. Some embodiments relate to a filter media assembly configured in a roll. In some embodiments, the filter media assembly includes a filter media having a leading end opposite a trailing end and first and second opposed side edges extending between the leading end and the trailing end.



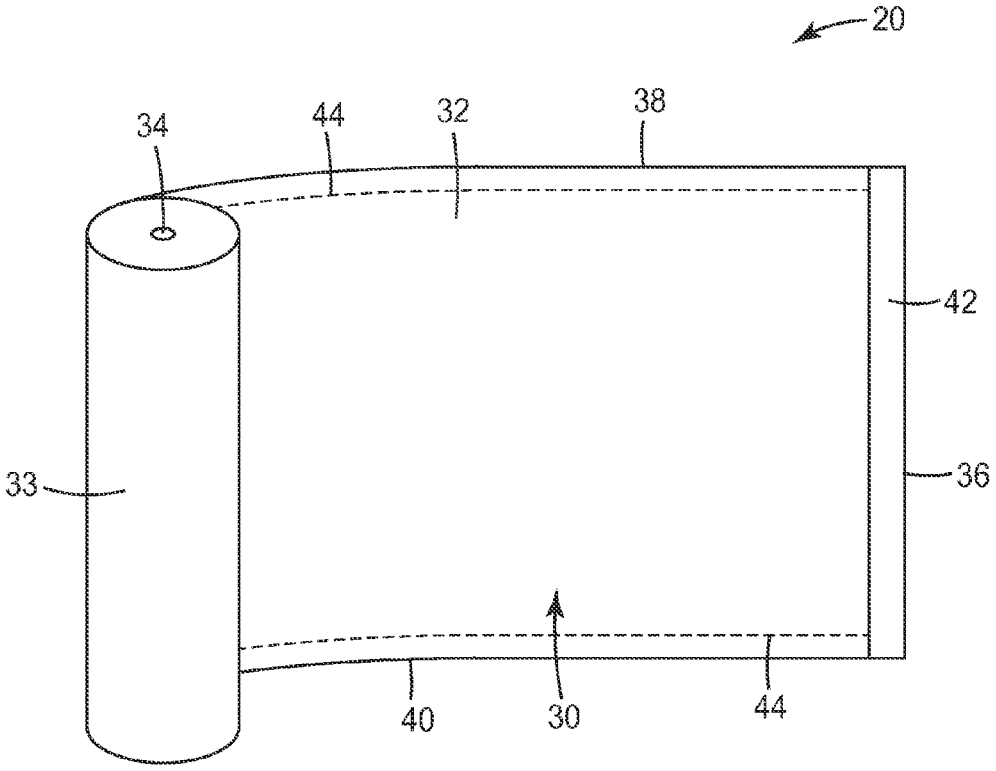


FIG. 1

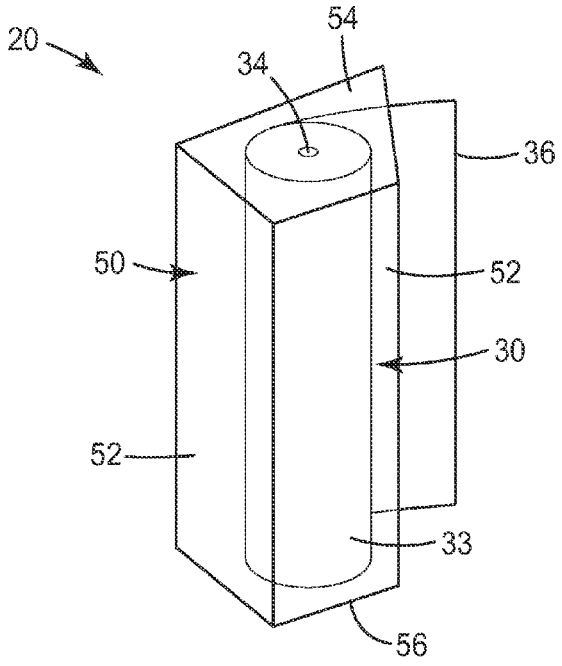

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FIG. 2A

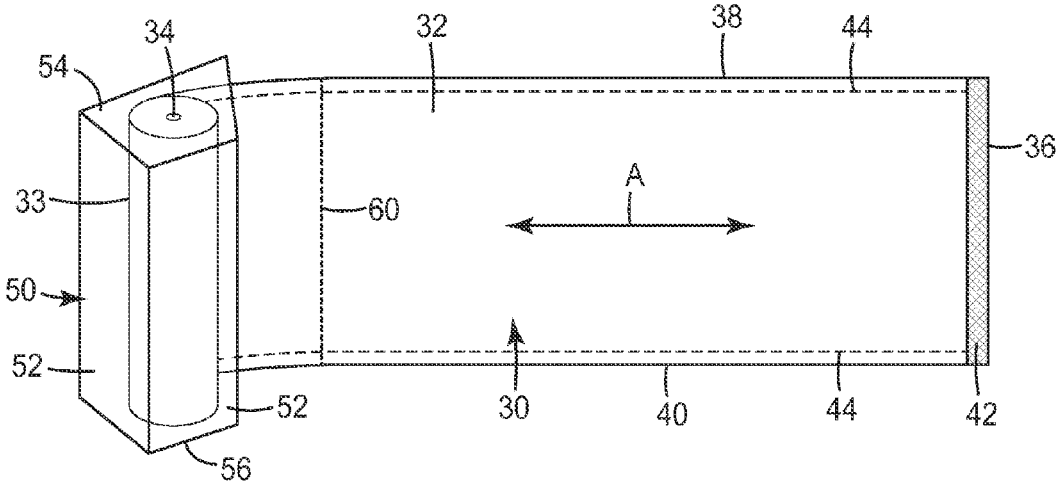
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FIG. 2B

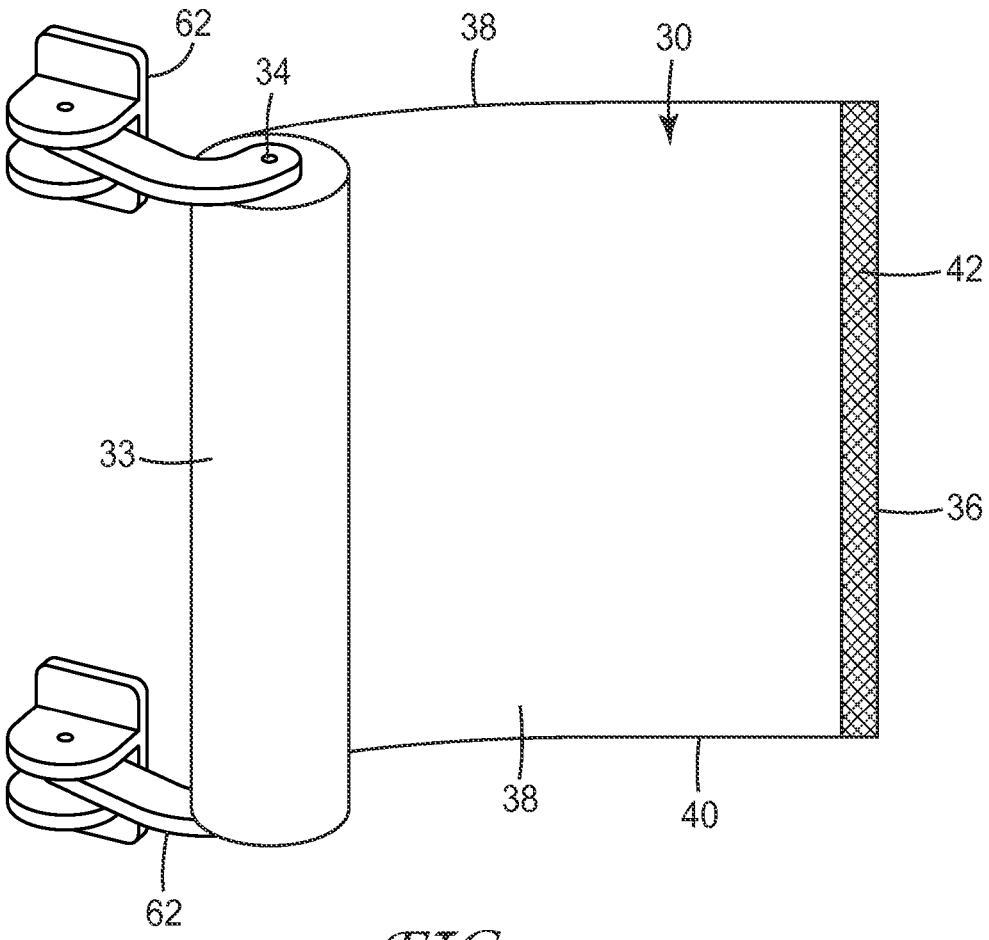

FIG. 3

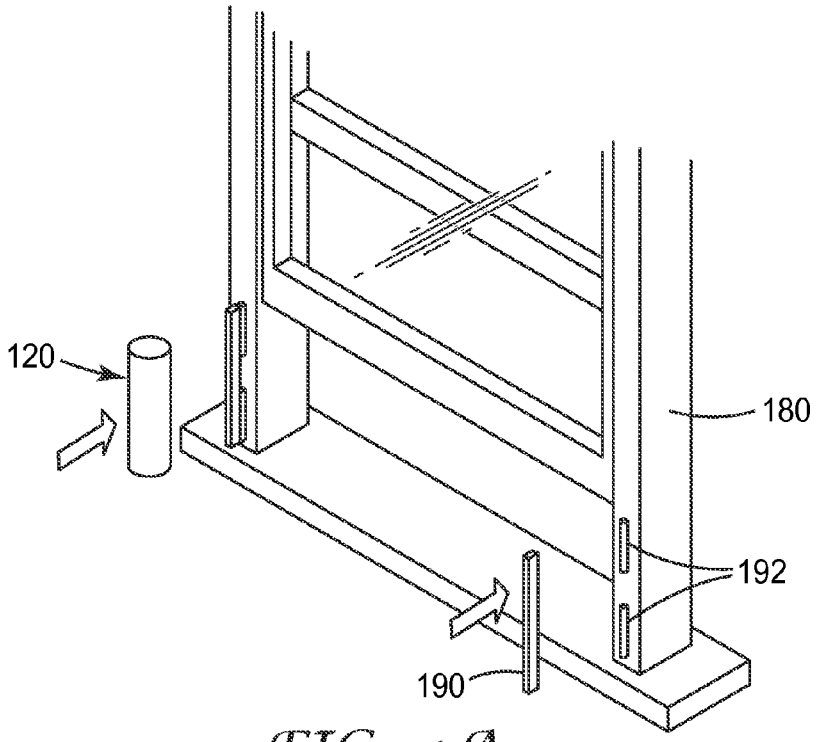

FIG. 4A

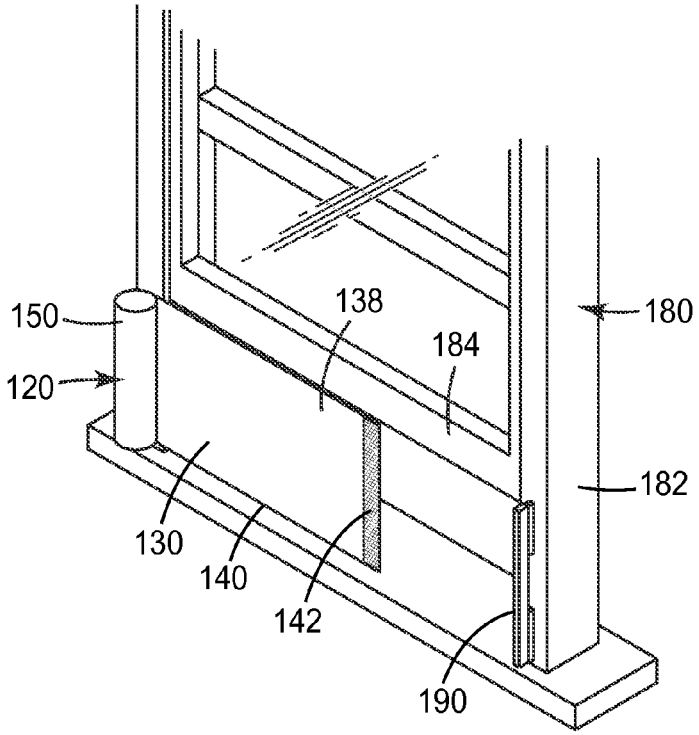

FIG. 4B

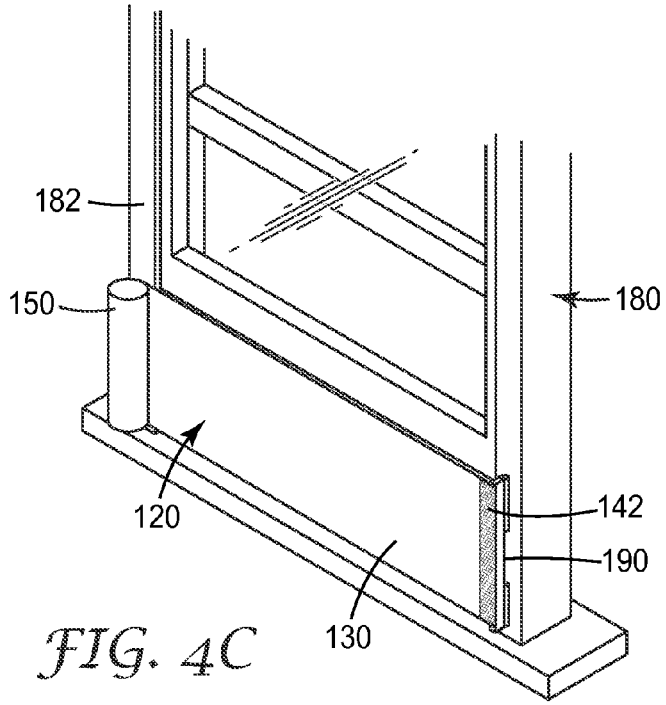

FIG. 4C

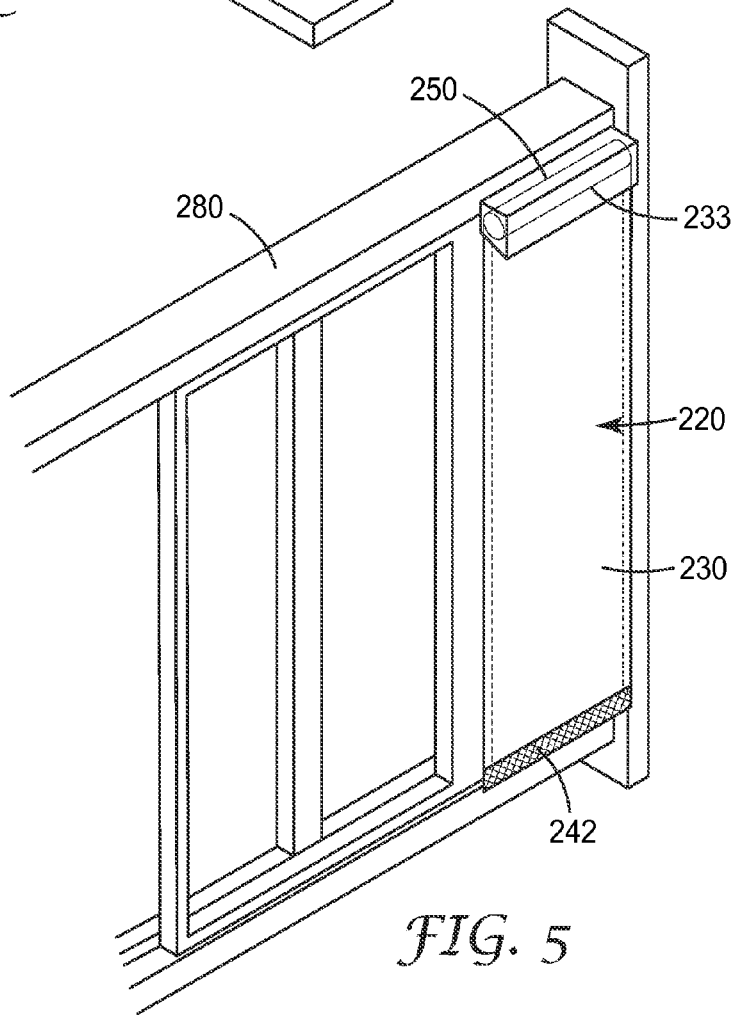

FIG. 5

AIR FILTER CONFIGURED IN A ROLL

TECHNICAL FIELD

[0001] The present disclosure relates to air filters. More particularly, it relates to adjustably sized air filter systems capable of use in a window opening.

BACKGROUND

[0002] Windows are available in a large variety of sizes and can include vertically or horizontally operable sashes to provide air flow between an exterior and an interior of a building structure. Occupants of a building structure often desire opening windows to let fresh air into an interior of a home, business, or otherwise enclosed space. However, in many locations, such as highly populated areas of China, the outside air is more contaminated than the indoor air. Novel filtering solutions are needed to let the fresh aspects of the outdoor air in without letting in the pollution or contaminants. Outdoor contaminants may include larger particles such as pollen, dust, and mold spores and smaller particles such as those forming $PM_{2.5}$, bacteria, and viruses. Gaseous outdoor pollutants such as odors, NO_x, SO_2, ozone, and others may also be of concern in some locations.

SUMMARY

[0003] The inventors of the present disclosure recognized that, in light of the above, a need exists for an air filter that protects users from air quality contaminants, allows fresh air get into the home through windows, can be easily installed and used by consumers, is versatile to fit in most locations, and/or has minimal impact on lighting and visibility. In some embodiments, the filter is a window air filter.

[0004] The inventors of the present disclosure invented various embodiments of air filters, methods of making air filters, and methods of using air filters.

[0005] Some embodiments relate to an air filter comprising filter media assembly configured in a roll, the filter media assembly including filter media having a leading end opposite a trailing end and first and second opposed side edges extending between the leading end and the trailing end.

[0006] In some embodiments, the air filter further comprises a housing for containing the filter media assembly. In some embodiments, the leading edge can be releasably retained on at least one of the exterior or interior of the housing. In some embodiments, the filter media assembly is replaceable within the housing. In some embodiments, at least one of the leading edge and the trailing edge includes a looped structure, a hooked structure, and/or a fastening device. In some embodiments, the first end includes a handle. In some embodiments, the filter media assembly is retractable on the roll. In some embodiments, the roll includes a central member that is under spring tension. In some embodiments, the central member provides stopping points. In some embodiments, the filter media assembly includes sufficient filter media for multiple uses. In some embodiments, the filter media assembly includes separation and/or perforation lines or points.

[0007] Some embodiments further include a hinged attachment mechanism. In some embodiments, the hinged attachment mechanism is combined with the housing or attached to the central member. In some embodiments, the hinged attachment mechanism is rotatable.

[0008] In some embodiments, the filter media is at least one of moisture-resistant, moisture-repellant, electrostatically charged, an electret nonwoven web, and/or not electrostatically charged. In some embodiments, the filter media includes at least one of carbon, activated carbon, a nonwoven, a thermoplastic, a thermosetting material, a porous foam, fiberglass, paper, a high loft spunbound web, a low loft spunbound web, a meltblown web, and/or bi-modal fiber diameter meltblown media. In some embodiments, the filter media is pleated. In some embodiments, the filter media is at least one of self-supporting and non-self-supporting.

[0009] Some embodiments further include a cutting device capable of cutting the filter media to a desired size. In some embodiments, the cutting device is integrated into the housing.

[0010] In some embodiments, the air filter is a window air filter.

[0011] Some embodiments relate to a kit comprising an air filter as described above or herein and a cutting device capable of cutting the filter media to a desired size. In some embodiments, the cutting device is integrated into the housing.

[0012] Some embodiments relate to a kit comprising an filter as described above or herein and an attachment device capable of permanently or semi-permanently attaching the air filter to a window. In some embodiments, the attachment device is at least one of a nail, a screw, a hook, an adhesive, and/or an adhesive backed interlocking strip.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. **1** is a perspective view of an exemplary retractable air filter in accordance with principles of the present disclosure;

[0014] FIG. **2**A is a perspective view of an exemplary retractable air filter in a retracted state in accordance with principles of the present disclosure;

[0015] FIG. **2**B is a perspective view of an exemplary retractable air filter in a un-retracted state in accordance with principles of the present disclosure;

[0016] FIG. **3** is a perspective view of an exemplary retractable air filter in accordance with principles of the present disclosure;

[0017] FIGS. **4**A-**4**C are perspective views of an exemplary retractable air filter for use in, for example, a vertically opening window in accordance with principles of the present disclosure; and

[0018] FIG. **5** is a side view of an exemplary retractable air filter installed in, for example, a horizontally opening window in accordance with principles of the present disclosure.

DETAILED DESCRIPTION

[0019] Various embodiments and implementations will be described in detail. These embodiments should not be construed as limiting the scope of the present application in any manner, and changes and modifications may be made without departing from the spirit and scope of the embodiments and implementations. For example, many of the embodiments, implementations, and examples are discussed with specific reference to window air filters, but these should not be construed to limit the application scope to this one exemplary implementation. Further, only some end uses have been discussed herein, but end uses not specifically described herein are included within the scope of the present

application. As such, the scope of the present application should be determined by the claims.

[0020] One embodiment of a retractable filter **20** useable in a window in accordance with principles of the present disclosure is illustrated in FIG. **1**. The retractable filter **20** includes a filter media assembly **30** having a filter media **32**. In some embodiments, the filter media assembly **30** can be in the form of a roll **33**. In some embodiments, the filter media **32** is wound on a central member **34** and can be easily expanded and retracted (i.e. unrolled and rolled back up). Details on the various components are provided below.

[0021] In general terms, the adjustable length of the filter media assembly **30**, due to the retractable nature, allows it to fit in a wide variety of window sizes. The retractable filter **20** can be attached to a partially opened window. The retractable filter **20** can fit a wide variety of window sizes. The retractable filter **20** can be employed in a partially open window, where only 10-30% of the window area is blocked, for example, leaving a large percentage of the window area still open for light passage and visibility.

[0022] In some embodiments, a roll of filter media assembly **30** has a first, or leading, end **36** and a second, or trailing, end (not shown) opposite the first end **36** adjacent to a central member **34**. First and second side edges **38**, **40** extend between the first end **36** and the second end. In some embodiments, the filter media assembly **30** is generally rectangular when extended. In some embodiments, the first end **36** can include a handle **42** for increased usability. In some embodiments, one or both of the first and second side edges **38**, **40** can include a looped structure (generally indicated by dashed line **44**) or other fastening device, as is discussed in more detail below.

[0023] As illustrated in FIGS. **2**A-**2**B, in some embodiments, the central member **34** may be contained within a housing **50**. The housing **50** can be any suitable shape for containing the roll **33** and/or providing expansion and retraction of the filter media assembly **30**. Some exemplary shaped include rectangular or tubular. In some embodiments, the housing **50** includes at least one side **52** and, optionally, top and bottom ends **54**, **56**. In some embodiments, the leading end **36** of the filter media assembly **30** is easily accessible to a user and/or can be releasably retained on an exterior or interior of the housing **50**. In some embodiments, the filter media assembly **30** is replaceable within the housing **50**. In some embodiments, the filter media assembly **30** can be user replaceable without replacing the housing **50** and/or mounting components (see, e.g., FIG. **3**). In some embodiments, the filter media assembly **30** may also be replaceable without requiring replacement of internal winding (e.g. spring) components. For example, a refill filter media assembly **30** may slidably engage the central member **34** containing the winding components. The housing **50** can provide several benefits, such as, for example, improved seal between the filter media **32** and the window frame, improved aesthetic design, and/or enhanced locations and surface area for mounting the retractable filter **20** to the window structure. In some embodiments, the housing **50** provides a further benefit by firmly defining and fixing the distance between the mounting members for the two ends of the media central roll **34**, which aids in assembly versus requiring the user to measure and install separate brackets.

[0024] In some embodiments, the filter media assembly **30** is retractable onto the roll **33** and unwound, or expanded, from the roll **33**, as indicated by arrow "A" of FIG. **2**B. In some embodiments, the central member **34** can be a spring-wound inner shaft or similar structure to provide retractability of the filter media assembly **30**. In some embodiments, when the user desires to use the retractable filter **20** in the window, the filter media assembly **30** is unrolled by pulling on the handle **42** of the leading end **36**. In some embodiments, the filter media assembly **30** unwinds from the central shaft member **34**, which is under a spring tension, as the user continues to pull. In one embodiment, the central member **34** and spring mechanism (not shown) can provide stopping points, where the length of the unwound filter media assembly **30** can be temporarily fixed, until the spring mechanism is re-engaged. When the user wants to return the filter media assembly **30** to within the housing **50** or otherwise retract the filter media assembly **30**, for example to close the window, the user re-engages the spring mechanism, which re-winds the filter media assembly **30** back into the housing **50**.

[0025] In some embodiments, the filter media assembly **30** includes filter media **32** of suitable size to fit a wide variety of window dimensions. In some embodiments, the filter media assembly **30** may be longer than needed for a single use. In some embodiments, the filter media assembly **30** has a length suitable to provide for one or more filter media **32** changes, for example, wherein the dirty filter media **32** is discarded, and a clean segment of filter media **32** is unwound from the next section on the filter media assembly **30**. In some embodiments, the filter media assembly **30** can be cut to expose a new length of clean filter media **32**, providing for multiple filter changes from a single filter media assembly **30**. With particular reference to FIG. **2**B, in some embodiments, the filter media assembly **30** includes a plurality of separation lines **60** to divide the filter media assembly **30** into discrete filter lengths. In some embodiments, each separation line **60** can be formed from any number of through-cuts suitable to provide separation. In one embodiment, the separations lines **60** are perforated lines formed at positions along the filter media assembly **30** corresponding to common window widths. The separation lines **60** can be at varying (e.g., increasing or decreasing) distances from one another or uniform distances. Additionally, or alternately, a cutting device (not shown) may be integrated into the housing **50**. Any cutting device may be used. In some embodiments, the cutting device can, for example, be a thin metal strip having a serrated edge.

[0026] In some embodiments, the filter media assembly **30** may incorporate looped structures **44**, for example, either integrally or by addition, such as lamination, into one or both of the first and second side edges **38**, **40**. The loop structure **44** may be mated to a hook structure (see, e.g., FIG. **4**A) which is applied to the window frame and/or sash members. In some embodiments, the combined hook/loop structure holds in the filter media assembly **30** in place and reasonably seals the side edges **38**, **40** from air bypassing the filter media assembly **30**. In some embodiments, low-profile hooks, such as used in diapers, may be used, preferably with an adhesive back-side coating. In some embodiments, the hook and loop may be reversed in attachment orientation. In some embodiments, for example, where the retractable filter **20** is mounted in a recessed window, where a good mating edge for hook and loop attachment may not be available, the retractable filter **20** may include secondary strips or structures that can be attached to the window frame and/or sash to help facilitate the engagement. In some embodiments, the

filter media **32** may also or alternatively be conformable, which will allow the filter media **32** to attach to hook structures in multiple planes.

[0027] FIG. **3** illustrates an exemplary retractable filter **20** including a hinged attachment mechanism **62**, which may be combined with the housing **50** or which may be attached directly to the central member **34** at the roll **33** and the window. In one embodiment, the hinge **62**, or similar mechanism, is rotatable to allow the filter media assembly **30** to pivot away from the window when the filter media assembly **30** is not in use and swing into the window when in use. This motion could allow for easier user interface and help enable better sealing of the filter media assembly **30** to the window cavity. In some embodiments, a locking mechanism (not shown) may be included to help retain the housing **50** in one or more rotated positions.

[0028] The particular filter media **32** selected for the filter media assembly **30** can be particularly suited have any of the particular desired characteristics described herein. In some embodiments, the filter media assembly **30** is constructed from moisture-resistant materials. In some embodiments, the filter media may include additional layers or features to specifically block or repel water, such as rain. In some embodiments, an electrostatic charge is optionally imparted into or onto material(s) of the filter media **32**. In some embodiments, an electrostatically charged media **32** may be used, of which many grades are available, and many of which offer high efficiency with low pressure drop. In some embodiments, the filter media **32** can be an electret nonwoven web. Electric charge can be imparted to the filter media **32** in a variety of ways as is well known in the art, for example by hydrocharging, corona charging, etc. (e.g., as described in U.S. Pat. No. 7,947,142, the entirety of which is incorporated by reference herein).

[0029] In other embodiments, the filter media **32** is not electrostatically charged. In some embodiments, additional multi-functional media grades, which incorporate activated carbon or other materials for purifying gas-phase pollutants, may also or alternatively be incorporated into the filter structure. In some embodiments, the filter media **32** can be constructed, for example, from nonwoven fibrous media formed of thermoplastics or thermosetting materials such as polypropylene, linear polyethylene and polyvinyl chloride. Other suitable, non-limiting materials for the filter media include porous foams, nonwovens, papers, fiberglass, or the like. In some embodiments, the filter media **32** comprises a filter media that attracts and captures dust, allergens (such as pollen and mold spores), and/or fine particle pollution from the outdoor air.

[0030] Other nonwoven webs useful with the filter media **32** can be a high loft spunbond webs, such as described, for example, in U.S. Pat. No. 8,162,153 to Fox et al., the entirety of which is incorporated herein. In other embodiments, the filter media **32** can be a low loft spunbond web, such as is described in U.S. Pat. No. 7,947,142 to Fox et al., the entirety of which is incorporated herein. In yet other embodiments, nonwoven webs useful with the filter media **32** are generated by other techniques and/or have other characteristics, such as the meltblown nonwoven webs disclosed in U.S. Pat. No. 6,858,297 to Shah et al., the entirety of which is incorporated herein. Other non-limiting example of useful nonwoven web formats include bi-modal fiber diameter meltblown media such as those described in U.S. Pat. No. 7,858,163, the entirety of which is incorporated herein.

[0031] In some embodiments, the filter media **32** is an electrostatically charged nonwoven type of media. In some embodiments, the filter media **32** can be a pleated filter media including at least a portion that has been folded to form a configuration comprising rows of generally parallel, oppositely oriented folds. In some embodiments, pleats can be formed in the filter media **32** (or in the pleated filter media assembly **30**) using various methods and components as are well known in the art, e.g., to form a pleated filter for use in applications such as air filtration., for example those described in U.S. Pat. No. 6,740,137 to Kubokawa et al. and U.S. Pat. No. 7,622,063 to Sundet et al., the entire teachings of both of which are incorporated herein by reference.

[0032] In some embodiments, the filter media **32** can consist of the filter media or web alone or can include one or more additional components or structures applied or assembled to the filter media **32** so long as the resultant filter media assembly **30** can at least be transitioned from the rolled condition to the unrolled condition without significantly damaging the structural integrity of the filter media assembly **30**. In some embodiments, the filter media can be repeatedly transitioned between the rolled and unrolled conditions without significantly damaging the structural integrity of the filter media assembly **30**. The filter media **32** of the assembly **30** can be self-supporting or non-self-supporting. For example, where the filter media assembly **30** consists of the filter media **32** alone, the filter media or web can be self-supporting or non-self-supporting. In some embodiments, where the filter media assembly **30** consists of the filter media or web **32** and a support structure, the filter media **32** can be non-self-supporting with an additional supporting structure rendering the filter media assembly **30**, as a whole, to be self-supporting. For example, the filter media **32** can be wire-backed. As used herein, the term "self-supporting filter media or web" can describe at least one of the following conditions: (1) a filter media or web that is deformation resistant without requiring stiffening layers, adhesive or other reinforcement in the filter media web; or (2) the filter media generally maintains its shape when subjected to an airstream as described, for example, in U.S. Pat. No. 7,169,202 to Kubokawa, the entire teachings of which are incorporated herein by reference; or (3) a web or media having sufficient coherency and strength so as to be drapable and handleable without substantial tearing or rupture. As used herein, the term "non-self-supporting" can denote an air filter media that is not capable, in the absence of a support frame and/or a support grill, of withstanding the forces encountered due to typical air flow.

[0033] In some embodiments, the retractable air filters **20** are useful in protecting users from outside air quality contaminants As discussed above, an electrostatically charged media **32** may be used. Additional multi-functional media grades, which incorporate activated carbon or other materials for purifying gas-phase pollutants, may also be incorporated into the filter media assembly **30**. By incorporating an extended surface area and by covering moderate portion of the window, in combination with using a low pressure drop web enabled by the electrostatic charging, a reasonably low pressure drop can be achieved for the filter, which may help provide moderate airflow through the filter.

[0034] FIGS. **4**A-**4**C illustrate aspects of the materials and construction of an exemplary retractable filter **120**, similar to retractable filter **20**, installed in a sliding-type window **180**, which can be either single or double hung. Sliding windows are predominant in North America and China. Attachment of the retractable filter **120** to a window **180**, with or without housing **150**, may be either permanent or semi-permanent. In some embodiments, attachment mechanisms **190**, **192** provide secure holding of the retractable filter **120** to the window **180** because the attachment point may undergo moderate stress from the inner spring forces as the filter media assembly **130** is extended and retracted. Some exemplary permanent fixation options include nails, screws, and certain types of adhesives. In some embodiments, the attachment is semi-permanent, such as using Command™ strips, adhesively backed interlocking hooks, rare earth magnets, etc. The housing **150** may be attached to the window frame **182** (or surrounding structures) in the major plane of the window, or it may be attached to the window frame **182** (or surrounding structures) perpendicular to the major plane of the window **180**. In another embodiment, the housing **150** may not be mounted to the window frame **182** at all, and may rather be pinched between the window sash **184** and the window frame **182**. When expanded, the side edges **138**, **140** of the filter media assembly **130** can be attached to the window frame/sill members with mechanical or adhesive components.

[0035] Finally, similar to the vertical sliding window **180** of FIGS. **4**A-**4**C discussed above, FIG. **5** illustrates an exemplary retractable filter **220** installed in a horizontal sliding window **280**. In some embodiments, the housing **250** of the retractable filter **220** is attached at one end of the window **280**, the window **280** is partially opened, and the filter media assembly **230** is expanded to cover the window gap. It is noted that a small gap may be created between the two window segments, allowing air to flow from the outside between the two window segments and bypassing the filter media assembly **230** to gain entry to the indoors. In some embodiments, this bypass may be avoided by the use of a piece of foam, weather-stripping, etc. (not shown).

[0036] The air filters of the present disclosure can be placed in any desired frame or housing. Some exemplary frames are described in, for example, U.S. Patent Application No. 62/041,496 and 62/041,499, both of which are incorporated in their entirety herein. The air filter assembly of the present disclosure can be used in a powered air filtration system such as, for example, that described in U.S. Patent Application No. 62/041,501, incorporated herein in its entirety. The air filter assembly or media of U.S. Pat. No. 62/206,928 can be used in the air filters of the present disclosure.

[0037] The terms first, second, third and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequential or chronological order. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein.

[0038] All references mentioned herein are incorporated by reference in their entirety.

[0039] Moreover, the terms top, bottom, over, under and the like in the description and the claims are used for descriptive purposes and not necessarily for describing relative positions. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other orientations than described or illustrated herein.

[0040] The recitation of all numerical ranges by endpoint is meant to include all numbers subsumed within the range (i.e., the range 1 to 10 includes, for example, 1, 1.5, 3.33, and 10).

[0041] Those having skill in the art will appreciate that many changes may be made to the details of the above-described embodiments and implementations without departing from the underlying principles thereof. Further, various modifications and alterations of the present invention will become apparent to those skilled in the art without departing from the spirit and scope of the invention. The scope of the present application should, therefore, be determined only by the following claims and equivalents thereof.

1. An air filter comprising:

filter media assembly configured in a roll, the filter media assembly including filter media having a leading end opposite a trailing end and first and second opposed side edges extending between the leading end and the trailing end.

2. The air filter of claim **1**, further comprising:

a housing for containing the filter media assembly.

3. The air filter of claim **2**, wherein the leading edge can be releasably retained on at least one of the exterior or interior of the housing.

4. The air filter of claim **2**, wherein the filter media assembly is replaceable within the housing.

5. The air filter of claim **1**, wherein at least one of the leading edge and the trailing edge includes a looped structure, a hooked structure, and/or a fastening device.

6. The air filter of claim **1**, wherein the first end includes a handle.

7. The air filter of claim **1**, wherein the filter media assembly is retractable on the roll.

8. The air filter of claim **1**, wherein the roll includes a central member that is under spring tension.

9. The air filter of claim **8**, wherein the central member provides stopping points.

10. The air filter of claim **1**, wherein the filter media assembly includes sufficient filter media for multiple uses.

11. The air filter of claim **1**, wherein the filter media assembly includes separation and/or perforation lines or points.

12. The air filter of claim **1**, further including a hinged attachment mechanism.

13. The air filter of claim **12**, wherein the hinged attachment mechanism is combined with the housing or attached to the central member.

14. The air filter of claim **13**, wherein the hinged attachment mechanism is rotatable.

15. The air filter of claim **1**, wherein the filter media is at least one of moisture-resistant, moisture-repellant, electrostatically charged, an electret nonwoven web, and/or not electrostatically charged.

16. The air filter of claim **1**, wherein the filter media includes at least one of carbon, activated carbon, a nonwoven, a thermoplastic, a thermosetting material, a porous foam, fiberglass, paper, a high loft spunbound web, a low loft spunbound web, a meltblown web, and/or bi-modal fiber diameter meltblown media.

17. The air filter of claim **1**, wherein the filter media is pleated.

18. The air filter of claim **1**, wherein the filter media is at least one of self-supporting and non-self-supporting.

19. The air filter of claim **1**, further including a cutting device capable of cutting the filter media to a desired size.

20. The air filter of claim **19**, wherein the cutting device is integrated into the housing.

21. The air filter of claim **1**, wherein the air filter is a window air filter.

22. A kit, comprising:

an air filter of claim **1**; and

a cutting device capable of cutting the filter media to a desired size.

23. The kit of claim **22**, wherein the cutting device is integrated into the housing.

24. A kit, comprising:

an air filter of claim **1**; and

an attachment device capable of permanently or semi-permanently attaching the air filter to a window.

25. The kit of claim **24**, wherein the attachment device is at least one of a nail, a screw, a hook, an adhesive, and/or an adhesive backed interlocking strip.

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