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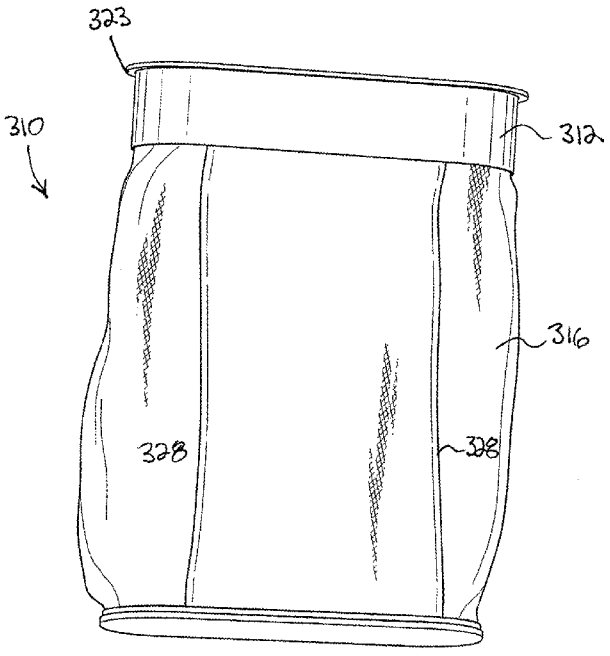


FIG. 2

(57) Abstract: A filter configured to separate debris from a flow of fluid. The filter includes a housing and a filter media coupled to the housing to form a collection container. The collection container is configured to store debris separated by the filter media from a flow of fluid. The filter further includes an inlet opening that extends through the housing to provide fluid communication into the collection container such that the flow of fluid with the debris can flow into the collection container and a relatively clean flow of fluid exits through the filter media. The filter further includes an attachment member that couples the filter media to the housing.

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# VACUUM FILTER

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application claims priority to the following: U.S. Provisional Patent Application No. 62/323,384, filed April 15, 2016, U.S. Provisional Patent Application No. 62/361,718, filed July 13, 2016, U.S. Provisional Patent Application No. 62/457,329, filed February 10, 2017, U.S. Provisional Patent Application No.62/457,543, filed February 10, 2017, the entire contents all of which are hereby incorporated by reference herein.

## FIELD OF THE INVENTION

**[0002]** The present invention relates to filters for vacuums.

## BACKGROUND

**[0003]** Conventional vacuum cleaners collect debris using either a dust bag or a dust bin connected to a cyclone. For vacuums utilizing a cyclone and dust bin to collect debris, the debris is disposed of and the cyclone and dust bin is reused. For vacuums utilizing a dust bag to collect and store debris, the bag is discarded and replaced with a new bag once the dust bag is full.

## SUMMARY

**[0004]** In one embodiment, disclosed is a filter configured to separate debris from a flow of fluid. The filter includes a housing and a filter media coupled to the housing to form a collection container. The collection container is configured to store debris separated by the filter media from a flow of fluid. The filter further includes an inlet opening that extends through the housing to provide fluid communication into the collection container such that the flow of fluid with the debris can flow into the collection container and a relatively clean flow of fluid exits through the filter media. The filter further includes an attachment member that couples the filter media to the housing.

**[0005]** In another embodiment, disclosed is a filter is configured to separate debris from a flow of fluid. The filter includes a housing having a first inner volume and a filter media having a first end and a second end. The filter further includes an attachment member that couples the filter media to the housing at least partially forming a collection container

configured to store the debris separated by the filter media. The first end of the filter media is folded such that at least a portion of the first end extends away from the housing forming an overlapping filter media section.

**[0006]** In another embodiment, disclosed is a filter configured to separate debris from a flow of fluid. The filter comprises a housing having a first inner volume, a filter media having a first end, a second end, and a second inner volume between the first and second ends. The filter media is coupled to the housing at the first end of the filter media such that the first and second inner volumes together at least partially define a collection container configured to store the debris separated by the filter media from the flow of fluid. The filter further includes an inlet opening that extends through the housing to provide fluid communication into the collection container such that the flow of fluid with debris can flow into the collection container and a relatively clean flow of fluid exits through the filter media between the first and second ends of the filter media. The filter media is collapsible into the first inner volume of the housing.

**[0007]** In another embodiment, disclosed is a filter configured to separate debris from a flow of fluid. The filter includes a first housing, a second housing having a first inner volume, and a filter media having a first end, a second end, and a second inner volume between the first and second ends. The filter media is coupled to the first housing at the first end of the filter media and the filter media is coupled to the second housing at the second end of the filter media such that the first and second inner volumes together at least partially define a collection container configured to store the debris separated by the filter media. The filter further includes an inlet opening that extends through the first housing to provide fluid communication into the collection container such that the flow of fluid with debris can flow into the collection container and a relatively clean flow of fluid exits through the filter media between the first and second ends of the filter media. The filter media is collapsible into the first inner volume of the second housing.

**[0008]** In another embodiment, disclosed is a filter configured to separate debris from a flow of fluid. The filter includes a first housing, a second housing, and a filter media having a first end, a second end, and an inner volume between the first and second ends. The filter media is coupled to the first housing at the first end of the filter media and the filter media is coupled to the second housing at the second end of the filter media such that the first and second housings and the inner volume of the filter media together at least partially define a

collection container configured to store the debris separated by the filter media. The filter further includes an inlet opening that extends through the first housing to provide fluid communication into the collection container such that the flow of fluid with debris can flow into the collection container and a relatively clean flow of fluid exits through the filter media between the first and second ends of the filter media. The filter media is collapsible between the first and second housing in a collapsed position and the filter media is movable to an expanded position.

**[0009]** In another embodiment, disclosed is a method of manufacturing a filter. The method includes providing a housing having an inlet aperture, rolling a filter media into a cylindrical shape with a first end and a second end, after rolling the filter media, attaching the first end of the filter media to the housing to close the first end of the filter media, after rolling the filter media, closing the second end of the filter media. The method further includes collapsing the filter media within in an inner volume of the housing.

**[0010]** Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

**[0011]** FIG. 1 is a perspective view of a filter in a collapsed position according to an embodiment of the invention.

**[0012]** FIG. 2 is a perspective view of the filter of FIG. 1 in an expanded position.

**[0013]** FIG. 3 is a perspective view of the filter of FIG. 2, illustrating filter media of the filter without an upper and lower housing.

**[0014]** FIG. 4 is a cross-sectional view of the filter in the collapsed position.

**[0015]** FIG. 5A is an exploded cross-sectional view of the filter in the expanded position.

**[0016]** FIG. 5B is a cross-sectional view of the filter along line 5B-5B of FIG. 5A.

**[0017]** FIG. 6 is a perspective view of an interior of the filter with a portion of the filter media cutaway.

**[0018]** FIG. 7A is a cross-sectional view of the filter, illustrating the filter media of the filter without the upper and lower housing.

**[0019]** FIG. 7B is an enlarged view of the filter of FIG. 7A, illustrating an embodiment of an attachment member.

**[0020]** FIG. 7C is an enlarged view of the filter of FIG. 7A, illustrating another embodiment of an attachment member.

**[0021]** FIG. 8A is a perspective view of a filter in a collapsed position according to an embodiment of the invention.

**[0022]** FIG. 8B is a perspective view of the filter of FIG. 8A in an expanded position.

**[0023]** FIG. 8C is a perspective view of an alternative embodiment of the filter of FIG. 8A in an expanded position.

**[0024]** FIG. 9A is a perspective view of a filter in a collapsed position according to an embodiment of the invention.

**[0025]** FIG. 9B is a perspective view of the filter of FIG. 9A in an expanded position.

**[0026]** FIG. 10A is a perspective view of a filter in a collapsed position according to an embodiment of the invention.

**[0027]** FIG. 10B is a perspective view of the filter of FIG. 10A in an expanded position.

**[0028]** FIG. 11A is a perspective view of a filter in a collapsed position according to an embodiment of the invention.

**[0029]** FIG. 11B is a perspective view of the filter of FIG. 11A in an expanded position.

**[0030]** FIG. 12A is a perspective view of a filter in a collapsed position according to an embodiment of the invention.

**[0031]** FIG. 12B is a perspective view of the filter of FIG. 12A in an expanded position.

**[0032]** FIG. 13A is a perspective view of a filter in a collapsed position according to an embodiment of the invention.

**[0033]** FIG. 13B is a perspective view of the filter of FIG. 13A in an expanded position.

**[0034]** FIG. 14A is a perspective view of a filter in a collapsed position according to an embodiment of the invention.

**[0035]** FIG. 14B is a perspective view of the filter of FIG. 14A in an expanded position.

**[0036]** FIG. 15A is a perspective view of a filter in a collapsed position according to an embodiment of the invention.

**[0037]** FIG. 15B is a perspective view of the filter of FIG. 15A in an expanded position.

**[0038]** FIG. 15C is a bottom side view of the filter of FIG. 15A in the collapsed position.

**[0039]** FIG. 16A is a cross-sectional view of a filter according to an embodiment of the invention.

**[0040]** FIG. 16B is a cross-sectional view of a filter according to an embodiment of the invention.

**[0041]** FIG. 17A is a cross-sectional view of a filter according to an embodiment of the invention.

**[0042]** FIG. 17B is a cross-sectional view of a filter according to an embodiment of the invention.

**[0043]** FIG. 18A is a perspective view of filter media for use in a filter embodying the invention.

**[0044]** FIG. 18B is a perspective view of filter media for use in a filter embodying the invention.

**[0045]** FIG. 18C is a perspective view of filter media for use in a filter embodying the invention.

**[0046]** FIG. 19 is a cross-sectional view illustrating a method of manufacturing a filter embodying the invention.

**[0047]** FIG. 20 is a cross-sectional view further illustrating the method of FIG. 19.

**[0048]** FIG. 21A is a cross-sectional view of a filter according to an embodiment of the invention.

**[0049]** FIG. 21B is a cross-sectional view of a filter according to an embodiment of the invention.

**[0050]** FIG. 22 is a cross-sectional view of a filter according to an embodiment of the invention.

**[0051]** FIG. 23 is a cross-sectional view of a filter according to an embodiment of the invention.

**[0052]** FIG. 24 is a perspective view of a housing for use in a filter embodying the invention.

**[0053]** FIG. 25 is a bottom side view of the housing of FIG. 24 before the housing is formed into the position illustrated in FIG. 24.

**[0054]** FIG. 26 is a perspective view of a filter according to an embodiment of the invention with the filter media in a collapsed position.

**[0055]** FIG. 27 is a perspective view of the filter of FIG. 36 illustrating the filter media in an expanded position.

**[0056]** 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

**[0057]** Figures 1 and 2 illustrate a filter 310. The filter 310 can move between a collapsed position (FIG. 1) and an expanded position (FIG. 2). The filter 310 may be supplied to the consumer in the collapsed position. Then, in one embodiment, the filter 310 is installed in a device in the collapsed position and then automatically moves to the expanded position. The filter 310 can automatically move to the expanded position by air

pressure, gravity, mechanical push or pull, etc. In an alternative embodiment, the consumer moves the filter to the expanded position prior to installing the filter into a device. The filter 310 can be used to filter any suitable fluid in several applications. For example, the filter 310 can be used in vacuum cleaners, air purifiers, HVAC systems, automotive applications, etc.

**[0058]** With reference to FIGS. 1 and 2, the filter 310 includes a first or upper housing 312, a second or lower housing 314, and filter media 316. The upper housing 312 includes an inlet opening 318 that provides fluid communication into the filter 310. In some embodiments, a valve 319 is located within the inlet opening 318 to open and close the inlet opening 318. For example, when the filter 310 is ready to be removed from the device (e.g., vacuum), the valve 319 is closed so that debris within the filter 310 does not escape through the inlet opening 318. The upper housing 312 has an inner volume 320 (see FIG. 5A) within the housing 312. Likewise, the lower housing 314 includes an inner volume 321. The inner volumes 320, 321 of the upper housing 312 and the lower housing 314 can be equal or one of the volumes can be greater than the other. In various alternatives, the inner volumes of one or both of the upper housing and the lower housing are small or inappreciable due to the shape of the housing. The upper housing 312 and the lower housing 314 can be formed from any suitable material, such as thermoplastic material, thermoset material, molded paper pulp, formed or molded filter media, or any other suitable material. Alternatively or additionally, the upper housing 312 forms a support collar 323 for installing the filter 310 in a vacuum cleaner.

**[0059]** With reference to FIG. 3, the filter media 316 includes a first end 322 and a second end 324. The filter media 316 is coupled to the upper housing 312 proximate the first end 322 while, the filter media 316 is coupled to the lower housing 314 proximate the second end 324. An inner volume 326 of the filter media 316 is defined between the first end 322 and the second end 324 of the filter media 316. Optionally, the filter media 316 includes one or more pleats 328 extending between the first end 322 and the second end 324. The pleats 328 enable the filter 310 to enlarge beyond the expanded position in a direction transverse to the direction traveled between the collapsed and expanded positions. In other words, the pleats 328 allow the filter 310 to billow outward in order to collect and store additional debris as the filter 310 fills. The illustrated filter media 316 typically includes a seam 330. Generally, the filter media 316 is a flat piece that is made tubular by joining two ends together, thereby creating the seam 330. As shown, the seam 330 is located within one of the

pleats 328 to substantially hide the seam 330. The seam 330 can be formed by sewing, heat welding, crimping, or other suitable means of coupling the two ends together.

**[0060]** With reference to FIGS. 1 and 2, the filter 310 can move between a collapsed position (FIG. 1) and an expanded position (FIG. 2). In the collapsed position, the filter media 316 is located within the inner volume 320 of the upper housing 312 and/or in the inner volume of the lower housing 314. Also, the upper housing 312 and the lower housing 314 enclose the filter media 316 in the collapsed position. In some embodiments, the upper housing 312 and/or lower housing 314 can snap or otherwise connect together to retain the filter 310 in the collapsed position by interlocking features provided in the upper and lower housings. Alternatively, the filter 310 may be held in the collapsed position by tape, film, bag, or other attachments. Typically, the filter 310 would be supplied to the user in the collapsed position. In the expanded position, the filter media 316 generally expands out to an operative length and is ready for use as a filter. In some applications, the filter 310 automatically moves from the collapsed position to the expanded position. For example, when a flow of dirty fluid enters the filter 310 through the inlet opening 318, the pressure of the fluid automatically expands the filter 310. In other applications, gravity may automatically expand the filter 310, or a mechanism may be used to push or pull one or both housings away from the other.

**[0061]** The inner volume 326 of the filter media, along with the inner volume 320 of the upper housing 312, and the inner volume 321 of the lower housing 314 together define a collection container 332 that stores debris separated by the filter media 316. That is, a dirty fluid (e.g., air and dust, dirt, or other particles) travels into the filter 310 through the inlet opening 318. The dirt or dust is separated from the air flow by the filter media 316 and relatively clean air flows out of the filter 310 through the filter media 316 between the housings 312, 314. This airflow is generally represented by the arrows 334.

**[0062]** The filter 310 further includes a first attachment member 336 that couples the filter media 316 to the upper housing 312. In the illustrated embodiments, the filter media is folded over the first attachment member 336 between the first end 322 and the second end 324 of the filter media 316, but generally closer to the first end 322, before it is connected to the upper housing 312. Stated another way, all or a portion of the first end 322 of the filter media 316 is folded over before being coupled to the upper housing 312. Similarly, the filter 310 includes a second attachment member 338 that couples the filter media 316 to the lower

housing 314 between the first end 322 and the second end 324 of the filter media 316, but closer to the second end 324. The first attachment member 336 is received within a groove 340 of the upper housing 312 holding the filter media in place, whereas the second attachment member 338 is received within a groove 342 of the lower housing 314. The grooves 340, 342 are formed with an inner wall 341 and an outer wall 343. As shown in FIG. 5A, the height H1 of the outer wall 343 is greater than the height H2 of the inner wall 341. In an alternative embodiment, the height H1 of the outer wall 343 is the same as the height H2 of the inner wall 341.

**[0063]** To couple the filter media 316 to the upper housing 312 in the illustrated embodiment, all or a portion of the end of the filter media 316 is folded over the first attachment member 336 and fitted into the groove 340 of the upper housing 312. As such, the filter media 316 is disposed between the groove 340 and the first attachment member 336. The fit between the groove 340 and the attachment member 336 with filter media 316 is a friction or limited clearance fit to wedge the filter media 316 and attachment member 336 into the groove 340 to couple the filter media 316 to the upper housing 312. Alternatively, the attachment member 336 is staked, welded, snap fit, adhered, or otherwise fastened to the upper housing 312 to couple the filter media 316 to the upper housing 312. In one alternative, at least a portion of the edge 322 of the first end 322 of the filter media 316 is retained in the groove 340 by fitting the attachment member 336 into the groove 340. The connection of the filter media 316 to the upper housing 312 is provided around the upper housing 312 inhibiting airflow through the connection.

**[0064]** To couple the filter media 316 to the lower housing 314, the filter media 316 is wrapped around the second attachment member 338 and fitted into the groove 342 of the lower housing 314 in a similar way as described for the filter media 316 coupling to the upper housing 312. As such, the filter media 316 is retained in the groove 342 by fitting the second attachment member 338 into the groove 342. The connection of the filter media 316 to the lower housing 314 is provided around the lower housing 314 inhibiting airflow through the connection. In various alternatives, the connection of the filter media 316 to the lower housing 314 may use a different method than the connection to the upper housing 312. In one alternative, the filter media 316 does not use a lower housing 314, instead closing the second end 324 with a seam or other closure.

**[0065]** The filter 310 may include a first overlapping filter media section 344 and a second overlapping filter media section 346. The first overlapping filter media section 344 is proximate the upper housing 312 and is a result of the first end 322 of the filter media 316 being folded such that at least a portion of the first end 322 extends away from the housing 312 forming the overlapping filter media section 344. In the illustrated embodiment, the first end 322 of the filter media 316 is folded over the attachment member 336 in a manner that the first end 322 extends away from the upper housing 312 a desired length. As such, the filter media 316 overlaps to provide two layers at the first overlapping filter media section 344. The first overlapping filter media section 344 may extend around the perimeter of the filter 310 or may extend along one or more portions of the perimeter of the filter 310. In certain embodiments, all or desired portions of the overlapping filter media 344 may be trimmed, or filter media 316 positioned such that a desired amount of filter media 316 extends beyond the attachment member 336 in predetermined locations. In the embodiment shown in FIG. 15A, the first overlapping filter media section 344 includes a notch 345 in a portion. The notch 345 inhibits parts of a vacuum (e.g., a conduit that extends into the filter) from catching on the filter media when the conduit inserted and removed from the filter. The second overlapping filter media section 46 is proximate the lower housing 314 and is a results of the second attachment member 338 bending the filter media 316 in a manner that the second end 324 extends away from the lower housing 314. As such, the filter media 316 overlaps to provide two layers and forms the second overlapping filter media section 346. The second overlapping filter media section 346 may extend around the perimeter of the filter 310 or may extend along one or more portions of the perimeter of the filter 310. In certain embodiments, all or desired portions of the overlapping filter media 46 may be trimmed, or filter media 316 positioned such that a desired amount of filter media 316 extends beyond the second attachment member 338 in predetermined locations. In the illustrated embodiment, both of the first and second overlapping filter media sections 344, 346 are disposed in the inner volume 326 of the filter media 316. However, for certain embodiments the filter 310 may be constructed with the overlapping filter media portions 344, 346 being positioned to the outside of the filter 310.

**[0066]** As shown in FIGS. 5A and 6, the upper housing 312 may include one or more extension members 348 adjacent the groove 340. The extensions members 348 are positioned in a location to direct the overlapping filter media section 344 to extend in a direction along the outer wall 343 of the upper housing 312 and filter media 316. The extension members

348 may be integrally formed with the upper housing 312 or may be formed separately and installed in the filter 310.

**[0067]** As previously mentioned, the first overlapping filter media section 344 is proximate the upper housing 314. The length and width and location of the first overlapping filter media section 344 or the second overlapping filter media section 346 may be provided where it is in a direct path of some or all of the airflow (see arrow 334 of FIG. 7A) exiting the device (e.g., a discharge conduit of a vacuum) to receive impact of impinging debris as the debris enters the filter 310.

**[0068]** One or both of the attachment members 336, 338 may include a recess, protrusion, or other shape 350 configured for nesting or attaching to a fixture provided to guide the attachment member 336, 338 into the groove 340, 342. As shown in FIGS. 7B and 7C, the attachment member 336, 338 may include the fixturing recess, protrusion, or other shape 350 on the side facing out of the groove 340, 342.

**[0069]** Figures 8A and 8B illustrate a filter 410. The filter 410 can move between a collapsed position (FIG. 8A) and an expanded position (FIG. 8B). The filter 410 may be supplied to the consumer in the collapsed position. Then, in one embodiment, the filter 410 is installed in a device in the collapsed position and then automatically moves to the expanded position. The filter 410 can automatically move to the expanded position by air pressure, gravity, mechanical push or pull, etc. In an alternative embodiment, the consumer moves the filter to the expanded position prior to installing the filter into a device. The filter 410 can be used to filter any suitable fluid in several applications. For example, the filter 410 can be used in vacuum cleaners, air purifiers, HVAC systems, automotive applications, etc.

**[0070]** Referring to FIGs. 8A and 8B, the filter 410 includes a first or upper housing 412, a second or lower housing 414, and filter media 416. The upper housing 412 includes an inlet opening 418 that provides fluid communication into the filter 410. In some embodiments, a valve is located within the inlet opening 418 to open and close the inlet opening 418. For example, when the filter 410 is ready to be removed from the device (e.g., vacuum), the valve is closed so that debris within the filter 410 does not escape through the inlet opening 418. The upper housing 412 has an inner volume 420 (see FIG. 16A) within the housing 412. Likewise, the lower housing 414 includes an inner volume. The inner volumes of the upper housing 412 and the lower housing 414 can be equal or one of the

volumes can be greater than the other. The upper housing 412 and the lower housing 414 can be formed from any suitable material, such as thermoplastic material, thermoset material, molded paper pulp, formed or molded filter media, or any other suitable material.

**[0071]** The filter media 416 includes a first end 422 (see FIG. 16A). The filter media 416 is coupled to the upper housing 412 at the first end 422. Likewise, the filter media 416 has a second end and the filter media 416 is coupled to the lower housing 414 at the second end. As will be discussed in more detail below, the first and second ends of the filter media 416 can be attached to the housings 412, 414 using a variety of methods. An inner volume 424 (see FIG. 16A) of the filter media 416 is defined between the first end 422 and the second end (not shown in FIG. 16A) of the filter media 416.

**[0072]** The inner volume 424 of the filter media, along with the inner volume 420 of the upper housing 412, and the inner volume of the lower housing 414 together define a collection container 425 that stores debris separated by the filter media 416. That is, a dirty fluid (e.g., air and dust, dirt, or other particles) travels into the filter 410 through the inlet opening 418. The dirt or dust is separated from the air flow by the filter media 416 and relatively clean air flows out of the filter 410 through the filter media 416 between the housings 412, 414. This airflow is generally represented by the arrows 426 in FIG. 16A.

**[0073]** Referring to FIG. 8B, in one embodiment, a panel 428 is located at a seam of the filter media 416, for example along a vertical seam. In one alternative, the panel 428 is clear to allow a user to see how much debris is in the filter 410 to indicate to the user when the collection container 425 is full. In addition or in other embodiments, the panel 428 can be decorative and/or can include odor absorbing material.

**[0074]** Referring to FIG. 8C, in an alternative embodiment, the filter may be constructed such that the optional panel 428 may be provided along a horizontal seam. In this construction, the filter media 416 is divided into two sections, and the filter media 416 is attached to the housing 412. The second piece of filter media 416′ is attached to the filter media 416, optionally with the panel 428 provided along the horizontal seam between the filter media sections 416, 416′.

**[0075]** Referring to FIGs. 8A and 8B, the filter 410 can move between a collapsed position (FIG. 8A) and an expanded position (FIG. 8B). In the collapsed position, the filter

media 416 is located within the inner volume 420 (the inner volume being shown in one embodiment in FIG. 16A) of the upper housing 412 and/or in the inner volume of the lower housing 414. Also, the upper housing 412 and the lower housing 414 enclose the filter media 416 in the collapsed position. In some embodiments, the upper housing 412 and/or lower housing 414 can snap or otherwise connect together to retain the filter 410 in the collapsed position by interlocking features provided in the upper and lower housings. Alternatively, the filter 410 may be held in the collapsed position by tape, film, bag, or other attachments. Typically, the filter 410 would be supplied to the user in the collapsed position. In the expanded position, the filter media 416 generally expands out to an operative length and is ready for use as a filter. In some applications, the filter 410 automatically moves from the collapsed position to the expanded position. For example, referring to FIG. 27A, when a flow of dirty fluid (represented by arrows 426) enters the filter 410 through the inlet opening 418, the pressure of the fluid automatically expands the filter 410. In other applications, gravity may automatically expand the filter 410, or a mechanism may be used to push or pull one or both housings away from the other.

**[0076]** FIGs. 9A and 9B illustrate a filter 510 according to another embodiment. The filter 510 includes features similar to the filter 410 of FIGs. 8A and 8B and only some differences between the filters 410, 510 will be discussed. The filter 510 includes a lower housing 514 that is generally flat and has very little, if any, inner volume. In the illustrated embodiment, in the collapsed position, the filter media 516 is virtually entirely received in the inner volume of the upper housing 512. In this embodiment, the lower housing 514 functions as a cap to close the upper housing 512 and retain the filter media 516 in the collapsed position. Alternatively, at least a portion of the filter media 516 is received in the inner volume of the upper housing 512.

**[0077]** FIGs. 10A and 10B illustrate a filter 610 according to another embodiment. The filter 610 includes features similar to the filters discussed above and only some differences between the filters will be discussed. The filter 610 includes an upper housing 612 that is generally flat and has very little, if any, inner volume. In the illustrated embodiment, in the collapsed position, the filter media 616 is virtually entirely received in the inner volume of the lower housing 614. In this embodiment, the upper housing 612 functions as a cap to close the lower housing 614 and retain the filter media 616 in the collapsed position. Alternatively,

at least a portion of the filter media 616 is received in the inner volume of the lower housing 614.

**[0078]** FIGs. 11A, 11B, 12A and 12B illustrate a filter 710 according to another embodiment. The filter 710 includes features similar to the filters discussed above and only some differences between the filters will be discussed. The filter 710 includes an upper housing 712 and a lower housing 714 and either or both of the upper and lower housings may be generally flat or may have an inner volume. The filter 710 further includes an intermediate portion 730. In the illustrated embodiment, in the collapsed position, the filter media 716 is received between the housings 712, 714 and surrounded and enclosed by the intermediate portion 730. In some embodiments, the intermediate portion 730 is a tear-away style component that remains attached to either the upper housing 712 or the lower housing 714. For example, there is a perforation or similar attachment between the intermediate portion 730 and the upper housing 712 and/or lower housing 714. The perforation is torn or broken to allow the filter 710 to move to the expanded position (FIG. 11B). FIG. 11B illustrates the intermediate portion 730 remaining attached to the upper housing 712 in the expanded position. FIG. 12B illustrates the intermediate portion 730 remaining attached to the lower housing 714 in the expanded position. In yet another alternative, the intermediate portion is connected to the upper housing and/or lower housing with engaging features such as snap-fits, friction-fits, protrusions, tabs, hooks, interlocks, or other features that engage corresponding features such as recesses, openings, snap-fits, friction-fits, tabs, protrusions, hooks, interlocks, or other features to connect the intermediate portion with the adjacent housing. Engaging features between the intermediate portion and adjacent housings may be configured so that the connection to one of the adjacent housings is stronger than the connection to the other housing to control whether the intermediate portion remains with the upper housing or the lower housing when moving to the expanded position.

**[0079]** FIGs. 13A and 13B illustrate a filter 810 according to another embodiment. The filter 810 includes features similar to the filters discussed above and only some differences between the filters will be discussed. In the illustrated embodiment, the filter 810 includes an upper housing 812 and a lower housing 814 and either or both of the upper and lower housings may be generally flat or may have an inner volume. The filter 810 further includes an intermediate portion 830, and in the collapsed position, the filter media 816 is virtually entirely received between the housings 812, 814 and surrounded and enclosed by the

intermediate portion 830. In the illustrated embodiment, the intermediate portion 830 is a tear-away style component that the user removes (as illustrated in FIG. 13A) from connection with both housings 812, 814 before using the filter 810. In some embodiment, the intermediate portion 830 can be formed by paper, film, tape, paperboard, a sleeve, or other suitable components. In one alternative, the intermediate portion and the lower housing are combined into one removable or tear-away component, with the bottom of the filter media being closed with a seam.

**[0080]** FIGs. 14A and 14B illustrate a filter 910 according to another embodiment. The filter 910 includes features similar to the filters discussed above and only some differences between the filters will be discussed. The filter 910 includes an upper housing 912 similar to the housing 412 of the filter 410 of FIGs. 8A and 8B. The filter 910 further includes a lower end 932 of the filter media 916 that is closed with a seam, illustrated in FIG. 14B as a flat seam or rolled seam. In the collapsed position, the filter media 916 is entirely received in the inner volume of the upper housing 912. In some embodiments, the filter media 916 is enclosed in the collapsed position in the upper housing 912 by a closure device on the bottom of the upper housing 912. The closure device can include film, foil, paper, a cap, tape, bag, sleeve, or other suitable devices holding the filter media 916 and the upper housing 912 in the collapsed position. The closure device may include a perforation, slit, tear line, or hinge that allows the filter media 916 to move to the expanded position. In some embodiments, the closure device or cover would remain in place during and after installation of the filter 910 in the device. Then, the device may include a feature that automatically opens or shears the cover allowing the filter media to move to the expanded position. Alternatively or in addition, airflow from the device through the inlet opening 918 causes the filter media 916 to automatically expand and tear, push, and/or swing open the closure device, automatically expanding the filter 910. In other embodiments, the closure device may be removed, such as by peeling or tearing, by the user before or immediately after installing the filter 910.

**[0081]** FIGs. 15A – 15C illustrate a filter 1010 according to another embodiment. The filter 1010 includes features similar to the filters discussed above and only some differences between the filters will be discussed. The filter 1010 includes an upper housing 1012 similar to the housing 412 of the filter 410 of FIGs. 8A and 8B or any other disclosed embodiment. The filter 1010 further includes a lower end of the filter media 1016 that includes a gusset bottom 1034. The gusset bottom 1034 can be formed from media material, thermoplastic

molded or die cut material, film, foil, or other suitable materials. In some embodiments, the gusset bottom 1034 is air permeable. Also in some embodiments, the gusset bottom 1034 can be a self-standing type gusset. In the collapsed position, the filter media 1016 is at least partially received in the inner volume of the upper housing 1012. In some embodiments, the filter media 1016 is enclosed in the collapsed position in the upper housing 1012 by a closure device on the bottom of the upper housing 1012. The closure device can include film, foil, paper, a cap, tape, bag, sleeve, or other suitable devices holding the filter media 1016 and the upper housing 1012 in the collapsed position. The closure device may include a perforation 1069, slit, tear line, or hinge that allows the filter media 1016 to move to the expanded position. In some embodiments, the closure device or cover would remain in place during and after installation of the filter 1010 in the device. Then, the device may include a feature that automatically opens or shears the cover. Alternatively or in addition, airflow from the device through the inlet opening 1018 causes the filter media 1016 to automatically expand and tear, push, and/or swing open the closure device, automatically expanding the filter 1010. In other embodiments, the closure device may be removed, such as by peeling or tearing, by the user before or immediately after installing the filter 1010.

**[0082]** FIG. 16A illustrates one possible way to attach the filter media 416 to the upper housing 412 (or any of the upper housings described herein). In the embodiment of FIG. 16A, the filter media 416 is welded onto an inside surface 436 of a sidewall 438 of the upper housing 412 at the first end 422 of the filter media 416. The media 416 can also be attached to the housing 412 using adhesive. In other embodiments, including when the upper housing 412 is formed from thermoplastic, the housing 412 may be overmolded onto the filter media 416. FIG. 16B illustrates the attachment described above with regard to FIG. 16A except that the housing 412 has a different shaped sidewall 438 and the end 422 of the filter media 416 abuts a top wall 440 of the housing 412. In the embodiments illustrated in FIGs. 16A and 16B, the attachment is generally radial or transverse to the direction of the filter media, with a mandrel, horn, or other attachment process support being provided through the lower end of the filter prior to the lower end being closed.

**[0083]** FIG. 17A illustrates another possible way to attach the filter media 416 to the upper housing 412 (or any of the upper housings described herein). In the embodiment of FIG. 17A, the filter media 416 is welded onto an inside surface 442 of the top wall 440 of the upper housing 412 at the first end 422 of the filter media 416. Alternatively, the media 416

can be attached to the housing 412 using adhesive. In other embodiments, not shown, when the upper housing 412 is formed from thermoplastic, the housing 412 may be overmolded onto the filter media 416. FIG. 27B illustrates the attachment described above with regard to FIG. 17A except that the housing 412 has a different shaped sidewall 438. In the embodiments illustrated in FIGs. 17A and 17B, the attachment is generally axial or along the direction of the filter media, with a mandrel, horn, or other attachment process support being provided through the lower end of the filter prior to the lower end being closed.

**[0084]** FIGs. 18A – 18C illustrate how the first end 422 of the filter media 416 may be prepared before attaching the filter media 416 to the housing 412 (similarly, how the second end of the filter media 416 could be prepared before attachment to the lower housing 414). FIG. 18A illustrates the first end 422 of the filter media 416 in its original thickness and the first end 422 can be attached to the housing 412 in its original thickness. Alternatively, as illustrated in FIG. 18B, the filter media 416 can be compressed along the first end 422 to create an area 441 of reduced thickness and increased density. The area 441 of reduced thickness is where the welding or overmolding to the housing 412 will be made. FIG. 18C illustrates another embodiment where a secondary strip of material 442 is welded other otherwise attached to the end 422 of the filter media 416. Then, the secondary strip of material 442 is welded, overmolded, or otherwise attached to the housing 412. In some embodiments, the secondary strip of material 442 includes a film and/or extrusion and can be applied to one or both sides of the filter media 416.

**[0085]** FIGs. 19 and 20 illustrate one possible method of attaching the housings 412, 414 (or other housings discussed herein) onto the filter media 416 by overmolding. As shown in FIG. 20, the filter media 416 is placed into the mold 444 over the mold core being provided through the lower end of the filter prior to the lower end being closed. Then, the material of the housings 412, 414 is injected over the filter media 416. In the illustrated method of FIG. 20, the filter media 416 having the reduced thickness 441 at the end 422 is utilized. The mold 444 shuts off or closes against the media 416 at the area 441 of reduced thickness (near area of arrow 446 in FIG. 20). The injected material adheres to the filter media 416 along the area of reduced thickness 441 to attach the filter media 416 to the housings 412, 414. In various alternatives, filter media having end treatment shown in FIG. 18A, 18B, and 18C may be utilized.

**[0086]** In another alternative, as discussed with reference to FIG. 8C, the filter media 416 may be divided into at least two portions, with the first portion of the filter media 416 being attached to the upper housing 412. Attaching a smaller portion of media to the upper may be useful in handing the filter media in a welding or molding process where internal support is needed. Then, after attachment of the first portion to the upper housing, the second piece of filter media 416′ is attached to the first portion of filter media 416 using traditional bonding, sewing, or welding techniques. In one embodiment, not shown, the panel 428 is attached directly to the upper housing by welding, overmolding, adhesive, or other technique, and the filter media 416 is attached to the panel.

**[0087]** FIG. 21A illustrates a possible way to attach the filter media 416 to the lower housing 414 (or any of the lower housings described herein). In the embodiment of FIG. 21A, the filter media 416 is welded onto an outside surface 446 of a sidewall 448 of the lower housing 414 at the second end 423 of the filter media 416. The filter media 416 can also be attached to the housing 414 using adhesive. FIG. 21B illustrates one possible way to attach the filter media 316 to a flat lower housing 314 (similarly could be used to attach to a flat upper housing 412 or any of the housings described above). A ring 450 optionally having projections 452 may be fitted to capture the lower end of the filter media 416 between the ring and the housing 414 and may be heat staked or otherwise fastened to attach the filter media 416 and the housing 414.

**[0088]** FIG. 22 illustrates an alternative embodiment where a portion 454 of the upper housing 412 is formed by the filter media 416, generally by making the filter media 416 in the portion 454 more rigid or stiffer than the other areas of the filter media 416. The portion 454 is stiffened by compression molding, vacuum thermoforming, or a combination of both, and/or coating/impregnating the portion 454 with thermoset, thermoplastic, or other material to make a rigid or semi rigid upper portion having a desired shape made with the filter media 416. An inlet piece 456, including the inlet opening 418, is inserted through an aperture 457 of the portion 454. The inlet piece 456 can be attached by welding or adhesive. In the illustrated embodiment, the inlet piece 456 is attached to the inside of the portion 454 and in other embodiments, the inlet piece 456 may be attached to the outside of the portion 454. In another embodiment, the inlet piece is overmolded onto the filter media before, during, or after the stiffening operation.

**[0089]** FIG. 23 illustrates an alternative embodiment where the filter media 416 is formed with a generally closed end except for aperture 458. Then, the filter media 416 is attached to the housing 412 with the aperture 458 aligned with the inlet opening 418. The attachment could be made by welding or adhesive around the aperture 458.

**[0090]** FIGs. 24 and 25 illustrate an alternative embodiment where the housing 412 or housing 414 are formed by folding a die cut shape 460 (FIG. 25). The shape 460 is die cut and then folded to create the housing 412 or 414. The filter media can be attached to the housings 412 or 414 by welding or adhesive. In other embodiments, the housing can be formed from a single piece hinged from a top piece. The top and bottom die cut pieces could be separated and then bonded to each other or separately to the filter media by the methods previously discussed.

**[0091]** FIGs. 26 and 27 illustrate a filter 1110 according to another embodiment. The filter 1110 includes features similar to the filters discussed above and only some differences between the filters will be discussed. The filter 1110 includes an upper housing 1112 that includes a bag 112. In one embodiment, filter media 1116 is formed as a complete enclosure with a desired inlet 1118. The filter media is compacted and inserted into an open end of the bag 1112 and then the bag sealed, or alternatively, the bag 1112 formed and sealed around the compacted media. Optionally, the bag 1112 is attached to the filter material around the inlet 1118. The bag 1112 can be formed from foil, plastic, paper, or other suitable materials. The bag 1112 includes a tear-out bottom 1164 opposite the inlet 1118 at the top of the bag 1112. In some applications, the bag 1112 is installed into the device with the filter media 1116 in the collapsed position (FIG. 26). Then, when the device is used or turned on, the filter media 1116 automatically breaks through the bottom 1164 of the bag 1112 because of the airflow through the inlet 1118. Alternatively, the bag includes a portion that the user opens before loading into a device, such as a tear-away portion, tear or cut line, or other opening. In yet another alternative, a mechanism may be used to push or pull one end of the filter away from the other moving the filter to the expanded position.

**[0092]** Although the invention has been described in detail with reference to certain preferred embodiments, variations and modifications exist within the scope and spirit of one or more independent aspects of the invention as described.

CLAIMS

What is claimed is:

1. A filter configured to separate debris from a flow of fluid, the filter comprising:

a housing;

a filter media coupled to the housing to form a collection container configured to store debris separated by the filter media from a flow of fluid;

an inlet opening that extends through the housing to provide fluid communication into the collection container such that the flow of fluid with the debris can flow into the collection container and a relatively clean flow of fluid exits through the filter media; and

an attachment member that couples the filter media to the housing.

2. The filter of claim 1, wherein the housing includes a groove that receives the attachment member to couple the filter media to the housing.

3. The filter of claim 2, wherein the groove is formed with an inner wall and an outer wall, where the height of the outer wall is greater than the inner wall.

4. The filter of claim 2, wherein the filter media is disposed between the groove and the attachment member, thereby coupling the filter media to the housing.

5. The filter of claim 4, wherein the filter media is folded over the attachment member such that an end of the filter media extends away from the upper housing a desired length forming an overlapping filter media section.

6. The filter of claim 5, further comprising one or more extension members positioned in a location to direct the overlapping filter media section to extend in a direction along an outer wall of the filter.

7. The filter of claim 4, wherein the attachment member and the filter media are press-fit into the groove.

8. The filter of claim 4, wherein the attachment member and the filter media are fastened into the groove.

9. The filter of claim 1, wherein the housing is formed from a plastic material.

10. The filter of claim 1, wherein the housing is a first housing, the filter further comprising a second housing, wherein the first housing is coupled to a first end of the filter media and the second housing is coupled to a second end of the filter media, wherein the second housing includes a groove that receives a portion of the filter media, wherein a second attachment member is received within the groove of the second housing to couple the second end of the filter media to the second housing.

11. The filter of claim 10, wherein the groove of the second housing is formed with an inner wall and an outer wall, where the height of the outer wall is greater than the inner wall

12. The filter of claim 10, wherein one or both of the attachment member and the second attachment member includes a fixturing recess or protrusion.

13. A filter configured to separate debris from a flow of fluid, the filter comprising:

a housing having a first inner volume;

a filter media having a first end and a second end; and

an attachment member coupling the filter media to the housing at least partially forming a collection container configured to store the debris separated by the filter media, wherein

the first end of the filter media being folded such that at least a portion of the first end extends away from the housing forming an overlapping filter media section.

14. The filter of claim 13, wherein the flow of fluid flows in a direction toward the overlapping filter media section.

15. The filter of claim 13, wherein the filter media is folded over the attachment member forming the overlapping filter media section.

16. The filter of claim 13, wherein the housing includes a groove that receives the attachment member to couple the filter media to the housing.

17. The filter of claim 13, wherein the filter media forms a perimeter, and the overlapping filter media section extends along one or more portions of the perimeter of the filter media.

18. The filter of claim 13, wherein the filter media forms a perimeter, and the overlapping filter media section extends around the perimeter of the filter media.

19. The filter of claim 13, wherein the housing is a first housing, the filter further comprising a second housing, wherein the filter media is coupled to the second housing at the second end of the filter media, wherein the second end of the filter media is folded such that at least a portion of the second end extends away from the second housing forming a second overlapping filter media section.

20. The filter of claim 17, wherein the second housing includes a groove that receives the attachment member to couple the filter media to the second housing.

21. A filter configured to separate debris from a flow of fluid, the filter comprising:

a housing having a first inner volume;

a filter media having a first end, a second end, and a second inner volume between the first and second ends, the filter media coupled to the housing at the first end of the filter media such that the first and second inner volumes together at least partially define a collection container configured to store the debris separated by the filter media from the flow of fluid; and

an inlet opening that extends through the housing to provide fluid communication into the collection container such that the flow of fluid with debris can flow into the collection container and a relatively clean flow of fluid exits through the filter media between the first and second ends of the filter media, and

wherein the filter media is collapsible into the first inner volume of the housing.

22. The filter of claim 21, further comprising a valve in the inlet opening, the valve movable between an opened position and a closed position.

23. The filter of claim 21, wherein the filter media includes a seam that extends from the first end to the second end of the filter media, the filter further comprising a panel that extends along the seam.

24. The filter of claim 23, wherein the panel is transparent.

25. The filter of claim 21, wherein the housing is formed from a plastic material.

26. The filter of claim 21, wherein the housing is a first housing, the filter further comprising a second housing, wherein the filter media is coupled to the second housing at the second end of the filter media, and wherein the second housing and the first housing enclose the filter media when the filter media is collapsed into the first housing.

27. The filter of claim 26, where the second housing is coupled to the first housing when the filter media is collapsed into the first housing.

28. The filter of claim 26, wherein the second housing defines a third inner volume, wherein the first, second, and third inner volumes together at least partially define the collection container.

29. The filter of claim 26, wherein the second housing is flat.

30. The filter of claim 21, wherein the second end of the filter media is closed with a seam.

31. The filter of claim 21, wherein the second end of the filter media includes a gusset.

32. The filter of claim 21, further comprising a cover coupled to the housing that retains the filter media in a collapsed position between the cover and the housing within the first inner volume of the housing.

33. The filter of claim 21, wherein the first end of the filter media is welded to the housing.

34. The filter of claim 21, wherein the housing is overmolded onto the first end of the filter media.

35. The filter of claim 21, wherein the first end of the filter media is attached to the housing by adhesive.

36. A filter configured to separate debris from a flow of fluid, the filter comprising:

a first housing;

a second housing having a first inner volume;

a filter media having a first end, a second end, and a second inner volume between the first and second ends, the filter media coupled to the first housing at the first end of the filter

media and the filter media coupled to the second housing at the second end of the filter media such that the first and second inner volumes together at least partially define a collection container configured to store the debris separated by the filter media; and

an inlet opening that extends through the first housing to provide fluid communication into the collection container such that the flow of fluid with debris can flow into the collection container and a relatively clean flow of fluid exits through the filter media between the first and second ends of the filter media, and

wherein the filter media is collapsible into the first inner volume of the second housing.

37. The filter of claim 36, wherein the second housing and the first housing enclose the filter media when the filter media is collapsed into the second housing.

38. The filter of claim 36, where the second housing is coupled to the first housing when the filter media is collapsed into the second housing.

39. The filter of claim 36, where the first housing has a third inner volume, wherein the filter media is collapsible into the third inner volume of the first housing.

40. A filter configured to separate debris from a flow of fluid, the filter comprising:

a first housing;

a second housing;

a filter media having a first end, a second end, and an inner volume between the first and second ends, the filter media coupled to the first housing at the first end of the filter media and the filter media coupled to the second housing at the second end of the filter media such that the first and second housings and the inner volume of the filter media together at least partially define a collection container configured to store the debris separated by the filter media; and

an inlet opening that extends through the first housing to provide fluid communication into the collection container such that the flow of fluid with debris can flow into the collection container and a relatively clean flow of fluid exits through the filter media between the first and second ends of the filter media, and

wherein the filter media is collapsible between the first and second housing in a collapsed position and the filter media is movable to an expanded position.

41. The filter of claim 40, further comprising an intermediate portion between the first and second housings that holds the filter media in the collapsed position.

42. The filter of claim 41, wherein the intermediate portion and the first and second housings enclose the filter media in the collapsed position.

43. The filter of claim 41, wherein the intermediate portion is removably coupled to at least one of the first and second housing to allow the filter media to move to the expanded position.

44. The filter of claim 40, where the first and second housings enclose the filter media in the collapsed position.

45. The filter of claim 40, where the filter media is collapsible into the first housing, the second housing, or a combination of both in the collapsed position.

46. A method of manufacturing a filter, the method comprising:

providing a housing having an inlet aperture;

shaping a filter media into a cylindrical shape with a first end and a second end;

attaching the first end of the filter media to the housing to close the first end of the filter media;

closing the second end of the filter media; and

collapsing the filter media within in an inner volume of the housing.

47. The method of claim 46, further comprising, compressing the first end of the filter media before attaching the first end of the filter media to the housing.

48. The method of claim 46, further comprising, attaching a second material to the first end of the filter media before attaching the first end of the filter media to the housing.

49. The method of claim 46, where the step of attaching the first end of the filter media to the housing comprises attaching a second material to the housing and attaching the first end of the filter media to the second material.

50. The method of claim 49, where the filter media is a first filter media and the second material is a second piece of filter media.

51. The method of claim 46, wherein providing the housing and attaching the first end of the filter media to the housing includes overmolding the housing onto the first end of the filter media.

52. The method of claim 46, wherein attaching the first end of the filter media to the housing includes welding the first end of the filter media to the housing.

53. The method of claim 46, wherein attaching the first end of the filter media to the housing includes using adhesive to attach the first end of the filter media to the housing.

54. The method of claim 46, wherein the housing is a first housing, wherein closing the second end of the filter media includes attaching a second housing to the second end of the filter media.

55. The method of claim 46, wherein closing the second end of the filter media includes closing the second end of the filter media with a seam.

56. The method of claim 46, wherein closing the second end of the filter media includes attaching a gusset bottom.

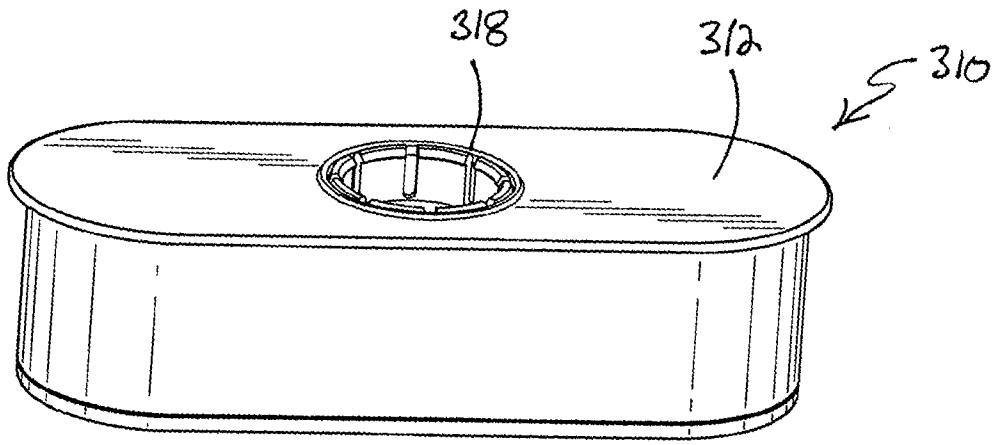



FIG. 1

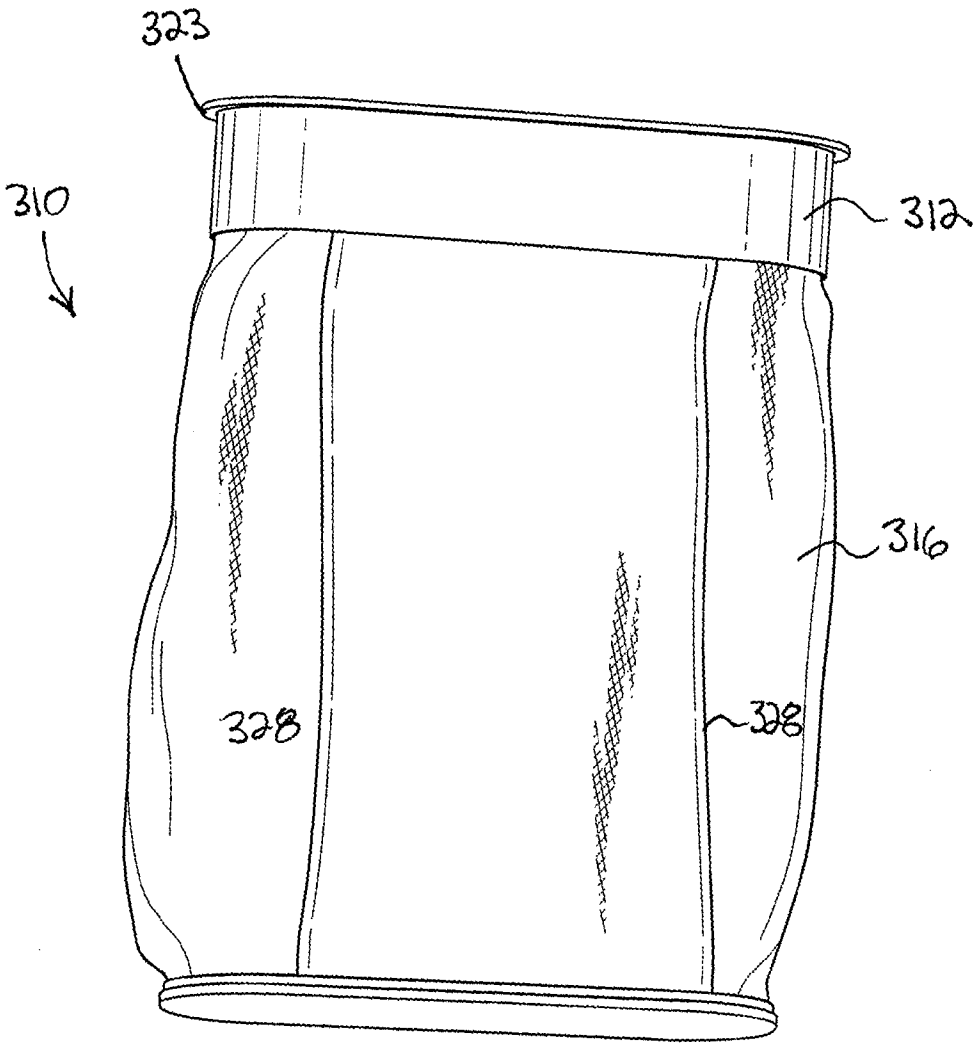
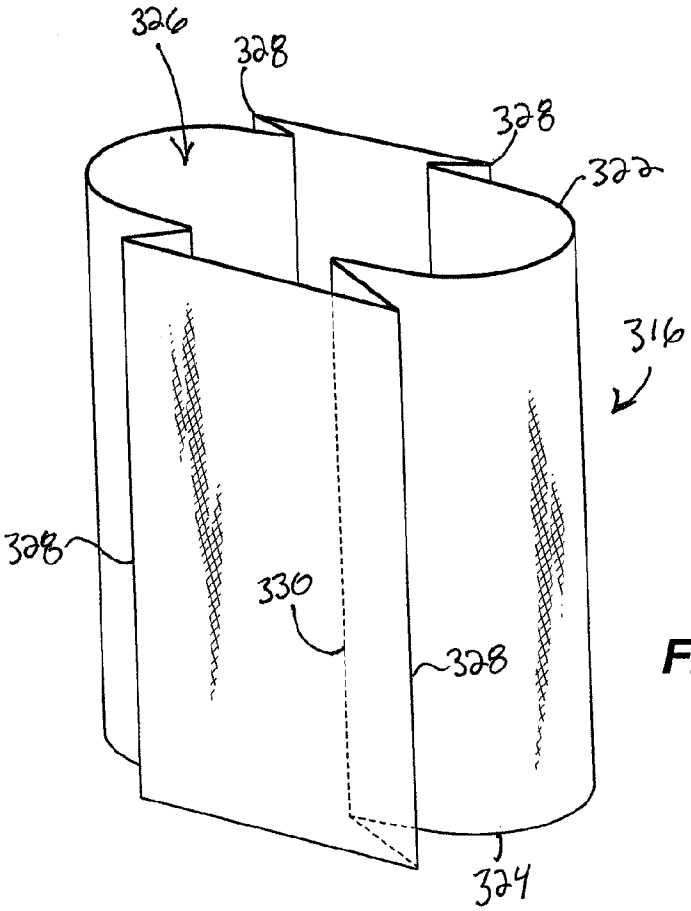



FIG. 2


326
328
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322
316
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330
328
324

FIG. 3

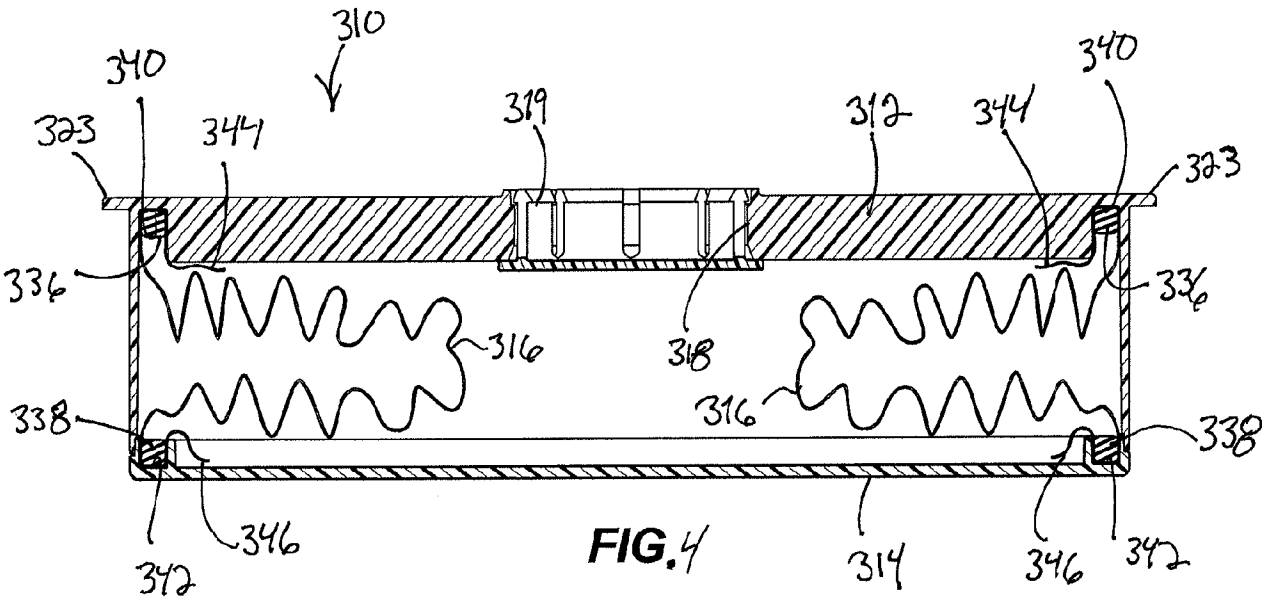
310
340
323
344
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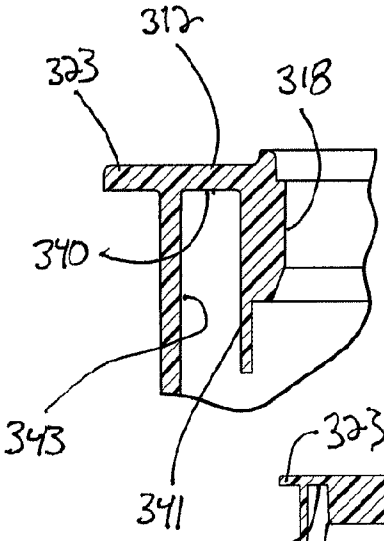
FIG. 4


312
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318
340
343
341

FIG. 5B


310
318
312
323
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343
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15B
A
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348
336
344
316
345
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334
332
346
338
H1
H2

FIG. 5A

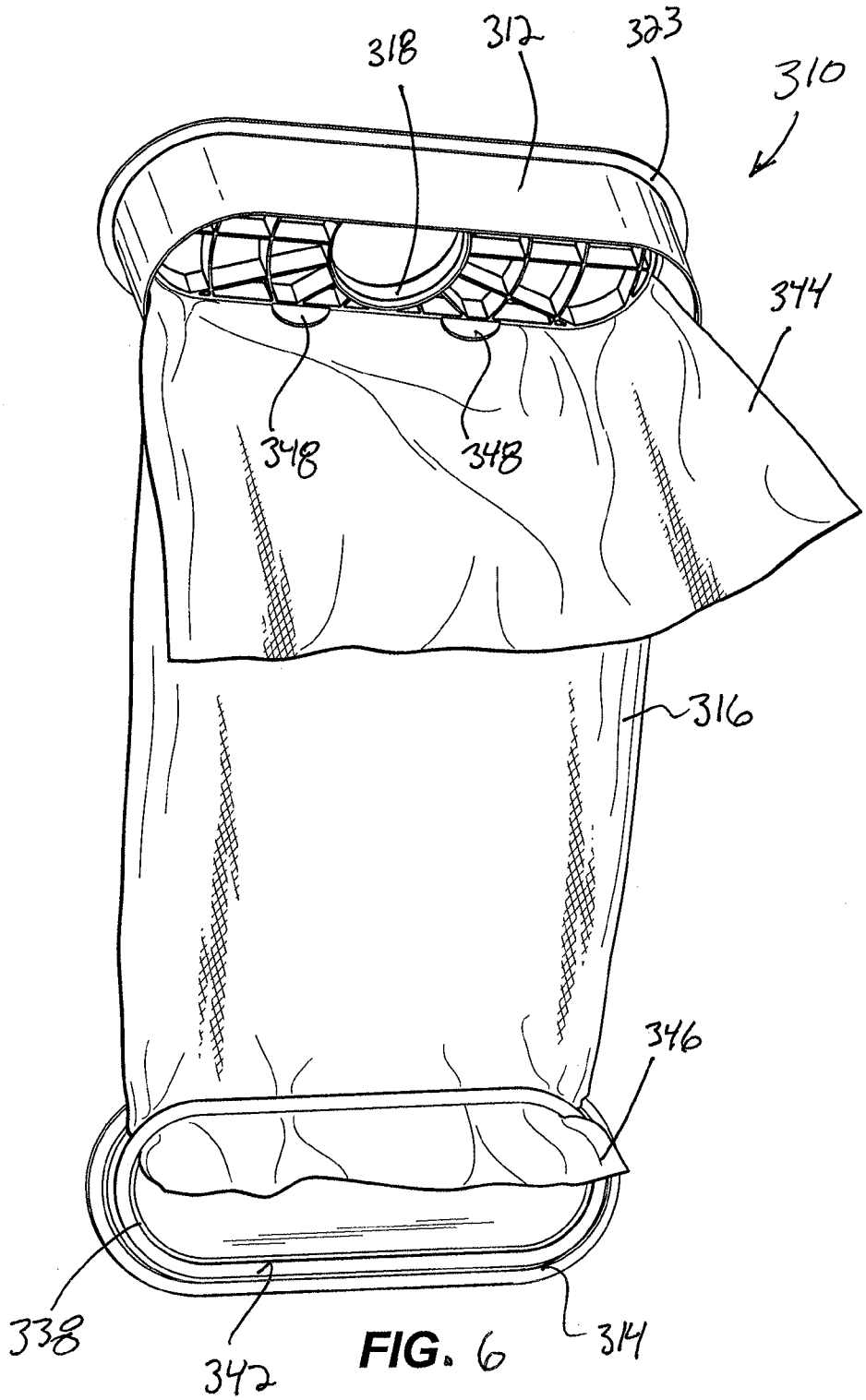


FIG. 6

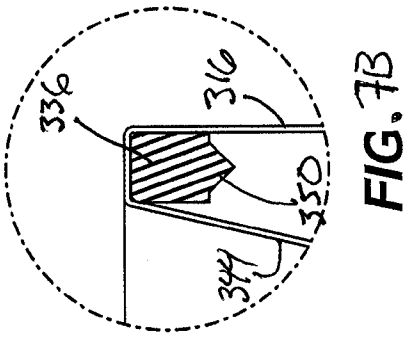


FIG. 7B

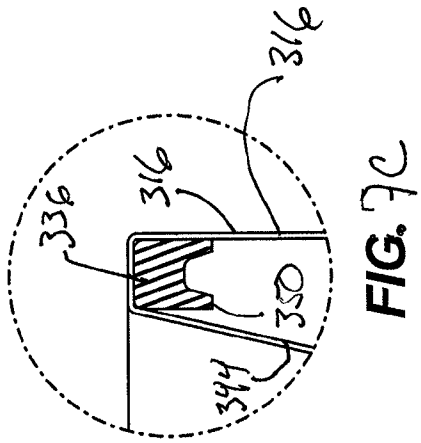


FIG. 7C

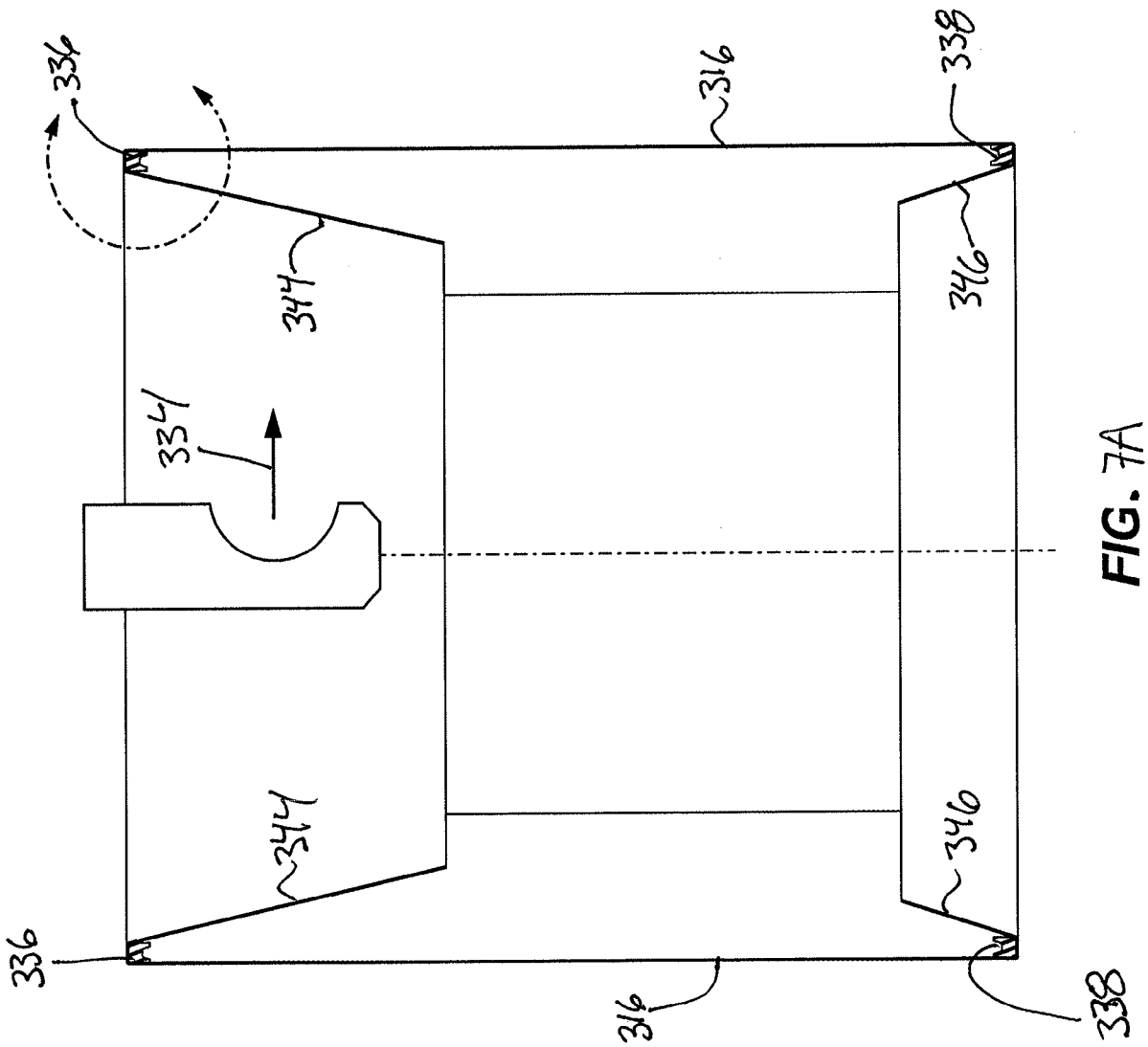


FIG. 7A

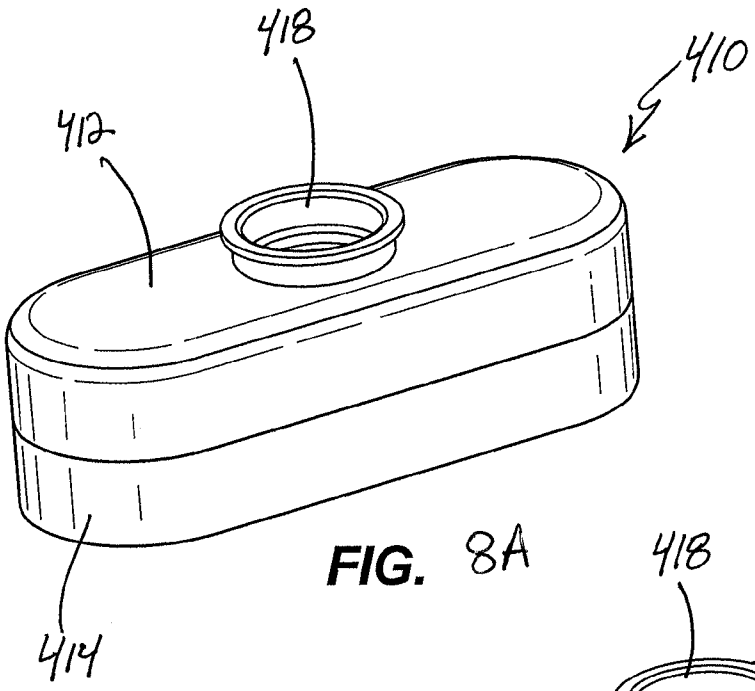


FIG. 8A

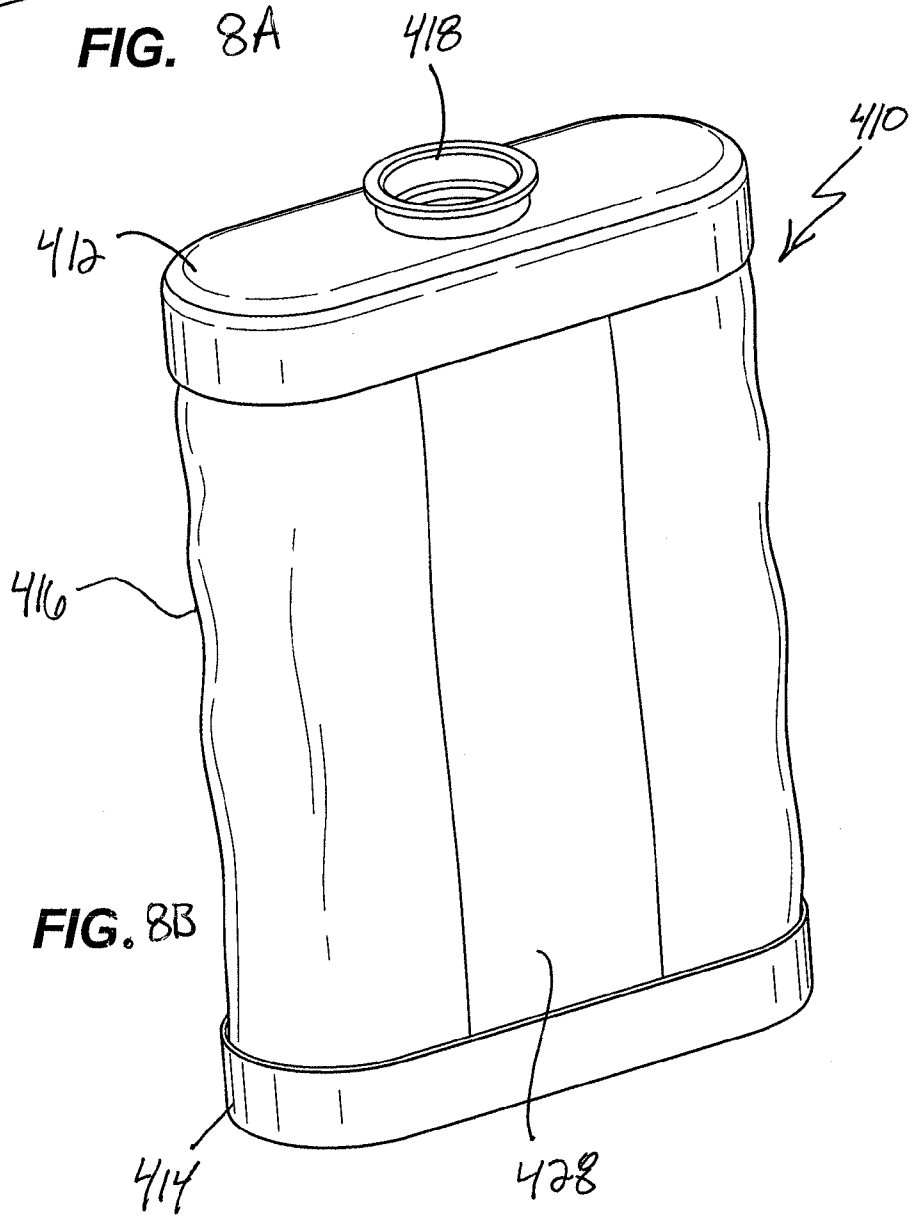


FIG. 8B

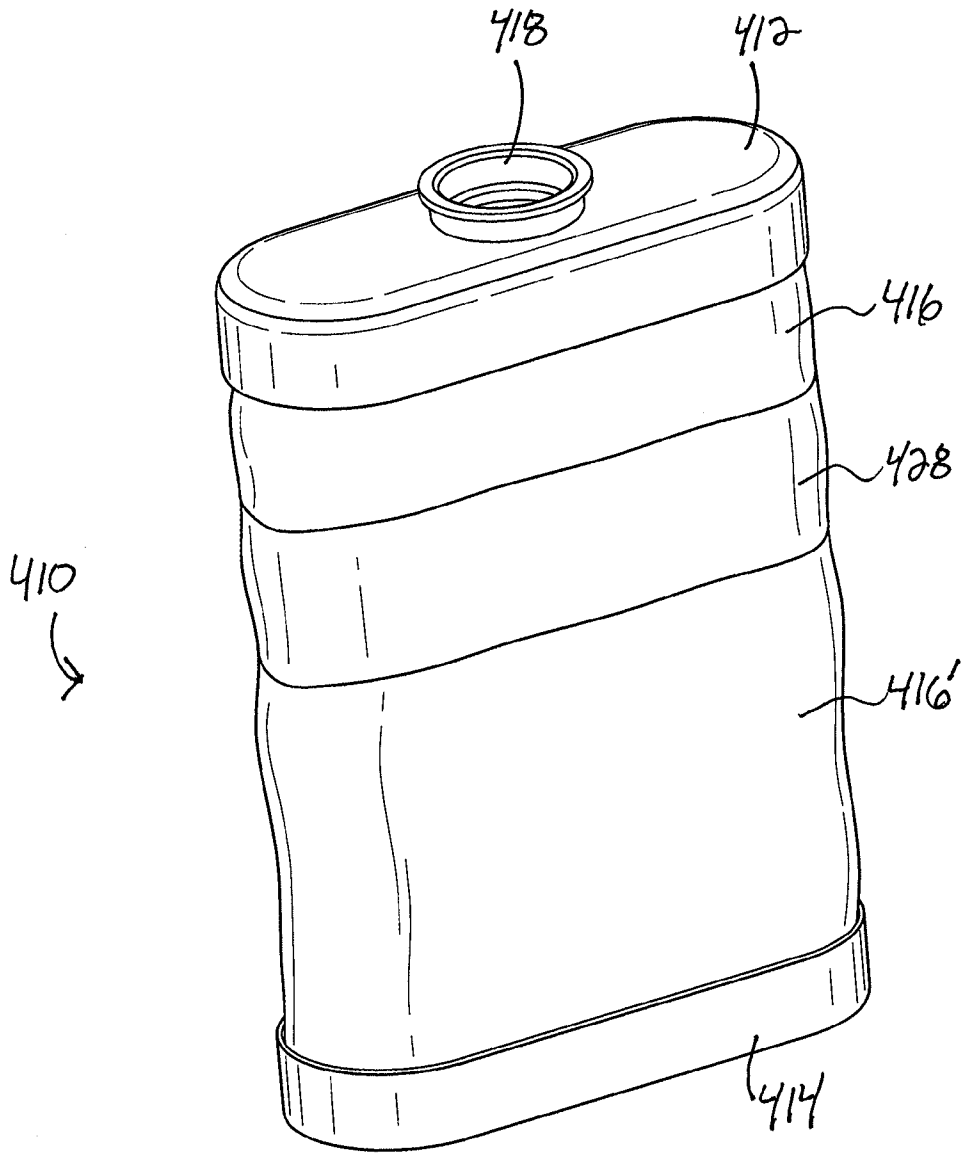


FIG. 8C

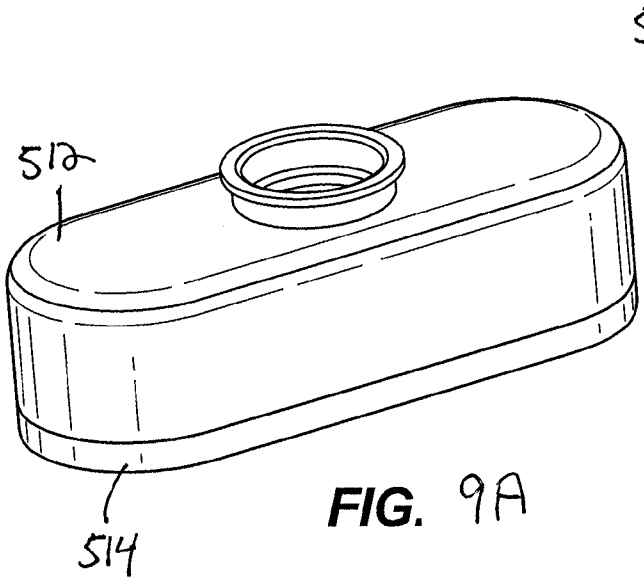


FIG. 9A

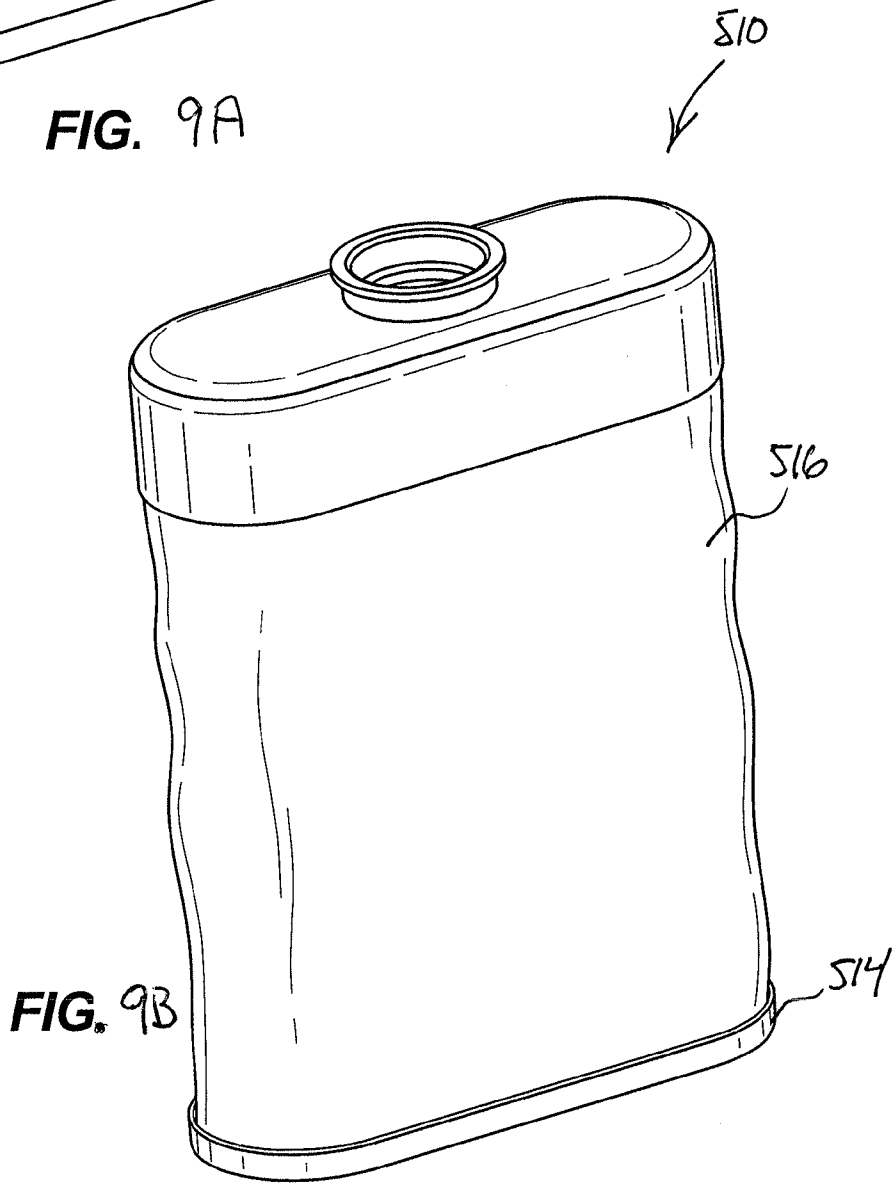


FIG. 9B

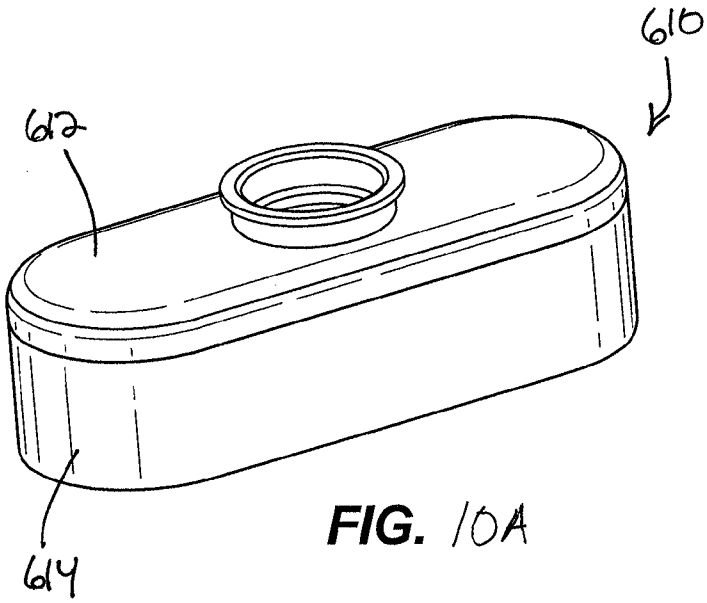


FIG. 10A

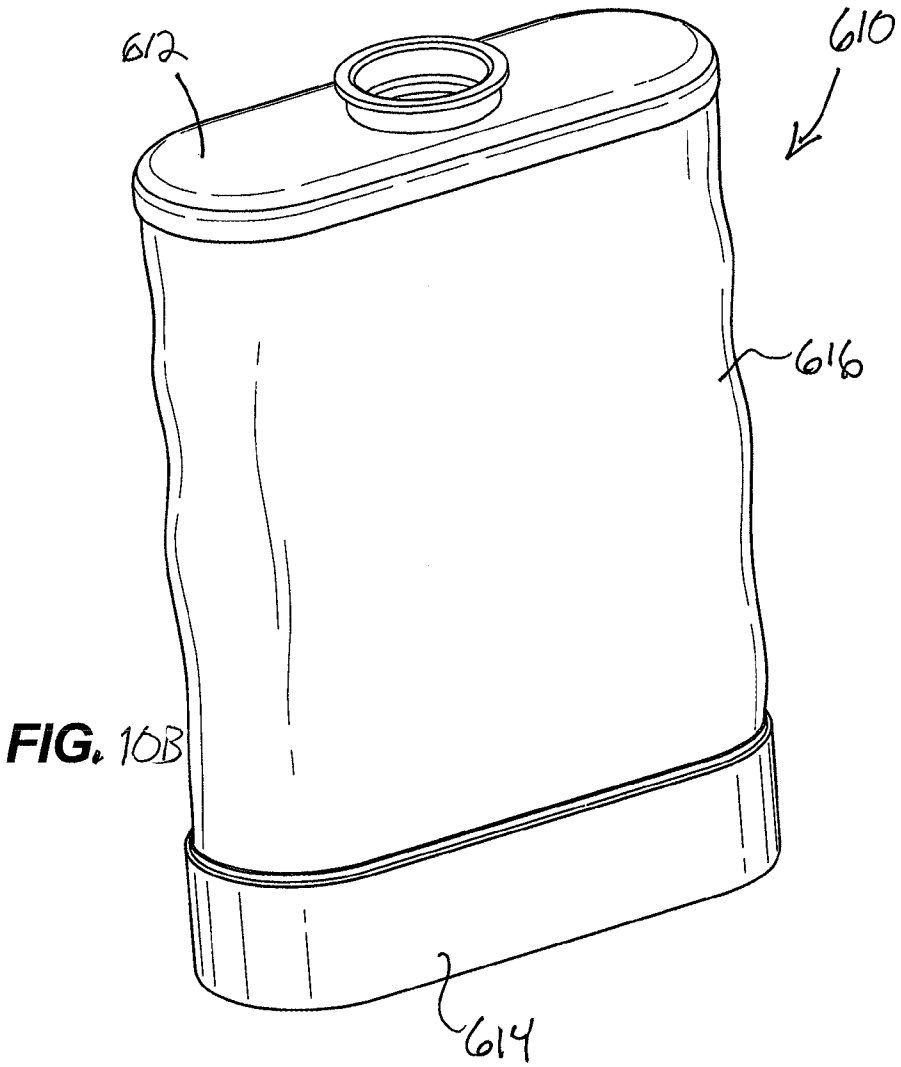


FIG. 10B

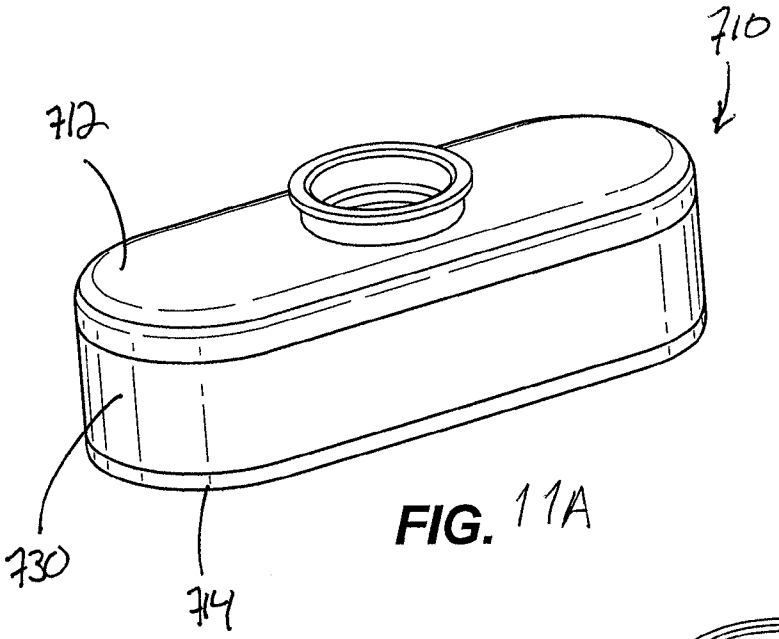


FIG. 11A

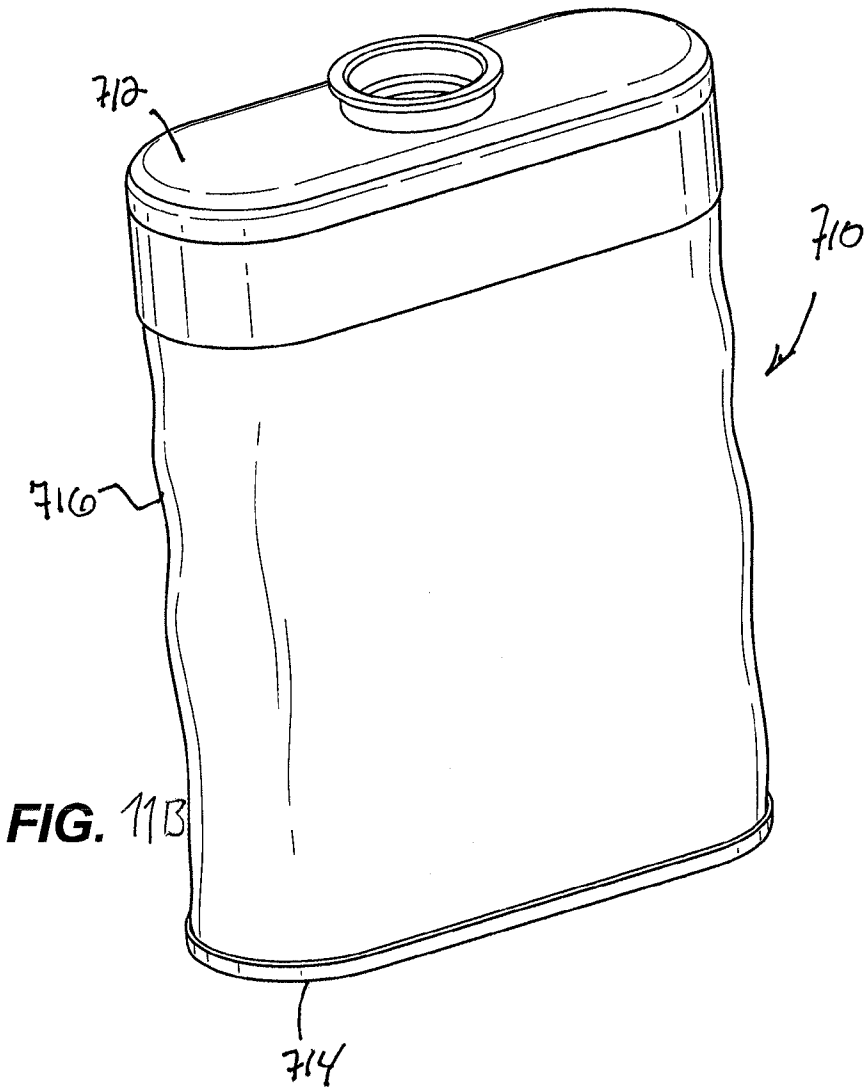


FIG. 11B

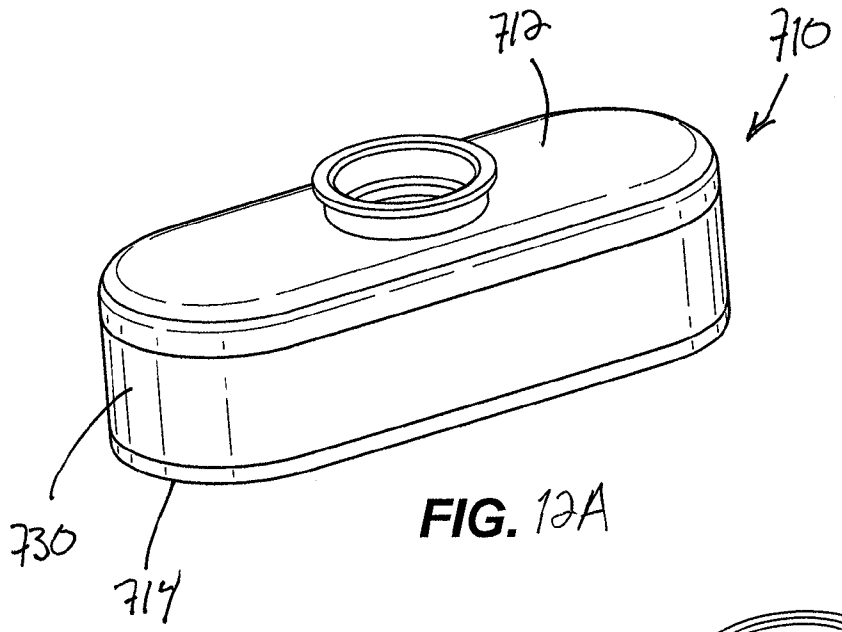


FIG. 12A

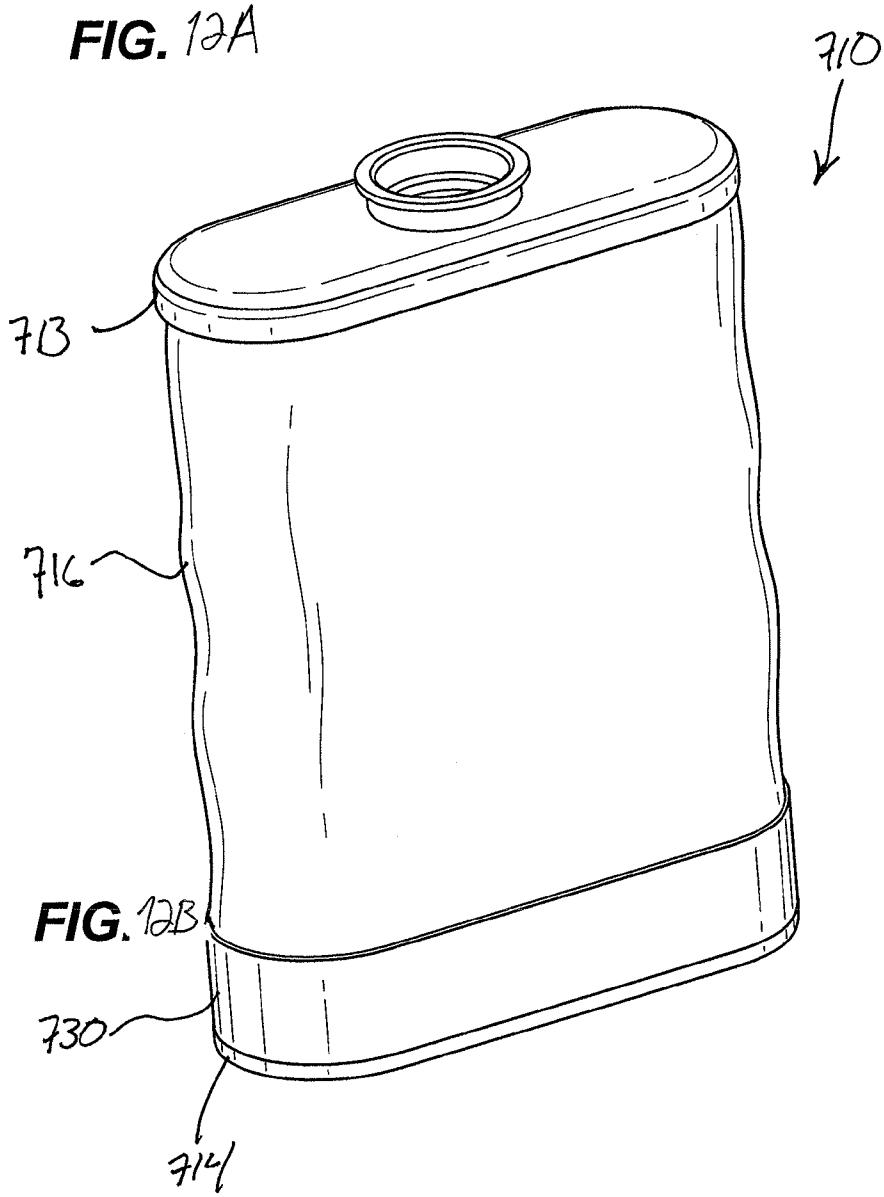


FIG. 12B

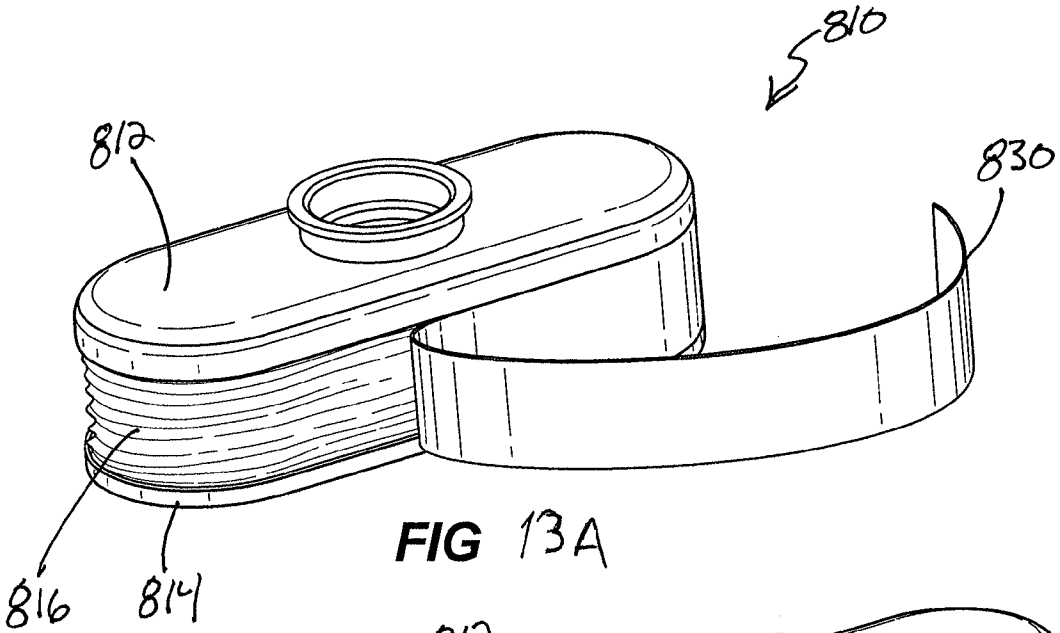


FIG 13A

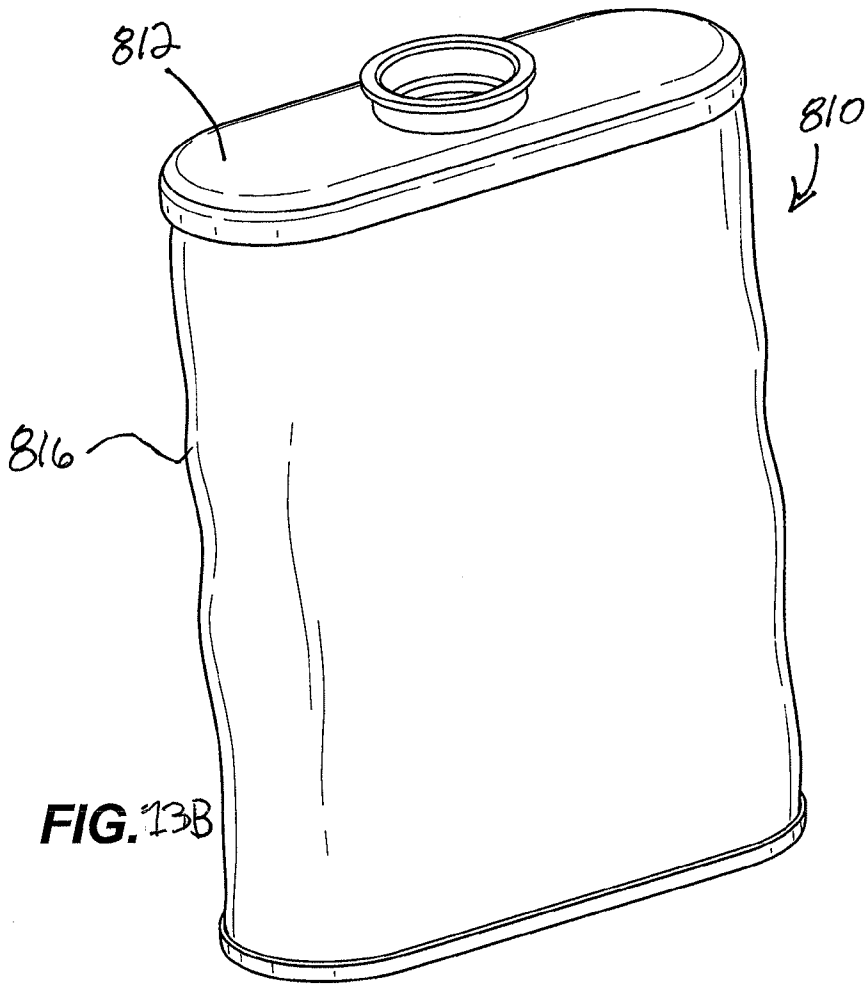


FIG. 13B

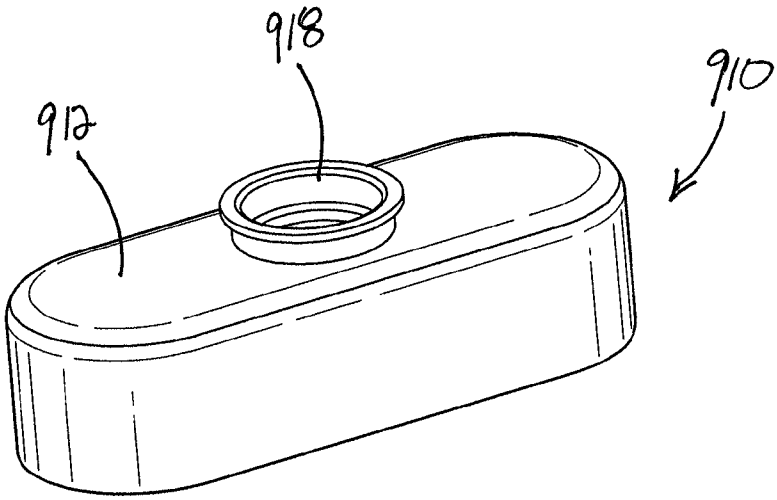


FIG. 14A

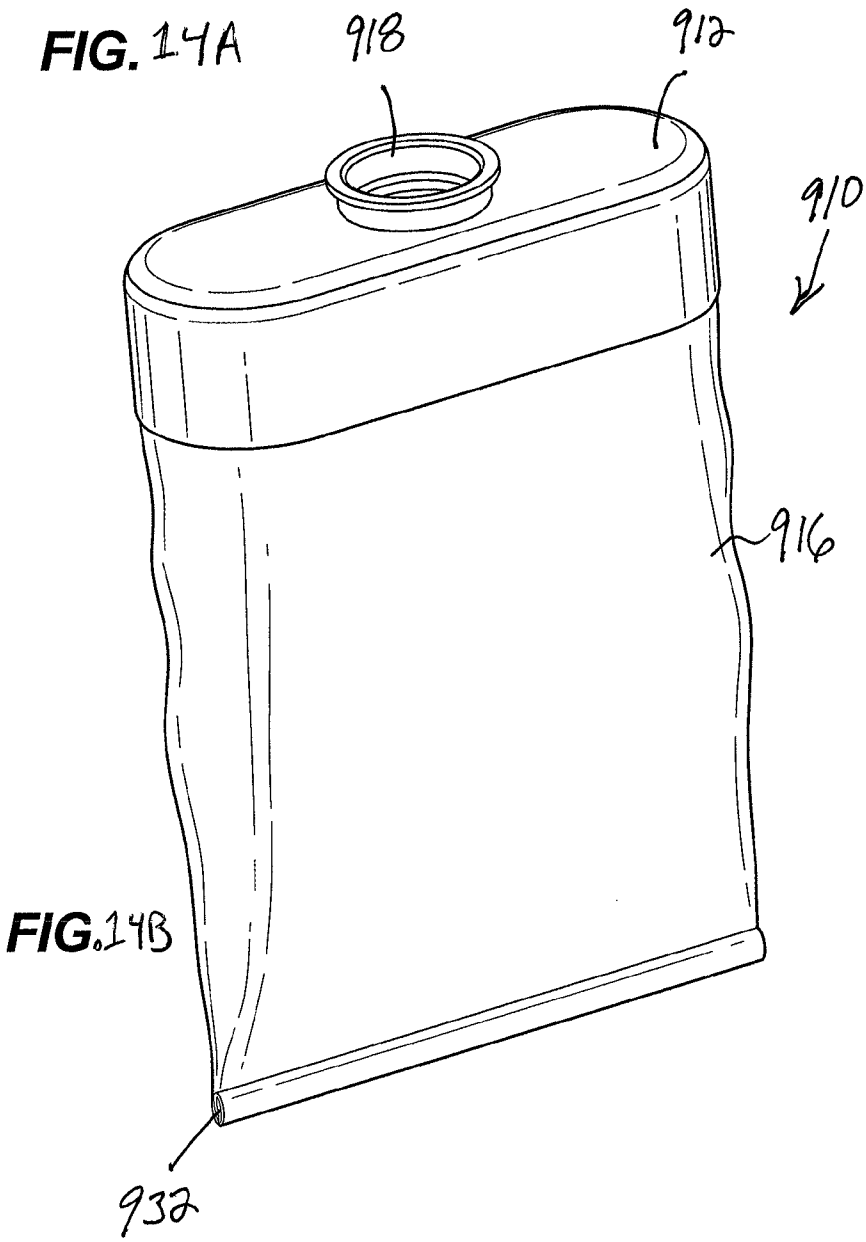


FIG. 14B

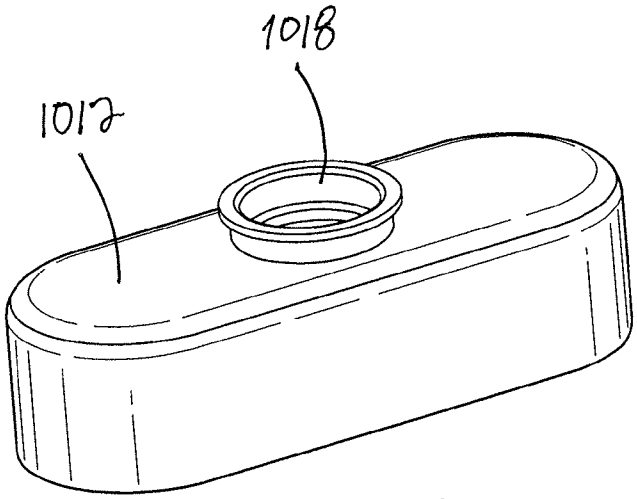


FIG. 15A

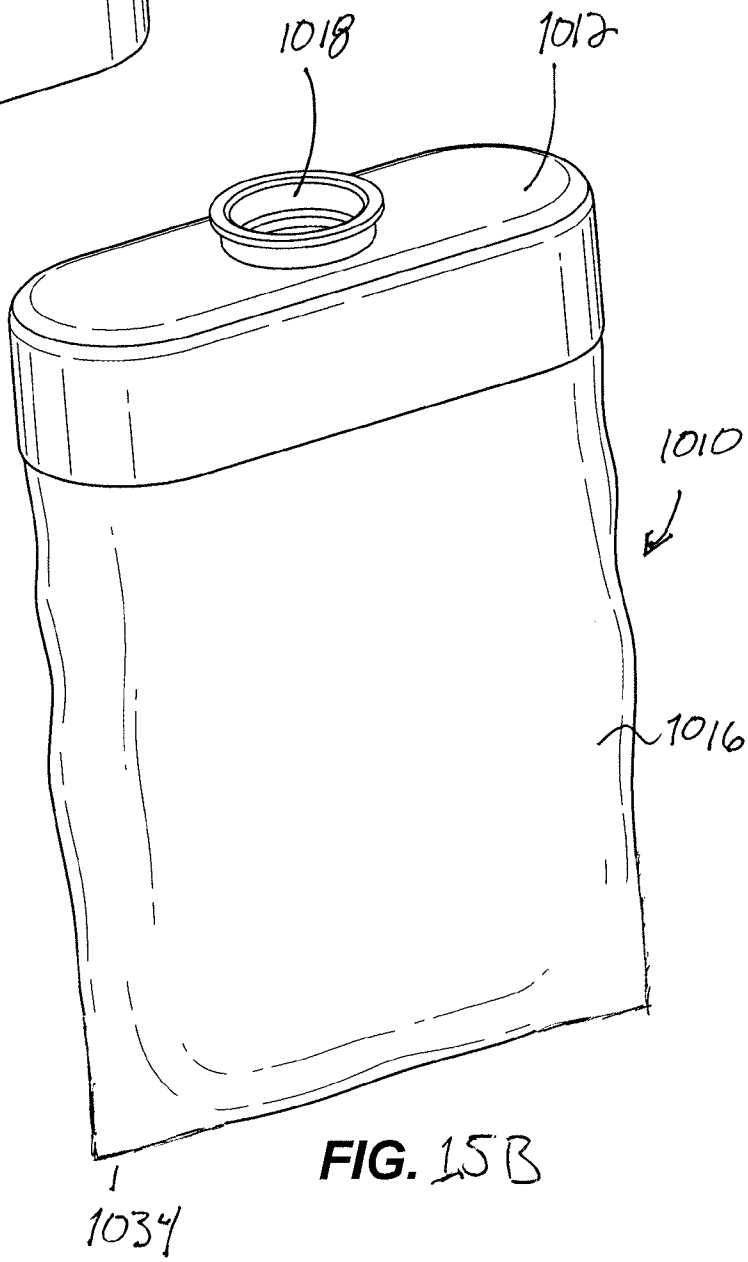


FIG. 15B

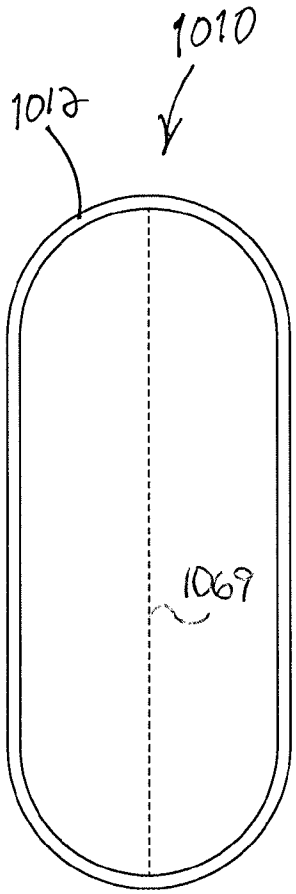


FIG. 15C

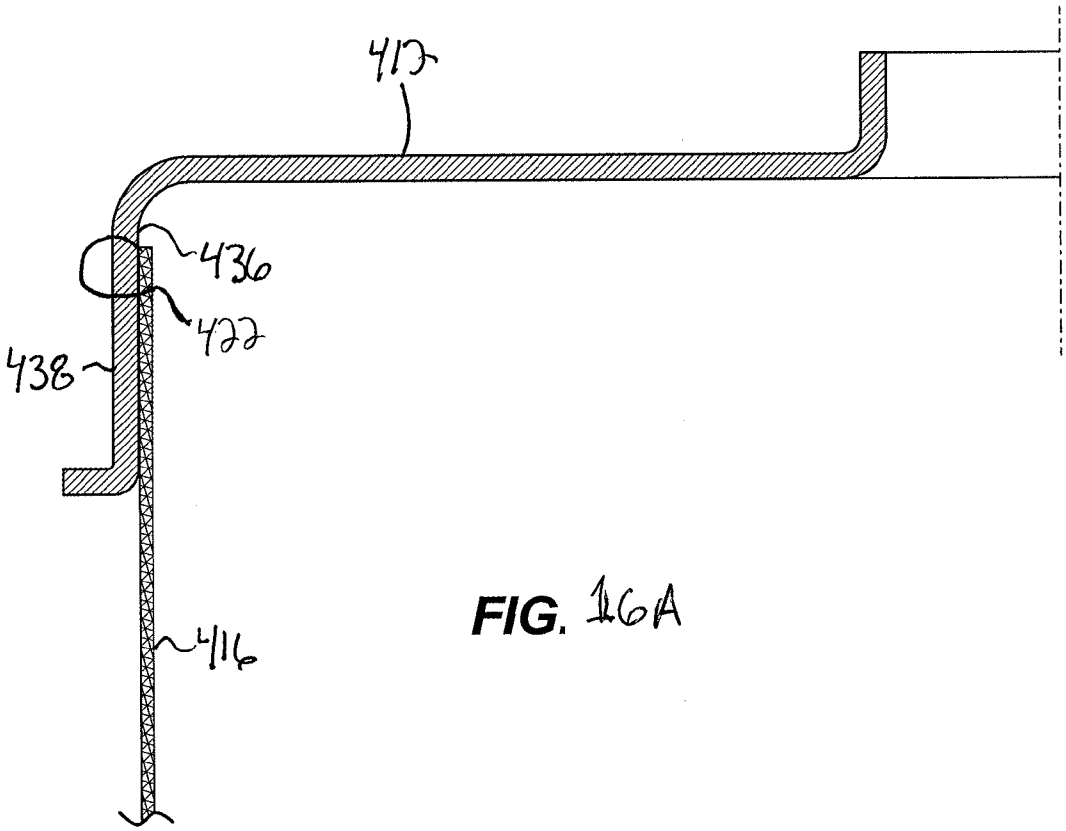


FIG. 16A

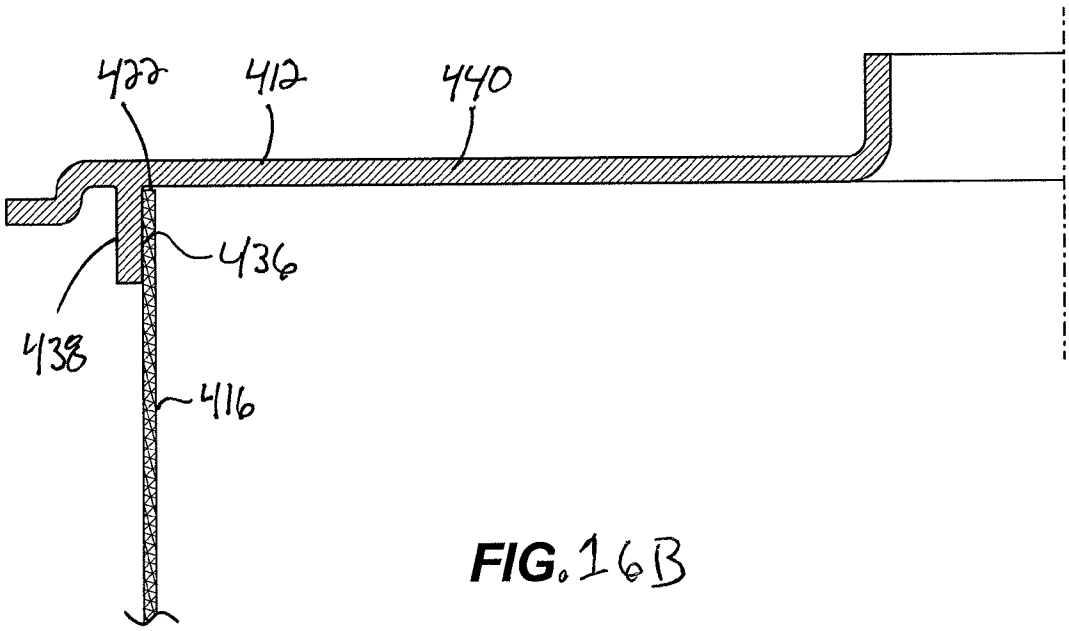


FIG. 16B

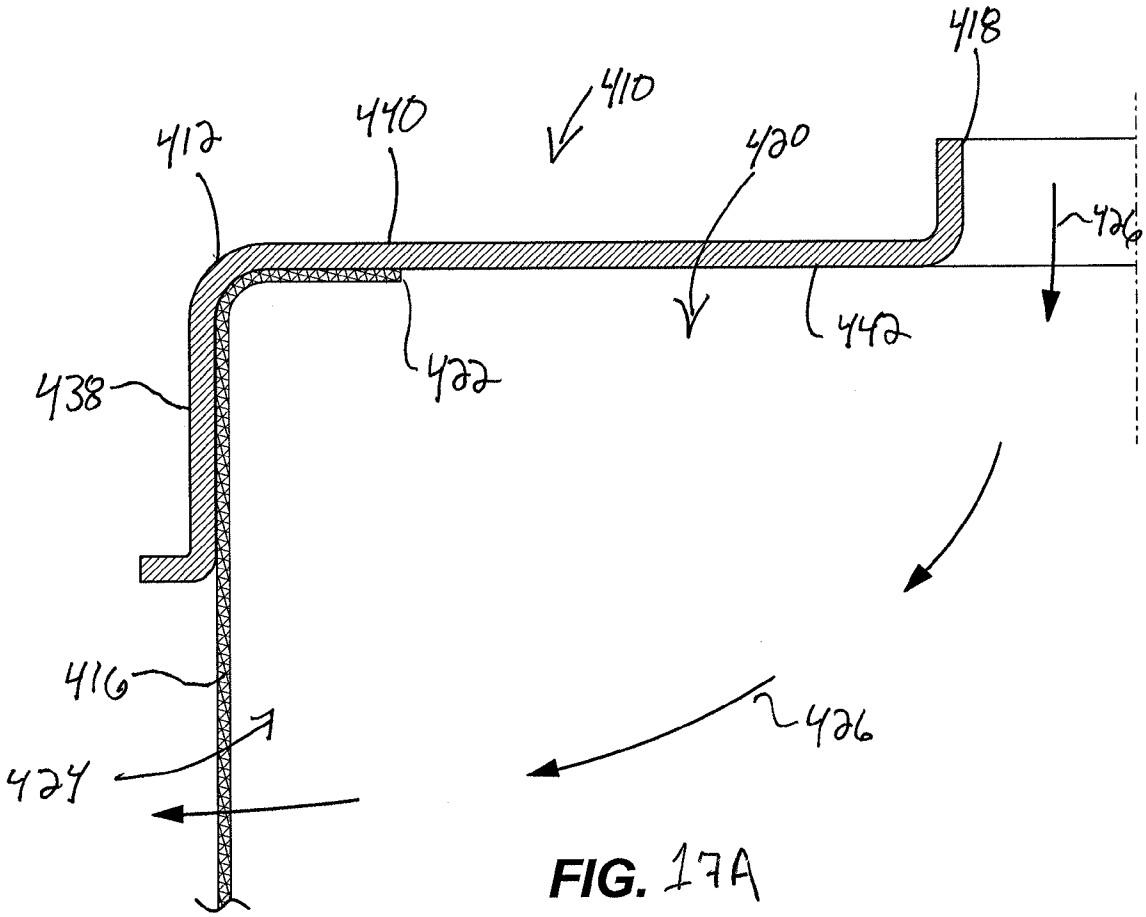


FIG. 17A

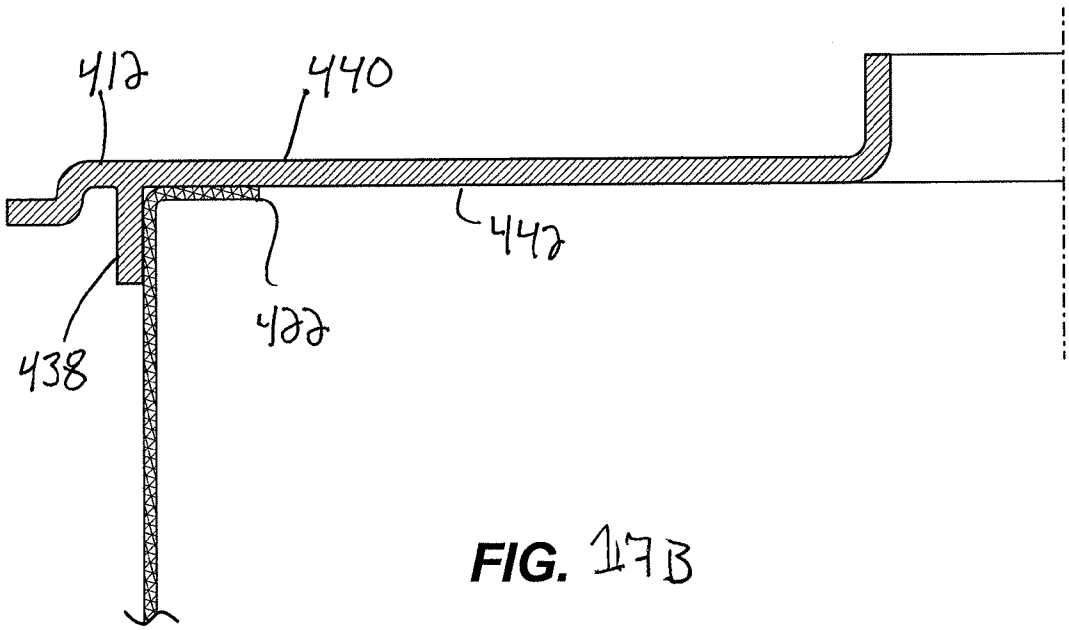


FIG. 17B

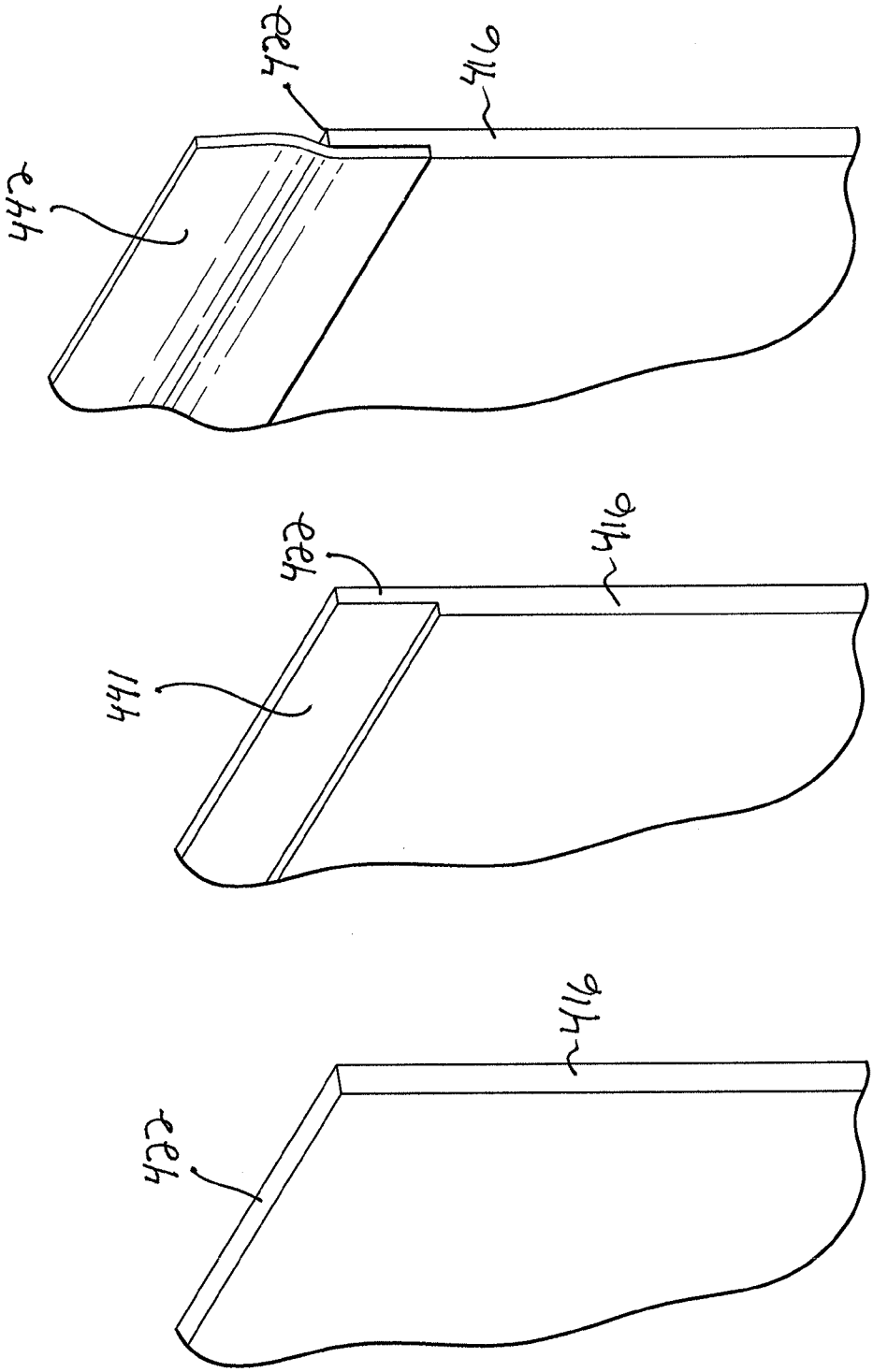


FIG. 18C

FIG. 18B

FIG. 18A

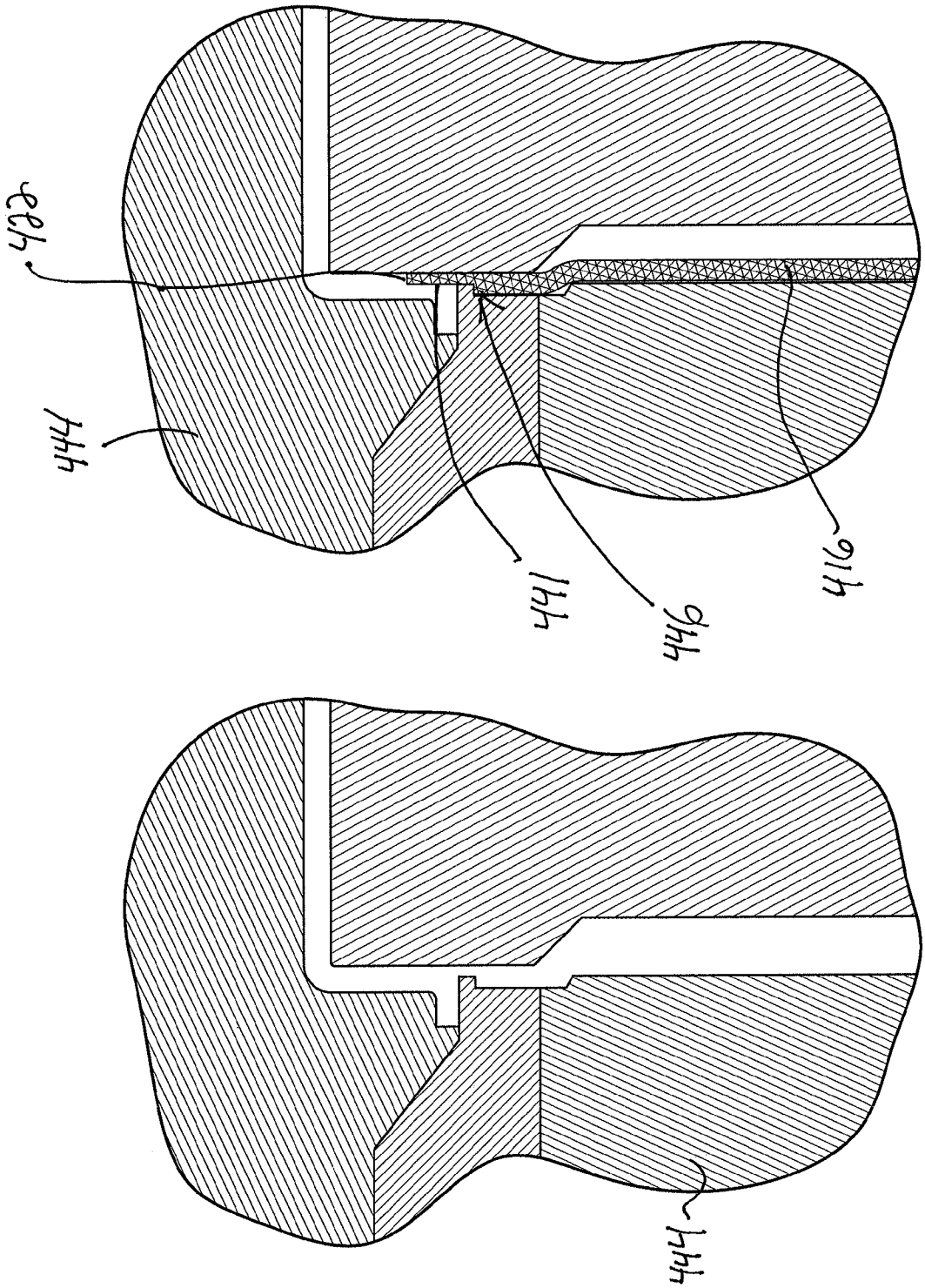


FIG. 19




FIG. 20

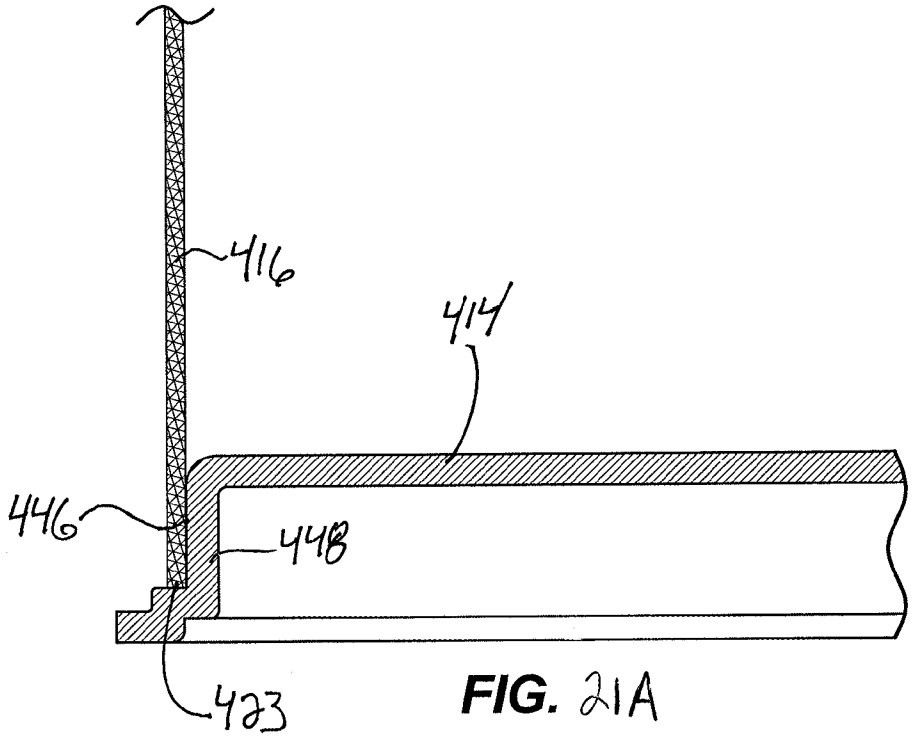


FIG. 21A

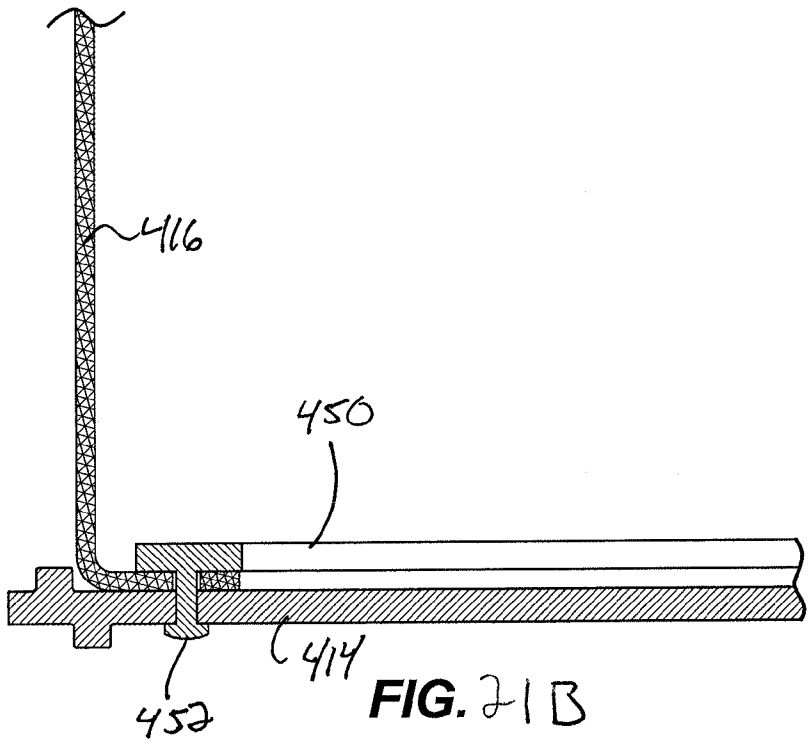


FIG. 21B

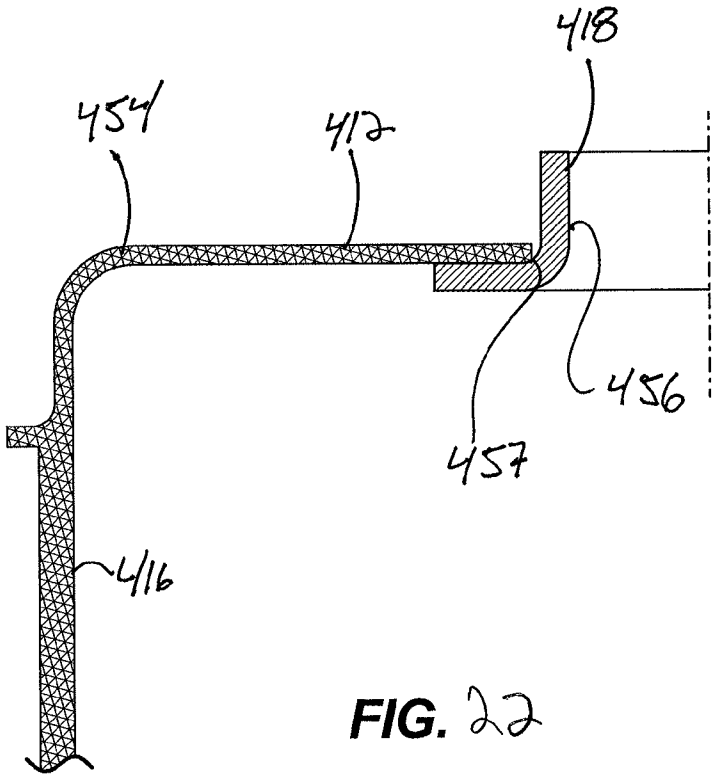


FIG. 22

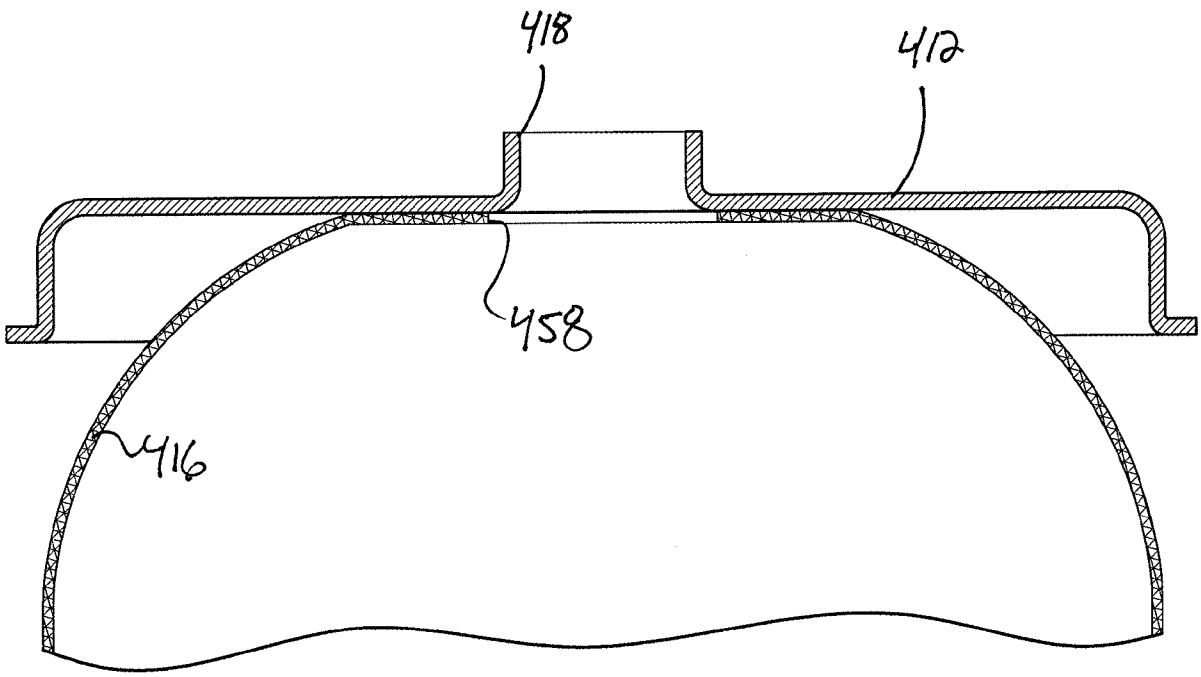


FIG. 23

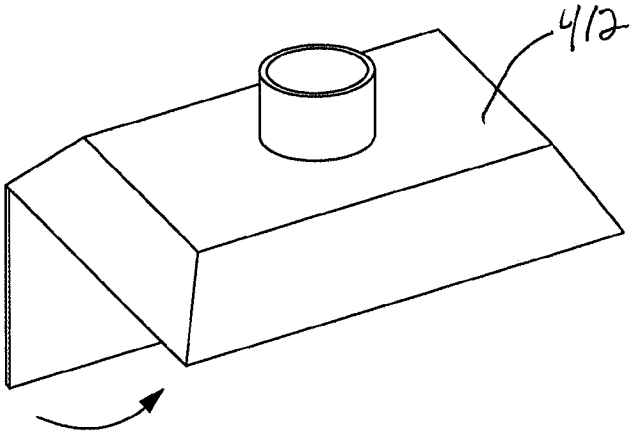


FIG. 24

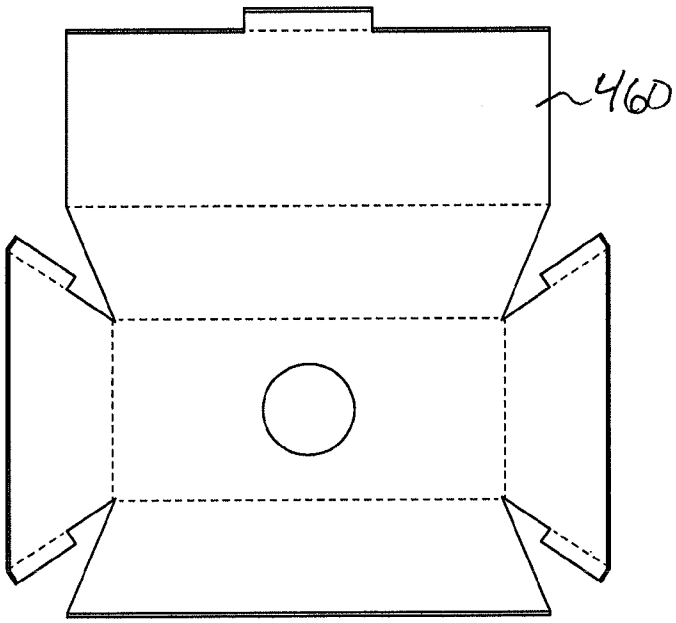


FIG. 25

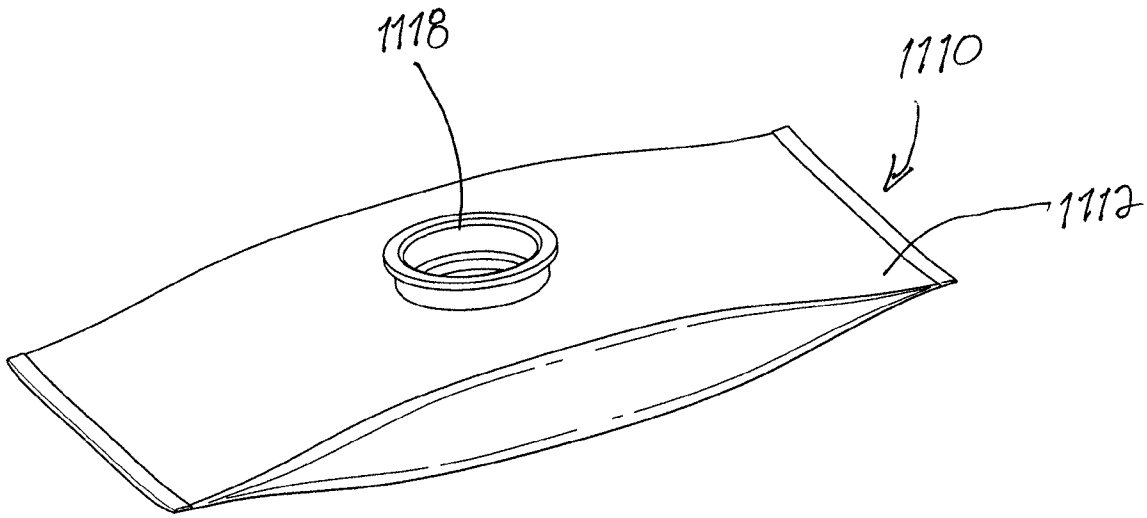


FIG. 26

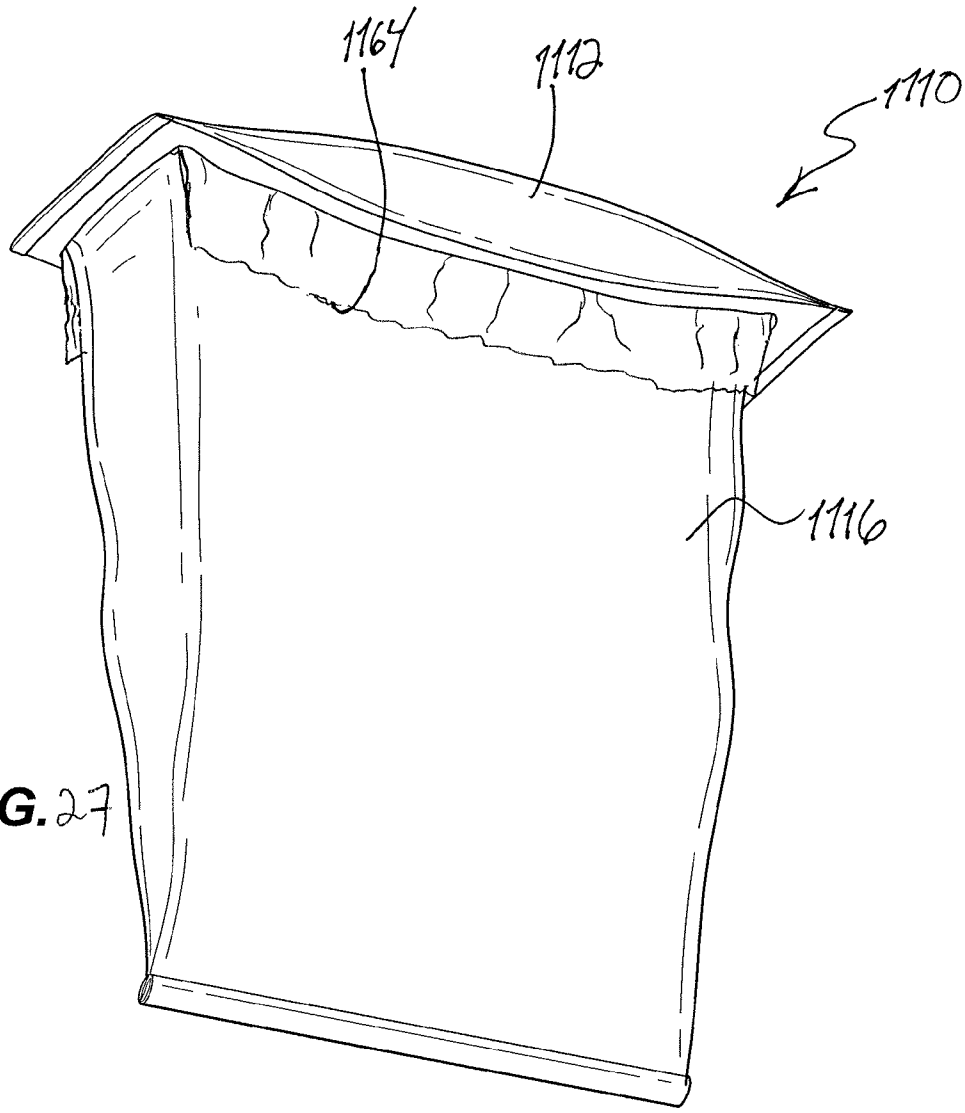


FIG. 27

# INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/027684

A. CLASSIFICATION OF SUBJECT MATTER
INV. B01D46/02 A47L9/10 A47L9/14 B01D46/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B01D A47L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | GB 879 781 A (ELECTROLUX LTD)<br>11 October 1961 (1961-10-11)<br>page 1, line 69 - page 2, line 10; figures 1-4 | 1,2,4-9 |
| X | EP 2 515 020 A1 (MANN & HUMMEL GMBH [DE])<br>24 October 2012 (2012-10-24)<br>abstract; figures 1,2<br>paragraphs [0009], [0012] | 1-5,7-9 |
| X | US 4 073 632 A (REINAUER THOMAS V ET AL)<br>14 February 1978 (1978-02-14)<br>abstract; figures 2,3,5<br>column 4, lines 37-49<br>column 5, line 4 - line 47 | 1-12 |
| X | US 4 276 069 A (MILLER DAVID L)<br>30 June 1981 (1981-06-30)<br>column 2, lines 42-52; figures 2,3 | 1,2,4,<br>7-9 |

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 21 June 2017 | 22/08/2017 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | Sembritzki, Thorsten |

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# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/027684

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-12

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/** 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-12

The claims refer to a filter having a housing with an inlet opening and a filter media coupled to the housing so that a container for debris separated by the filter media is formed. The filter further comprises an attachment member that couples the filter media to the housing which may be received in a groove of the housing.
The problem underlying these claims can be regarded as to improve the attachment of the filter media to the housing.

---

2. claims: 13-20

The claims refer to a filter having a housing with an inlet opening and a filter media coupled to the housing so that a container for debris separated by the filter media is formed. The filter further comprises an attachment member that couples the filter media to the housing wherein the end of the filter media is folded at the connection with the housing so that a portion of the media extends away from the housing and forms an overlapping media section.
The problem underlying these claims can be regarded as to improve the flow within the filter bag and to increase the separation efficiency.

---

3. claims: 21-56

The claims refer to a filter having a housing with an inlet opening, optionally a further housing and a filter media coupled to the housing portions so that a container for debris separated by the filter media is formed as well as a manufacturing method. The filter media is collapsible into at least one of the housing portions.
The problem underlying these claims can be regarded as to provide a filter wherein the filter bag can be collapsed and stored for transportation.

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2017/027684

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| GB 879781 A | 11-10-1961 | CH 363768 A | 15-08-1962 |
| | | DE 1149869 B | 06-06-1963 |
| | | FR 1195948 A | 20-11-1959 |
| | | GB 879781 A | 11-10-1961 |
| | | NL 112070 C | 16-08-2017 |
| | | NL 228980 A | 16-08-2017 |
| EP 2515020 A1 | 24-10-2012 | CN 102755793 A | 31-10-2012 |
| | | DE 102011018621 A1 | 25-10-2012 |
| | | EP 2515020 A1 | 24-10-2012 |
| | | US 2012267891 A1 | 25-10-2012 |
| US 4073632 A | 14-02-1978 | NONE | |
| US 4276069 A | 30-06-1981 | NONE | |