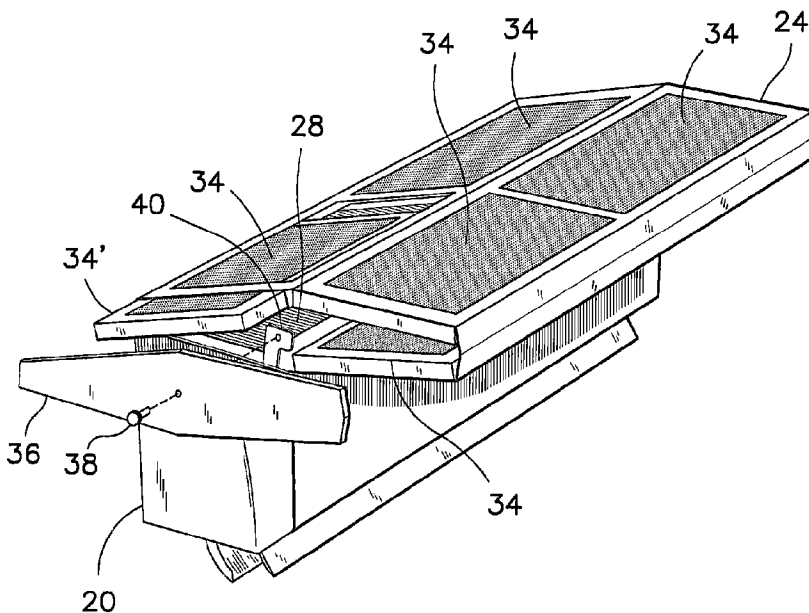




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(54) Titre : **FILTRE AUXILIAIRE POUR L'UNITE INTERIEURE D'UNE MINI-THERMOPOMPE BIBLOC**
(54) Title: **AUXILIARY FILTER FOR THE INDOOR UNIT OF A MINI-SPLIT HEAT PUMP**



(57) **Abrégé/Abstract:**

The indoor unit of a mini-split heat pump has an auxiliary filter mounted atop the air inlet opening of the indoor unit. The auxiliary filter comprising three parallel filtering stages and each of these filtering stages having an air flow capacity equivalent to a nominal air flow rating of the indoor unit. The three filtering stages improve low-air-quality tolerance of a residential indoor unit of a mini-split heat pump, so that commercial and industrial users can also benefit from these high efficiency heat pumps to reduce their carbon footprint.

ABSTRACT OF THE DISCLOSURE

The indoor unit of a mini-split heat pump has an auxiliary filter mounted atop the air inlet opening of the indoor unit. The auxiliary filter comprising three parallel filtering stages and each of these filtering stages having an air flow capacity equivalent to a nominal air flow rating of the indoor unit. The three filtering stages improve low-air-quality tolerance of a residential indoor unit of a mini-split heat pump, so that commercial and industrial users can also benefit from these high efficiency heat pumps to reduce their carbon footprint.

**TITLE: AUXILIARY FILTER FOR THE INDOOR UNIT OF A
MINI-SPLIT HEAT PUMP**

5 **FIELD OF THE INVENTION**

This invention pertains to filters for heat pumps, and more particularly it pertains to filters for operating a residential heat pump in a dusty environment.

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BACKGROUND OF THE INVENTION

Residential heat pumps, known as ductless mini-split heat pumps, are now associated with high efficiency, cost saving and excellent payback.

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Residential heat pumps have one or more indoor units that are installed relatively close to the ceiling. Heat pumps use a reverse CarnotTM cycle to extract heat from environmental air, to pump heated fluid into the heat exchangers of the indoor units and to circulate inside air through the heat exchangers.

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There is a double purpose for the installation of the indoor units near the ceiling. In addition to heating inside air through the heat exchanger, these units circulate warm air rising to the ceiling through the heat exchangers and force this warm air downward to maintain a
25 homogeneous heat throughout a room.

Residential mini-split heat pumps are designed for homes that are normally relatively clean and free of dust. Their filter screens are made to capture dust and debris carried from outside on residents' clothing, for

example. These filter screens must be cleaned periodically to maintain the efficiency of the indoor units. An indoor unit does not operate efficiently in a basement having a woodworking shop for example, or in a garage that is partly converted into a handyman shop. The dust present in these shops exceeds the design tolerance of an indoor unit.

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Similarly, these indoor units of mini-split heat pumps do not operate well in commercial establishments with heavy foot traffic, in manufacturing environments or in buildings located at remote locations, where periodic maintenance is difficult to schedule.

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For these reasons, it is believed that there is a need in the heating industry for an auxiliary filter that can be mounted to an indoor unit of a mini-split heat pump to allow these units to operate efficiently in commercial and industrial environments. A search in the prior art has given a few results of auxiliary filters for heat exchangers, but none of these filters can be used without a complete redesign of modern mini-split indoor units.

The following documents represent an inventory of filters available in the prior art.

- US 3,348,365, issued to D.D. Dupre on October 24, 1967;
- US 3,971,877, issued to L.Y. Lee on July 27, 1976;
- US 4,659,349, issued to A. Roti et al., on April 21, 1987;
- US 5,462,569, issued to S. Benjamin on October 31, 1995;
- 25 US 5,689,969, issued to M. Conroy on November 25, 1997;
- US 6,623,540, issued to R.L. Clayton on September 23, 2003;
- US 7,805,953, issued to T.A. Jensen on October 5, 2010;
- US 8,555,666, issued to N.E. Pettus on October 15, 2013;

Because of the limited space between the ceiling and the top of an indoor unit, the installations found in the prior art do not offer any suggestion to improve air filtration on an indoor unit of a mini-split heat pump.

5 Although the inventions of others deserve undeniable merits, there continues to be a need for an improved auxiliary filter for installation on indoor heat exchangers of mini-split heat pumps.

SUMMARY OF THE PRESENT INVENTION

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In the present invention, there is provided an indoor unit of a mini-split heat pump and an auxiliary filter mounted atop an air inlet opening of the indoor unit. The auxiliary filter is comprised of three parallel filtering stages and each of these filtering stages has an air flow capacity
15 equivalent to a nominal air flow rating of the indoor unit.

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In another aspect of the present invention, there is provided an indoor unit of a mini-split heat pump comprising an auxiliary filter mounted atop an air inlet opening of the indoor unit. The indoor unit has a casing
and the filtering stages of the auxiliary filter are incorporated inside that casing, so that the auxiliary filter and the indoor unit are part of a same apparatus.

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In another aspect of the present invention, there is provided a method for improving low-air-quality tolerance of a residential indoor unit of a mini-split heat pump, comprising the steps of: installing three stages of filtration in parallel above an air inlet opening of the indoor unit, wherein, each of the filtering stages has an air flow capacity equivalent to a nominal air flow capacity of the indoor unit.

The indoor unit with an auxiliary filter mounted thereon can be installed in commercial and industrial environments with unpredictable air quality. Because of this auxiliary filter, commercial and industrial users can also benefit from these high efficiency heat pumps to reduce their carbon footprint.

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It will be appreciated that whether the auxiliary filter is installed on indoor units in industrial plants, businesses or residences, the additional filtration implies a positive health benefit to people served.

10 This brief summary has been provided so that the nature of the invention may be understood quickly. A more complete understanding of the invention can be obtained by reference to the following detailed description of the preferred embodiment thereof in connection with the attached drawings.

15

BRIEF DESCRIPTION OF THE DRAWINGS

Two preferred embodiments of the auxiliary filter according to the present invention are described herein with the aid of the accompanying
20 drawings, in which like numerals denote like parts throughout the several views:

FIG. 1 is a perspective representation of an indoor heat exchanger of a mini-split heat pump with the first preferred auxiliary filter installed
25 thereon;

FIG. 2 is a perspective top, end and front side of the first preferred auxiliary filter with one end cap removed and one filter panel partly withdrawn from its seat;

FIG. 3 is an end view of an indoor unit with the first preferred auxiliary filter mounted thereon;

FIG. 4 illustrates an exploded view of the indoor unit and the first preferred auxiliary filter;

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FIG. 5 illustrates parallel air flows through the first preferred auxiliary filter;

FIG. 6 is a perspective view of a second preferred embodiment of the auxiliary filter incorporated in the casing of an indoor unit of a mini-split heat pump.

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The drawings presented herein are presented for convenience to explain the functions of all the elements included in the preferred embodiments of the present invention. Elements and details that are obvious to the person skilled in the art may not have been illustrated. Conceptual sketches have been used to illustrate elements that would be readily understood in the light of the present disclosure. These drawings are not fabrication drawings, and should not be scaled.

15

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DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring firstly to **FIGS. 1 - 4**, the space "A" available between the top of an indoor unit **20** and a ceiling **22** is usually about 4-1/2 inches to 6 inches or more. The first preferred auxiliary filter assembly **24** has a shape of a visor sitting on the top of the indoor unit **20**. The first preferred filter **24** has a total height "B" that is less than the available space "A". In the first preferred embodiment the height "B" is about 4-1/4 inches. The first preferred filter assembly **24** has a back portion

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overlapping the opening of the filter screen **28** of the indoor unit **20**, and a front portion overhanging the front door **30** of the indoor unit **20**, without preventing an operation of the front door.

5 The first preferred auxiliary filter **24** slides over the top of the indoor unit **20** and covers the air intake opening of the indoor unit **20** completely. The first preferred auxiliary filter **24** is retained on top of the indoor unit **20** by gravity or by magnetic tape, Velcro™ strips or similar attachment. Preferably, the center of gravity **32** of the first preferred auxiliary filter **24** is such that the auxiliary filter **24** remains on
10 the indoor unit **20** without requiring any fastener.

Many methods can be used to move the center of gravity **32** toward the wall side of the indoor unit **20**. Such methods may include adding ballast to that part of the first preferred auxiliary filter **24**, or adding an
15 accessory such as a handle for example, or air flow or temperature instrumentation.

Referring especially to **FIG. 2**, the first preferred auxiliary filter **24** contains three filter panels **34** mounted in a parallel flow. A removable
20 end cap **36** provides access to these filter panels **34** for the purpose of cleaning or replacing these filter panels. Panel **34'** is shown partly pulled out from its seat for the purpose of illustrating a replacement motion. Filter panels **34** can extend the full width of the auxiliary filter **24** or extend half the width, with another set of filter panels being
25 installed from the opposite end of the filter unit **24**. A second end cap **36** can be provided on that opposite end to provide access to this other set of filter panels **34**.

The end cap 36 is preferably retained to the casing of the auxiliary filter 24 by a thumb screw 38, attaching to a tab 40 on the casing. Other methods can be used to retain the end cap 36 or both end caps 36 to the casing of the first preferred auxiliary filter 24.

5 Referring now to FIG. 4, it will be appreciated that the preferred auxiliary filter 24 covers the air inlet opening 40 to the inlet screen 28 of the indoor unit 20 completely. Each filter panel 34 has a width that is equivalent to the width of the inlet opening 40 and a length that is either the full length of the inlet opening 40 or half the length such that two
10 filter panels 34 mounted end to end covers the air inlet opening 40 completely. All filter panels 34 in the first preferred auxiliary filter 24 have a same surface area.

The strip 42 illustrated around the air inlet opening 40 of the indoor unit
15 20 represents a magnetic strip or simply a strip of material having a smooth surface to afford easy sliding of the auxiliary filter 24 over the indoor unit 20. The strip 42 preferably has sealing properties to prevent air leakage around the air inlet opening 40. The sealing strip 42 may be installed around the air inlet opening 40 of the indoor unit 20 or around
20 the discharge opening 44 of the first preferred auxiliary filter 24, as can be seen in FIG. 5.

As can also be seen in FIG. 5, each filter panel 34 or each pair of filter panels 34 is mounted in a respective position and retained in place in
25 slides 46 formed inside the casing of the first preferred filter 24. In the first preferred auxiliary filter 24, a pair of filter panels 34 is mounted end-to-end in a first filtering stage "C" to draw air from the front of the indoor unit 20. A second pair of filter panels 34 is mounted end-to-end and located above the first pair in a second filtering stage "D" parallel to

the ceiling above the indoor unit **20**, drawing warm air from the ceiling region. A third pair of filter panels **34** is mounted end-to-end in a third filtering stage “**E**” above the air inlet opening **44** of the indoor unit **20**, and also drawing warm air from the ceiling region. Although pairs of filter panels **34** are mentioned herein, longer filter panels extending the full length of the air inlet opening **44** may be used.

Whether pairs of filter panels **34** or full-length filter panels **34** are used, each of filtering stages “**C**”; “**D**”; “**E**” has a surface area that is equivalent to the air inlet opening **40** of the indoor unit **20**. It will be appreciated that filtering stages “**C**”; “**D**”; “**E**” are mounted in parallel air flows. Each filter panels **34** is preferably made of pleated filter fabric to ensure that the filter panels **34** at each stage “**C**”; “**D**”; “**E**” has an air flow capacity that is larger than the CFM rating of the air inlet screen **28** of the indoor unit. Because the filtering stages “**C**”; “**D**”; “**E**” are mounted in parallel, the air flow capacity of the first preferred auxiliary filter **24** is three times as large as the air flow capacity (CFM) of the air inlet screen **28** in the indoor unit **20**.

An indoor unit of a mini-split heat pump having the first preferred auxiliary filter **24** mounted thereon can be operated efficiently in an environment which is three times as dusty as a residential apartment.

Because of the auxiliary filter **24**, mini-split heat pumps can be used in commercial and industrial environments that were considered impossible before. Low-cost heat can be made available to these commercial and industrial users to reduce their carbon foot print. Examples of these commercial and industrial users are: churches, shopping malls, control rooms and locker rooms of mills, manufacturing plants, office buildings, and power distributions substations. The increased availability of mini-

split heat pumps also include applications such as unmanned weather stations, lighthouses and forest fire watch towers, where preventive maintenance visits are far apart.

5 Referring now to FIG. 6, the auxiliary filter 50 according to the second preferred embodiment will be explained. In the second preferred embodiment, all three filtering stages "C"; "D"; "E" (not shown) are incorporated in a same casing as the heat exchanger and fan of the indoor unit. 20. The filter panels 34 of filtering stages "C" and "D" extend over the door 30 of the indoor unit 20. The door 30 of the indoor
10 unit is preferably hinged on hinge 52 below the filtering stage "C". The door 30 provides access to the filtering screen 28 of the indoor unit 20, for periodically cleaning the screen 28.

15 While two embodiments of the present invention has been illustrated in the accompanying drawings and described herein above, it will be appreciated by those skilled in the art that various modifications, alternate constructions and equivalents may be employed. Therefore, the above description and illustrations should not be construed as limiting the scope of the invention, which is defined in the appended
20 claims.

CLAIMS

What is claimed is:

1. In combination, an indoor unit of a mini-split heat pump and an auxiliary filter mounted atop an air inlet opening of said indoor unit, said auxiliary filter comprising three parallel filtering stages and each of said filtering stages having an air flow capacity equivalent to an air flow rating of said indoor unit.
2. The combination as claimed in **claim 1**, wherein each of said filtering stages comprising at least one filter panel.
3. The combination as claimed in **claim 2**, wherein each of said filter panels being made of pleated filtering fabric.
4. The combination as claimed in **claim 1**, wherein said indoor unit comprises a hinged access door in a front portion thereof and two of said filtering stages being mounted above a hinge of said access door.
5. The combination as claimed in **claim 4**, wherein said two of said filtering stages overhanging said front portion of said indoor unit.
6. The combination as claimed in **claim 1**, wherein said two of said filtering stages overhanging said front portion of said indoor unit; said third filtering stage covering said air inlet opening of said indoor unit, and said auxiliary filter being retained to said air inlet opening of said indoor unit by gravity.

7. The combination as claimed in **claim 2**, wherein said auxiliary filter comprising an end cap and longitudinal guides therein, and said filter panels being mounted in said guides and movably replaceable through said end cap.
8. The combination as claimed in **claim 7**, further comprising a sealing strip between said auxiliary filter and said air inlet opening of said indoor unit.
9. The combination as claimed in **claim 8**, wherein said sealing strip being a magnetic strip.
10. The combination as claimed in **claim 1**, wherein said indoor unit having an air inlet opening extending at six inches from a ceiling and said auxiliary filter has a total thickness of 4-1/4 inch above said air inlet opening.
11. An indoor unit of a mini-split heat pump comprising an auxiliary filter mounted atop an air inlet opening of said indoor unit, said auxiliary filter comprising three parallel filtering stages and each of said filtering stages having an air flow capacity equivalent to an air flow rating of said indoor unit; wherein said indoor unit having a casing and said filtering stages being incorporated in said casing.
12. The indoor unit as claimed in **claim 11**, further comprising longitudinal guides therein, and each of said filtering stages comprising filter panels mounted in said guides.

13. The indoor unit as claimed in **claim 12**, further comprising at least one end cap and said filter panels being movably replaceable through said end cap.
14. The indoor unit as claimed in **claim 13**, wherein said indoor unit having a front access door and two of said filtering stages overhanging said access door.
15. The indoor unit as claimed in **claim 11**, wherein two of said filtering stages having a downward air flow there through and one of said filtering stage having an upward air flow there through.
16. A method for improving low-air-quality tolerance of a residential indoor unit of a mini-split heat pump, comprising the steps of: installing three stages of filtration in parallel above an air inlet opening of said indoor unit, wherein each of said filtering stages having an air flow capacity equivalent to an air flow capacity of said indoor unit.
17. The method as claimed in **claim 16**, further comprising the step of installing filter panels in each of said filtering stages wherein each of said filter panels being made of pleated filtering fabric.
18. The method as claimed in **claim 16**, further comprising the step of installing said auxiliary filter on top of said indoor unit with two of said filtering stages overhanging said indoor unit.

19. The method as claimed in **claim 18**, also comprising the step of retaining said auxiliary filter above said indoor unit by gravity.

20. The method as claimed in **claim 16**, further comprising the step of directing an downward air flow through two of said filtering stages and an upward air flow through one of said filtering stages.

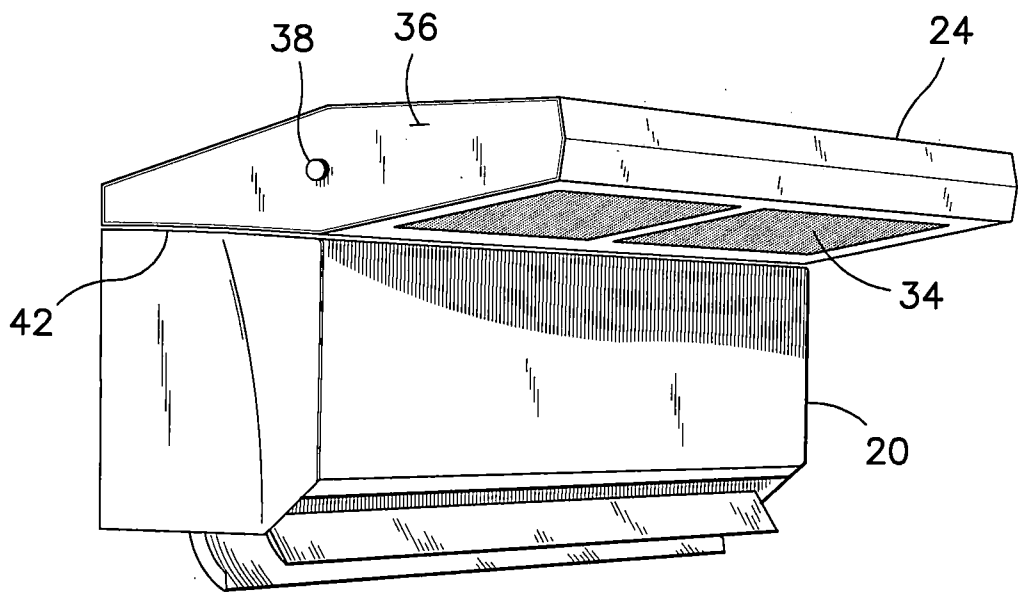


FIG. 1

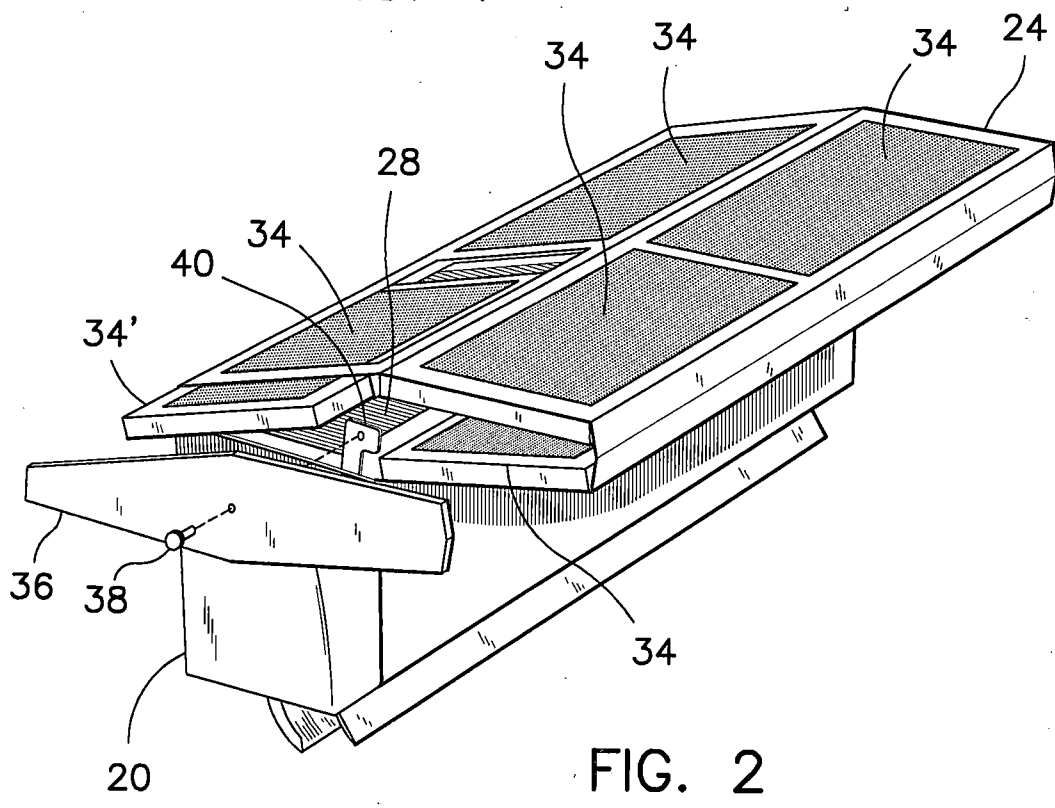


FIG. 2

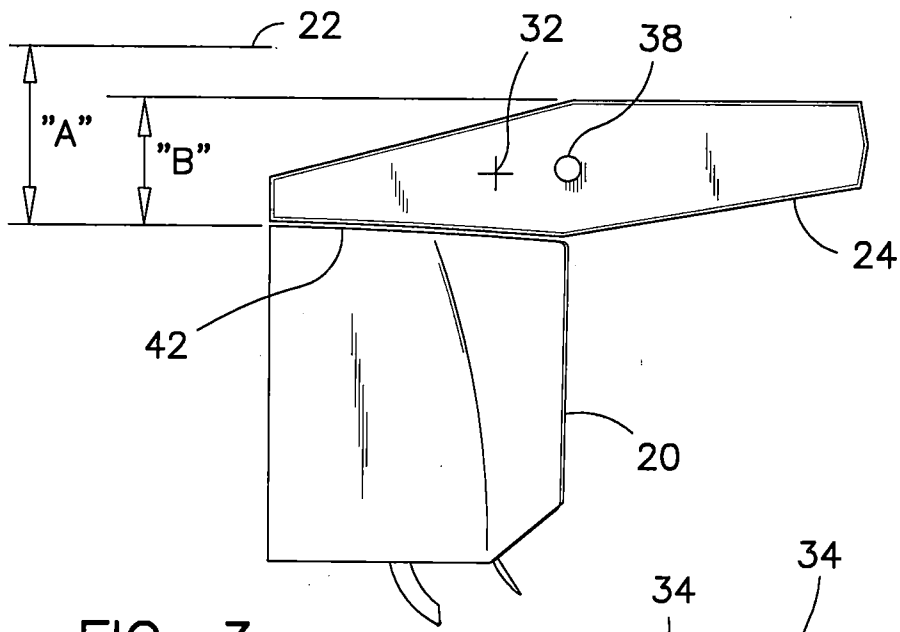


FIG. 3

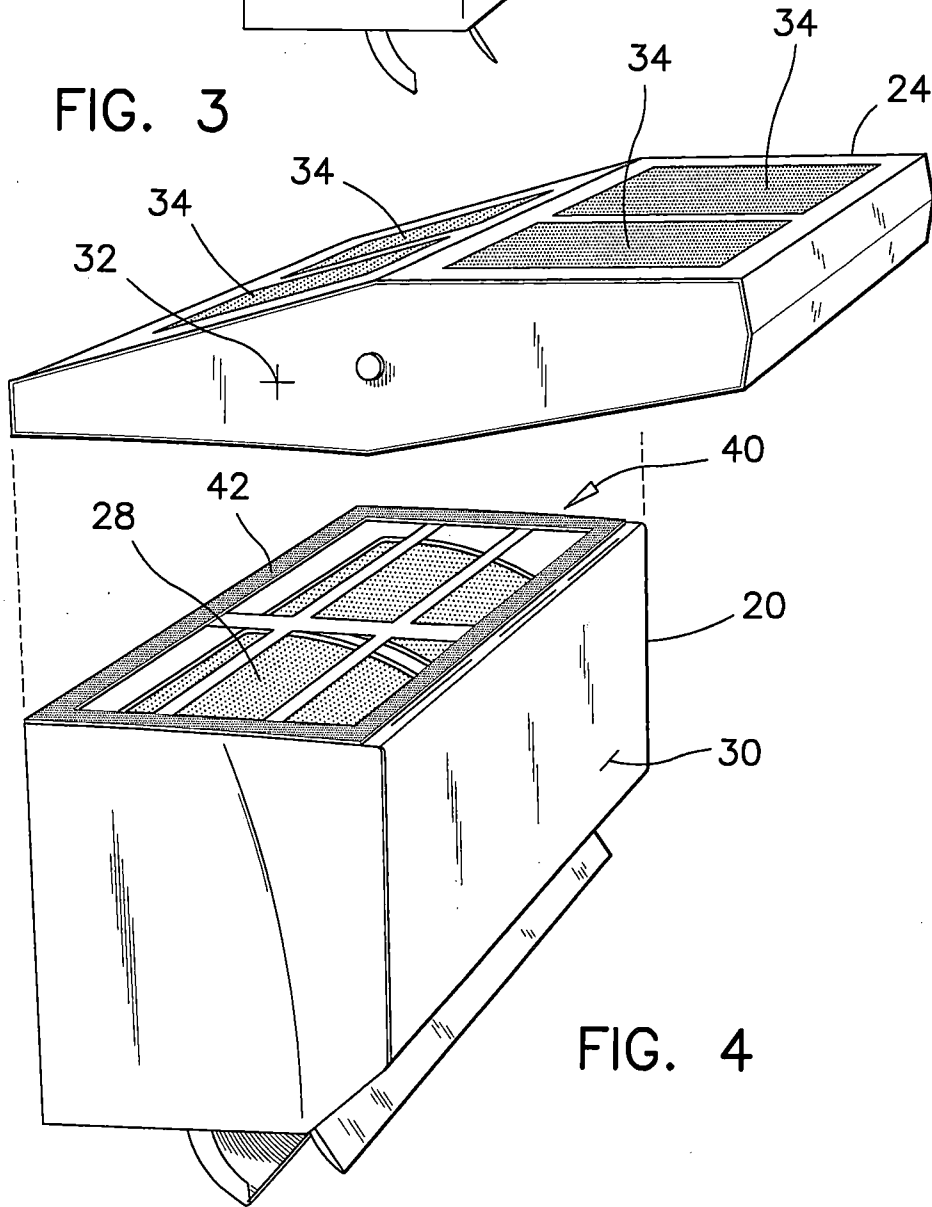


FIG. 4

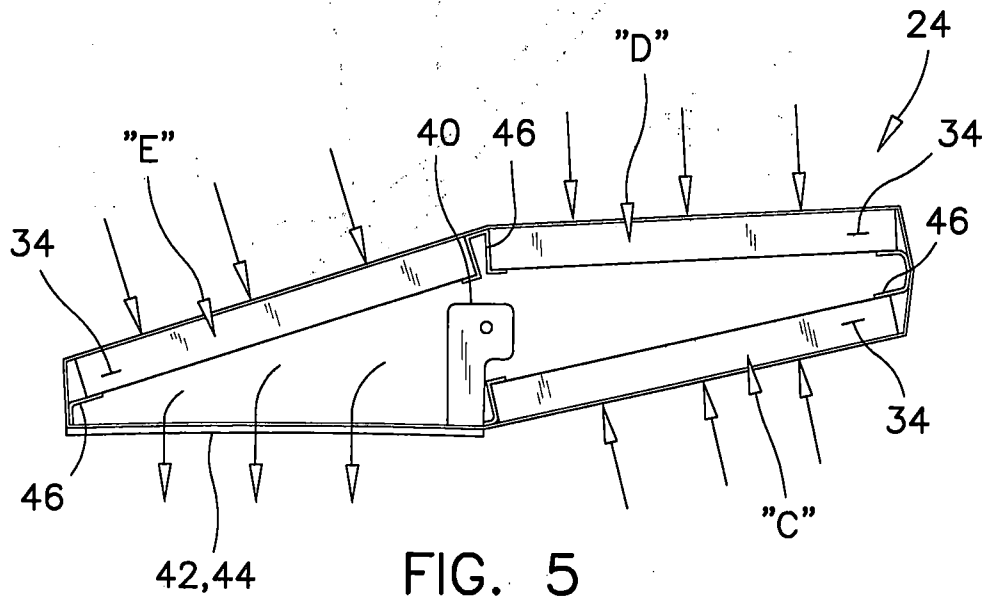


FIG. 5

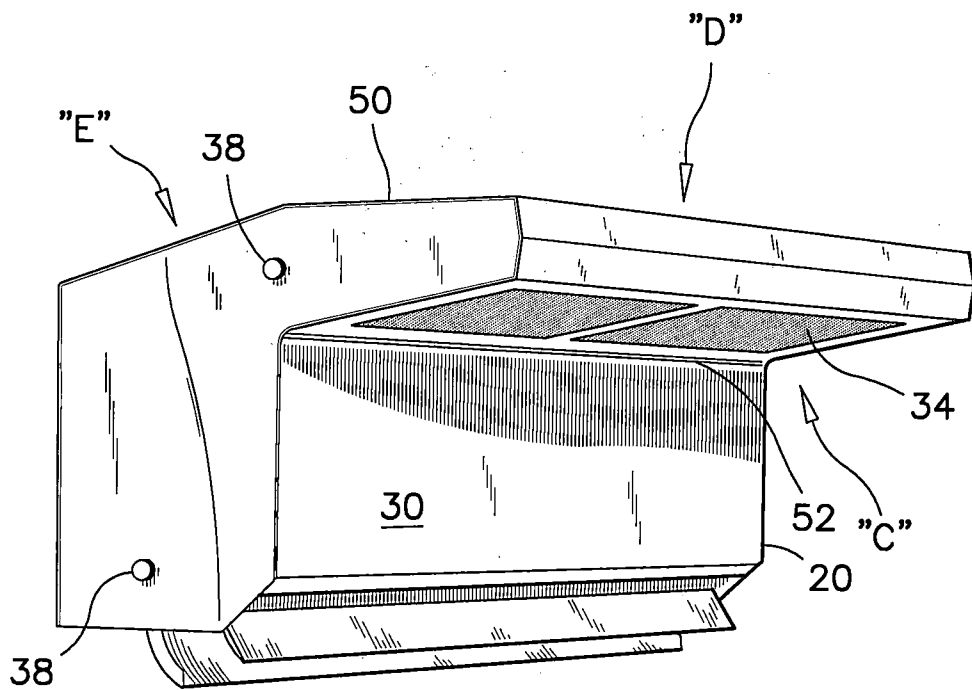


FIG. 6

