(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 September 2005 (09.09.2005)

PCT

(10) International Publication Number
WO 2005/082484 A1

(51) International Patent Classification[7]: B01D 29/01, 29/07, 29/21, 29/21, 46/52

(21) International Application Number: PCT/US2005/004073

(22) International Filing Date: 9 February 2005 (09.02.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/543,813 9 February 2004 (09.02.2004) US
60/543,805 11 February 2004 (11.02.2004) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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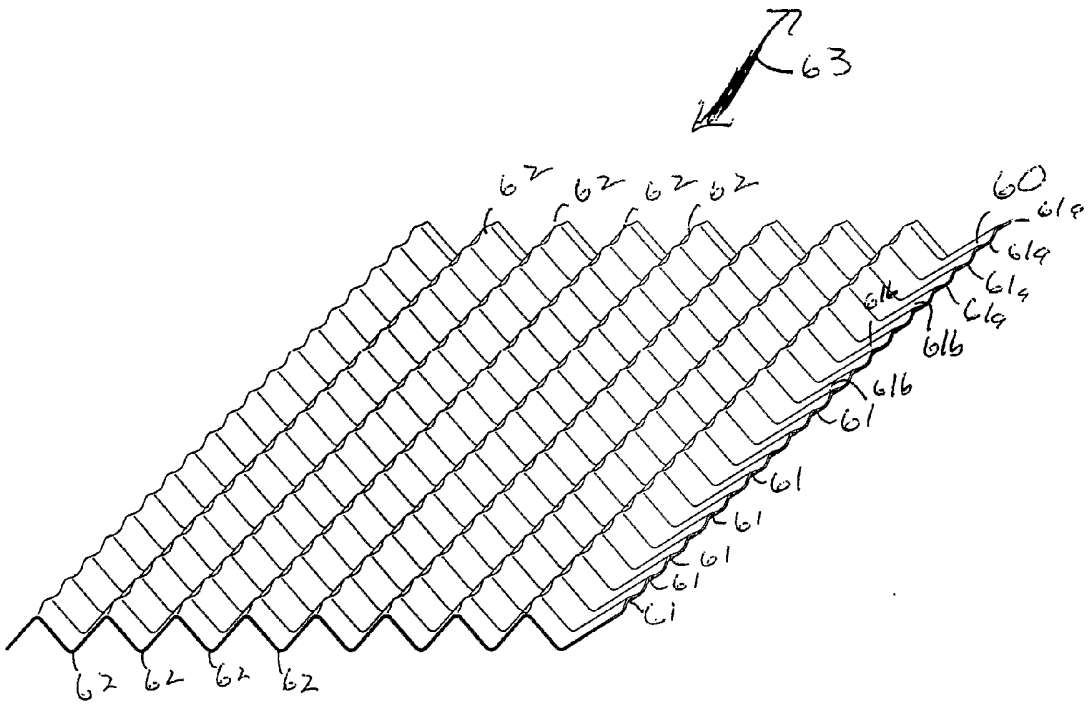
(54) Title: PLEATED CORRUGATED FILTER MEDIA



(57) Abstract: A filter element comprising pleated media having pleats (62) extending in a general direction (63) and corrugations (61) extending perpendicularly to the pleats.

WO 2005/082484 A1

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

PLEATED CORRUGATED FILTER MEDIA

Cross-Reference to Related Applications

The present application includes the disclosure of, with edits, U.S. Provisional Application 60/543,813 filed February 9, 2004; and U.S. Provisional Application 60/543,805, filed February 11, 2004. The complete disclosure of these two provisional applications is incorporated herein by reference. In addition, to the extent appropriate, request for priority from each of these filings is made.

Field of the Disclosure

The present disclosure relates to filtration media for use in fluid filtration such as air or liquid filtration. The disclosure particularly concerns media which is used, in filter elements, in a pleated form. The invention relates to preferred corrugation pattern or arrangement for such media.

Background

Fluid filtering is conducted in a variety of systems. For example, air filtering is used for: engine air intake; gas turbine intake; and compressor air intake. Liquid filtration is used for example in lube (oil) systems; hydraulic systems; and fuel systems.

In these and related types of filtration systems, typically the fluid to be filtered is passed through a filter media which operates as a barrier to passage of various contaminants, such as particulate contaminants.

In general, the filtration media for such systems is selected based upon its efficiency and load characteristics, for operation as a filter media. A variety of types and arrangements of media are known.

In many arrangements, the media is pleated, for use. This provides a relatively large surface area of media, in a given volume. Pleated media arrangements have been widely used for example in both panel filters and in coiled

filters. In a panel filter arrangement, the pleated media extends in a plane, and appropriate support framework or sealing framework is applied to the media. In coiled types of arrangements, the pleated media is generally formed into a coil or tube, with the pleats extending parallel to the central axis of the formed coil or tube.

As the number of pleats within any given volume increases, pleated media is subject to issues of undesirable levels of restriction increase due to pleat faces being adjacent one another.

In some systems to limit this restriction, the media is corrugated in a direction perpendicular to the pleat direction. Portions of these corrugations become pressed toward one another in a pleat, maintaining spacing between adjacent sections of the pleat. This will help maintain open pleats, for lower restriction to flow. In some systems still further modification of the media is conducted, for example adjacent pleat tips, to facilitate spacing. Both of these techniques are described for example in U.S. patent 4,615,804 issued October 7, 1986; the complete disclosure of which is incorporated herein by reference.

Summary of the Invention

According to the present disclosure a preferred pleated media for use in filter arrangements is provided. The pleated media has corrugations extending in a direction generally perpendicular to the pleats. Preferred corrugation sizes are provided.

Also provided are preferred filter element arrangements, including the media as characterized. Further, methods of use are provided.

Brief Description of the Drawings

Fig. 1 is a fragmentary schematic representation of pleated media.

Fig. 2 is a schematic perspective view of a panel filter element.

Fig. 3 is a schematic perspective view of a cylindrical filter element, with a portion broken away.

Fig. 4 is a side elevational view of the filter element of Fig. 3, with a portion broken away.

Fig. 5 is a schematic side elevational view of a conical filter.

Fig. 6 is a fragmentary perspective view of a corrugated sheet, shown folded for pleating.

Fig. 7 is a fragmentary schematic view of a corrugation in the sheet of Fig. 6.

Fig. 8 is a graph showing plots of corrugation inside height (depth) dimension B as a function of corrugation length (cycle length) A, for selected parameters as referred herein.

Detailed Description

A. Pleated Filter Media - Generally.

Filter media of the type of concern herein, generally comprises a non-woven matt of fibers. The fibers may be natural (for example cellulose), synthetic (for example polyester or polyolefin); or mixture of synthetic and natural. Such media is typically on the order of about .01 inch to .02 inch (0.25 - 0.51 millimeters or mm) thick, although alternatives are possible.

The filter media is typically used in a pleated form, so as to increase the surface area of media within any media volume.

The reference numeral 1, Fig. 1, schematically represents a typical sheet of pleated media. The pleated media 1 comprises a plurality of pleats 3, comprising a first set of pleat tips 3a and a second set of pleat tips 3b. Each of the pleat tips 3b is positioned between a pair of pleat tips 3a, except for pleat tips 3b at the ends of the sheet. Similarly each pleat tip 3a is positioned between two pleat tips 3b, except for any pleat tip corresponding to tip 3a, positioned at an end of the pleated media 1. Extending between the pleat tips 3a, 3b, are pleat surface panels 3c.

In general, the pleated media 1 forms a barrier filter. In the example shown in Fig. 1, fluid flow is represented by arrows 5. Thus, fluid directed in the direction of arrows 5 is filtered, as it passes through the pleated media 1. With a flow direction corresponding to arrows 5, pleat tips 3b are upstream pleat tips and pleat tips 3a are downstream pleat tips.

Referring to Fig. 1, the pleat direction or extension of the pleats is generally indicated by double headed arrow 7.

A direction perpendicular to the pleat direction is generally referred to as the machine direction, as indicated by double headed arrow 8. The term "machine direction" is generally an artifact term referring to a typical method used for processing of pleated media 1, in which the media is passed through a pleating machine in the machine direction 8, and is pleated perpendicularly to the machine direction. Herein, a direction generally perpendicular to the pleat direction will sometimes be referred to as the "machine direction" without regard to the method of processing the media to form the pleats. In some instances the direction perpendicular to the pleat direction will simply, alternatively, be so referenced.

In general, as the number of pleats per given volume increases, the pleat sides 3c come closer and closer to one another. Especially under the pressure of fluid flow in the direction of arrow 5, adjacent pleat surfaces restrict fluid flow. This type of restriction becomes a greater concern as either or both of the following occur: the pleat population per given distance in the machine direction increases; or the depth of the pleat increases. Typical pleats for air filtration are on the order of at least 0.25 inch (6.35 mm) deep, typically at 0.5 inch (12.7 mm) deep; many are 0.75 inch (19 mm) deep or greater.

In order to inhibit flow resistance from the pleats, in some instances the following types of modifications are made, in the media. First, the media is sometimes corrugated in a direction that will be perpendicular to the pleat direction. (The corrugation is typically done before pleating.) The sizes of such corrugations are discussed below. The use of such corrugations is wide spread, as described for example in U.S. patent 4, 615,804 in reference to Fig. 9, the complete disclosure of the '804 reference being incorporated herein by reference.

Another modification sometimes used, relates to modifications in pleat tips, to enhance pleat spacing. This approach is also described in the above-referenced '804 patent.

In Fig. 2, a panel filter 10 is depicted. The panel filter 10 comprises media 11, pleated in a configuration 12 comprising end pleats 13. The panel 10 depicted includes a frame construction 15 having a seal arrangement 16 thereon. The seal arrangement 16 is generally configured to form a seal with a housing or other structure in which the panel filter 10 is positioned, for use. The panel filter 10 depicted also includes a grid 18, across one surface of the panel filter arrangement 10.

While there are variations in panel filters from those shown in Fig. 2, in general the features are analogous, comprising: a plurality of parallel pleats; a seal arrangement secured within the panel filter; and, a rectangular configuration with one set of pleat tips 19 in a plane and the second set of pleat tips 20 in a separate plane. (Ends or opposite edges 14 of the pleats can be closed by sealant, or by being encased in a mold or frame, if desired.)

In general, media having corrugations extending perpendicularly to the pleat direction has been used in panel filters.

In other arrangements, the pleated media is coiled into a configuration around an open central area. An example of such a filter depicted in Figs. 3 and 4 referring to Fig. 3, filter arrangement 25 is depicted. The filter arrangement 25 comprises first and second end caps 26 and 27 having pleated media 29 extending therebetween. The pleats of the pleated media 29 generally extend in a direction between the end caps 26, 27. The particular filter arrangement 25 of Fig. 3 has an outer liner 31, shown broken away at one location, for viewing pleats. (Typically, pleats can be viewed through the liner 31, the arrangement 25 is simply not drawn that way, for convenience.) The outer liner 31 shown comprises expanded metal, although a variety of alternative outer liners, including plastic ones, can be used. Indeed in some instances an outer liner is simply not used.

For the particular arrangement 25 of Fig. 3, a direction perpendicular to the pleat direction is generally a circumference of the filter arrangement 25, indicated by the double headed arrow 33.

The particular filter arrangement 25 depicted, is generally cylindrical, although alternatives are possible. Typically, such elements as element 25 have an open end cap, in this instance corresponding to end cap 26, and a closed end cap, in this instance corresponding to end cap 27, although alternatives are possible. The term "open" when used in reference to an end cap, is meant to refer to an end cap which has an open central aperture 28 to allow air flow between an interior space 29a of the filter arrangement 25 and the exterior, without passage through the media 29. A closed end cap, by comparison, is an end cap which has no aperture therein.

A variety of arrangements have been developed for end caps 26, 27. The end caps may comprise polymeric material molded to the media. Alternatively they may comprise metal end caps or other preformed end caps secured to the media, with an appropriate adhesive or potting agent. The particular end caps 26, 27

depicted, are molded end caps, each comprising a compressible foamed polyurethane. End cap 26 is shown with a housing seal 30, for sealing the element 25 in a housing during use. The depicted seal 30 is an inside radial seal, although outside radial seals and axial seals are also possible.

Attention is now directed to Fig. 4, which is a side elevational view of arrangement 25, showing end caps 26 and 27.

It is noted that the element may include an inner liner extending between end caps 26, 27 along an inside of the media 29 as shown in Fig. 3 at 31, although in some arrangements such liners are optional. The inside liner, if used, can be metal, such as expanded metal or perforated metal, or it can be plastic.

The distance between the outside cylindrical surface and the inside cylindrical surface, defined by outer and inner pleat tips, is generally referenced as the pleat depth. (An analogous distance is pleat depth in panel filters, Fig. 2, or in conical filters, Fig. 5.)

Media corrugated in a direction perpendicular to what will be the pleat direction has been used in arrangements such as filter arrangement 25, Figs. 3 and 4. This is described for example in U.S. patent '804 referenced above.

An arrangement such as that depicted in Figs. 3 and 4 are sometimes referenced herein as a "cylindrical arrangement," using "cylindrically configured" media, or by similar characterizations. Not all filter arrangements that utilize coiled or tubular media are configured as cylinders. An example of this is illustrated in Fig. 5.

Referring to Fig. 5, filter arrangement 40 comprises extension of media 41 which is pleated, with pleat direction extending in the directions of arrow 42. Filter arrangement 40 is somewhat conical having a wide end 44 and a narrow end 45. At wide end 44 is positioned at end cap 47, and at narrow end is positioned at end cap 48. As with the cylindrical arrangement, a variety of open and closed end caps can be used. For the specific example depicted, end cap 47 is open and end cap 48 is closed.

Filter arrangement 40 includes outer support screen 50 extending between end caps 47 and 48. The particular arrangement 40 includes no inner support screen although one could be used. The arrangement 40 is generally described in detail in PCT/US 2003/33952 filed October 23, 2003, incorporated herein by reference.

Pleated filter arrangements having corrugations extending perpendicularly to the pleats, can be used in arrangements such as filter arrangement 40.

At 51, filter element 40 includes a seal arrangement, in this instance an axial seal, although an inside or outside radial seal is possible. Element 40 includes a non-continuously threaded mounting arrangement, 53, for mounting in a housing.

B. Use of Corrugated Media for Forming Pleats.

As indicated above, in general corrugated pleats of media have been used to form the pleated media, with the pleats extending generally perpendicularly to the corrugations. In Fig. 6 a fragmentary perspective view of a corrugated sheet 60 is shown. Referring to Fig. 6, sheet 60 includes individual corrugations 61. The corrugations can be viewed as comprising a series of alternating troughs 61a and peaks 61b. For a typical corrugated arrangement the troughs 61a and peaks 61b would generally be the same, but inverted relative to one another. When a sheet such as corrugated sheet 60 is used to form pleated media, typically the pleats 62 are generated perpendicularly to corrugation 60, thus the pleats would extend in the general direction indicated by arrow 63. In Fig. 6, sheet 60 is shown folded, to set pleats 62, although the pleats 62 are not folded closed as set they typically would be, when mounted in a pleated media arrangement.

Attention is now directed to Fig. 7 in which an individual corrugation 70 is depicted. Corrugation 70 may correspond to either one of corrugation 61a or 61b, Fig. 6. Referring to Fig. 7, the following dimensions to the media and corrugation are indicated:

(a) at T - the thickness of the media is indicated;

(b) at A - the individual corrugation length is depicted. A generally indicates the length for one cycle of corrugation between two adjacent valleys 70a, over a peak 70b and thus it extends between mid-points of troughs on opposite sides of corrugation 70;

(c) at B - is depicted a corrugation inside height. B generally corresponds to a distance of a distortion from flat, of a surface 70a of corrugation 70, corresponding to a concave side 71 of the pleat 70.

(d) at C - is indicated the corrugation thickness, corresponding to T+B, or alternatively stated the distance in projection between the convex side 72 of corrugation 70, and a convex side of a next adjacent, opposite, corrugation.

For a typical arrangement in the prior art, the following dimensions have been used in the pleated media: T = 0.013 inch (0.33 mm); A = 0.15 inch (3.81 mm); B = 0.015 inch (0.381 mm); C = T + B.

Such arrangements have been beneficial in providing for some desirable pleat spacing, in the prior art. In the next section, preferred new corrugation configurations for pleated media are characterized.

C. Further Regarding Corrugation Patterns.

According to the present disclosure, typical corrugation configurations are provided, for use in pleated media. Example media is as follows:

T = 0.01-0.02 inch, typically 0.011-0.014 inch; (0.254 mm - 0.51 mm; typically 0.28 mm - 0.36 mm), preferably no greater than 0.02 inch (0.51 mm).

A = greater than or equal to 0.15 inch (≥ 3.8 mm); usually ≥ 0.16 inch (4 mm) preferably greater than or equal to 0.175 inch (≥ 4.4 mm).

B = at least 0.018 inch (0.46 mm) preferably at least 0.19 inch (0.48 mm) typically 0.019 - 0.025 inch, inclusive (0.48 mm - 0.64 mm; most preferably greater than or equal to 0.02 inch (≥ 0.51 mm); and typically not greater than 0.027 inch (0.69 mm)..

C = T + B.

In more general terms, introducing corrugation into the media provides strain. The amount of strain acceptable for the media, is a function of the media type. Typical cellulose media extensively utilized for many filter applications, can readily accept 3% strain. Sometimes it cannot accept more than 10% strain. Typical media can readily accept about 8% strain, although in some instances it is preferred to place 6% strain or less on the media. Some preferred corrugation patterns for such media can be derived from Fig. 8. Referring to Fig. 8:

1. The solid (bottom) line X, identified in the legend as corresponding to 3% strain, is indicative of minimal typical corrugation inside height, or depth, (B) for improved arrangements according to the present disclosure,

plotted against (and reported as a function of) corrugation length (cycle length), A. It is noted that the graph of Fig. 8 is presented in inches.

The solid line X shown in Fig. 8 represents typical (usually cellulose) media having corrugations with a corrugation length (A) of 0.1 inch (2.54 mm) to 0.38 inch (9.65 mm).

The lines show typical, corresponding, minimal corrugation inside heights (depths) along the line, from 0.01 inch (0.25 mm) to 0.04 inch (1 mm).

2. The hyphenated (top) line Y, indicated in the legend as corresponding to 8% strain, indicates a typical, maximum inside corrugation height (depth) (B) for a typical cellulose media, as a function of corrugation cycle lengths within the same range as previously identified, i.e., 0.1 inch (2.54 mm) - 0.38 inch (9.65 mm).

The maximum values for B on line Y, as shown, range from 0.018 inch (0.457 mm) to 0.067 inch (1.7 mm). The bottom solid line X and the top hyphenated line Z represent a range of typical maximum and minimum values for the inside corrugation height (or corrugation depth) B, as a function of the typical corrugation length (or cycle) A. For any given length (A) typical useable corrugation depths B, would be between the ranges indicated by the plots of the two lines, X, Y, inclusive. By "inclusive" in this context, it is meant that points on the line are included in the range.

3. The middle line Z, indicated in the legend as corresponding to 6% strain, defines a typical preferred upper limit on corrugation height for a typical cellulose media. Here, again, the plot is from a corrugation (cycle) length A of 0.1 inch (2.54 mm) to 0.38 inch (9.65 mm). The inside corrugation height (depth) B for this range of cycle lengths would extend from 0.015 inch (0.38 mm) to 0.052 inch (1.32 mm) over this range.

In general, then, typical corrugation patterns according to the present disclosure will be provided with a corrugation (cycle) length within the range of 0.1 inch - 0.38 inch (0.25 - 9.65 mm).

The typical range for a corrugation inside height (B) or cycle, then, can be determined as a function of the cycle length (corrugation length) A used, by Fig. 8. Typically it will be on or between lines X and Y, usually on or between lines X and Z, for a given corrugation (cycle) length A.

Thus, for typical applications the corresponding corrugation height (depth) B will be either on the solid line X shown in Fig. 8 or above it, with an upper limit on corrugation height (depth) B, being either on the hyphenated 8% strain line Y, or below it, with corrugation depth B varying with corrugation (cycle) length A, as shown. Typically the corrugation depth B will be on the dotted line Z (6% strain) or below it, again with corrugation depth B varying corrugation length A (i.e., cycle length) as shown.

Alternately stated, the lines drawn represent boundaries on or between which, typical corrugation depths (B) and cycle lengths A (corrugation length) would be selected, as shown.

Typical corrugation lengths (cycles) will be within the range of 0.15 inch - 0.18 inch (3.8 - 4.6 mm); and, typical inside corrugation heights (B) will be within the range of 0.018 inch - 0.023 inch (0.45 mm - 0.6 mm).

Herein when reference is made to corrugation dimensions, reference is meant to a measurement taken visually using commercially available optical comparators such as the MicroVu Spectra or 500 HP Optical Comparator equipped with 20x magnification. A 0.5 inch wide by 7 inch long (12.7 x 178 mm) sample of media, with the width cut parallel to the corrugations, is supported at both ends and positioned in the comparator stand such that the thickness of the media is projected perpendicular to the corrugations on the comparator screen. Corrugation depth is the average measurement taken between the peaks and valleys of four corrugations, discounting any fibers or fuzz projecting from the media surface.

Advantage will be obtained if at least 50 percent of the corrugations in the sheet are constructed with the preferred corrugation dimensions characterized above. More preferably, at least 75 percent of the corrugations correspond to the preferred dimensions; most preferably, at least 95 percent of the corrugations. In general, the advantages relate to flow characteristics and load characteristics of the resulting media.

The preferred corrugated media can be formed by passing an appropriate media between corrugation rollers. The media would then be pleated, for use.

Herein focus is on the media definition as it is used to form the pleated media, as opposed to a focus on the corrugation definition of the rollers used to form the media. Further, since the media is typically rolled into coils, after it is

corrugated, for storage, the intent is on defining the media definition as it is unrolled and used in the pleating process to form the pleated media.

The pleated and corrugated media can be formed with modified pleat tips according to the '804 patent referenced above.

A variety of materials can be used for the media. The particular choice of media will in part be a factor of: the fluid to be filtered; the efficiency desired; the load characteristics desired; and, the media characteristics needed for the environment of use with respect to resistance to damage by that environment.

A typical media useable for air filtration, as an air filter media in an engine intank system, is one having Frazier permeability of at least 4.0 meter/minute (13 feet/min.); a dry breaking strength in the machine direction of at least 10.0 kilogram/inch (22.0 lb./inch); a wet breaking strength in a cross direction of at least 1.8 kilogram/inch (4.0 lb./inch); and a dry burst strength of at least 124 kpa (18.0 psi). However, alternative media can be used with arrangements according to the present disclosure.

A preferred media for many air filter applications would be one which has a cumulative efficiency of at least 99.95% on ISO fine dust at a dust concentration of zero visibility and 2.2 meter/min (7.2 feet/min) face velocity to 6.17 kpa (25 inch H_2O) restriction rise. However, alternative media can be used.

The preferred media as characterized above, can be used in any of a variety of filter arrangements for both liquid filtering. General constructions in accord with the figures discussed above, can be used. However, the media can be applied in alternate arrangements as well.

What is claimed:

1. A filter element comprising:

(a) pleated media having corrugations extending perpendicularly to pleats therein; the corrugations having:

(i) a corrugation length of at least 3.8 mm; and,

(ii) a corrugation inside height of at least 0.46 mm.

2. A filter element according to claim 1 wherein:

(a) the pleated media has:

(i) a corrugation inside height of 0.48 mm to 0.64 mm, inclusive.

3. A filter element according to claim 2 wherein:

(a) the media has a thickness of no greater than 0.51 mm.

4. A filter element according to claim 3 wherein:

(a) the pleated media has a pleat depth of at least 12.7 mm.

5. A filter element according to claim 4 wherein:

(a) the pleated media has a pleat depth of at least 19 mm.

6. A filter element according to claim 5 including:

(a) first and second end caps with the media coiled and extending between the end caps.

7. A filter element according to claim 6 wherein:

(a) the media is configured in a cylindrical shape.

8. A filter element according to claim 6 wherein:

(a) the media is configured in a conical shape.

9. A filter element according to claim 5 wherein:

(a) the pleated media is positioned in a panel filter.

10. A filter element comprising:

(a) pleated media having corrugations extending perpendicularly to pleats therein; the corrugations having:

(i) a corrugation length (A) and a corrugation inside height (B) wherein:

(A) the corrugation inside height B is a variable selected based on corrugation length A wherein, in a plot of B as a function of A, between values of 2.54 mm to 9.65 mm for A, the value B is no smaller than a value represented on a line extending between values of:

(i) A, B of 2.54 mm, 0.25 mm; and

(ii) A, B of 9.65 mm, 1 mm, inclusive.

(D) the corrugation inside height B is a variable selected based on corrugation length A wherein, in a plot of B as a function of A, the value B is no larger than a value on a line extending between values of:

(i) A, B of 2.54 mm, 0.457 mm; and

(ii) A, B of 9.65 mm, 1.7 mm, inclusive.

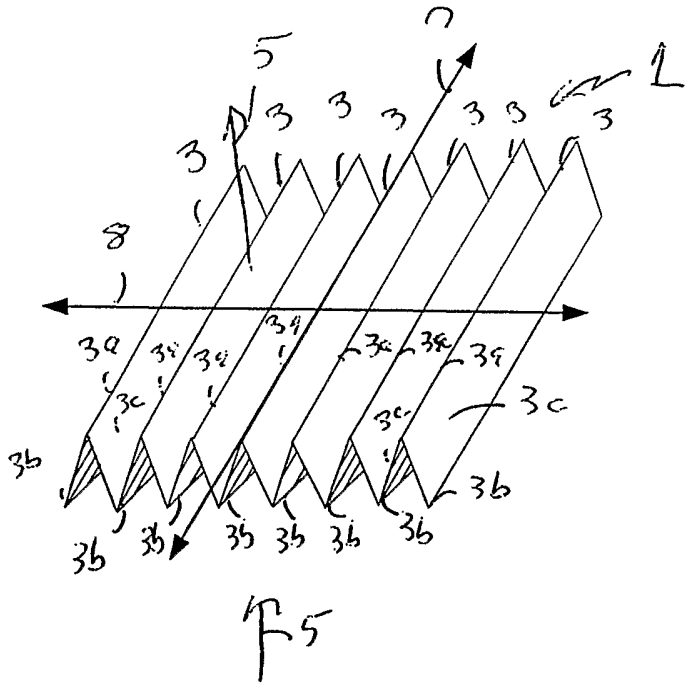
11. A filter element according to claim 10 wherein:

(a) the corrugation inside height B is a variable selected based on corrugation length A wherein the value B is no larger than a value represented on a line extending between values of:

(i) A, B of 2.54 mm, 0.38 mm; and

(ii) A, B of 9.65 mm, 1.32 mm, inclusive.

FIG. 1



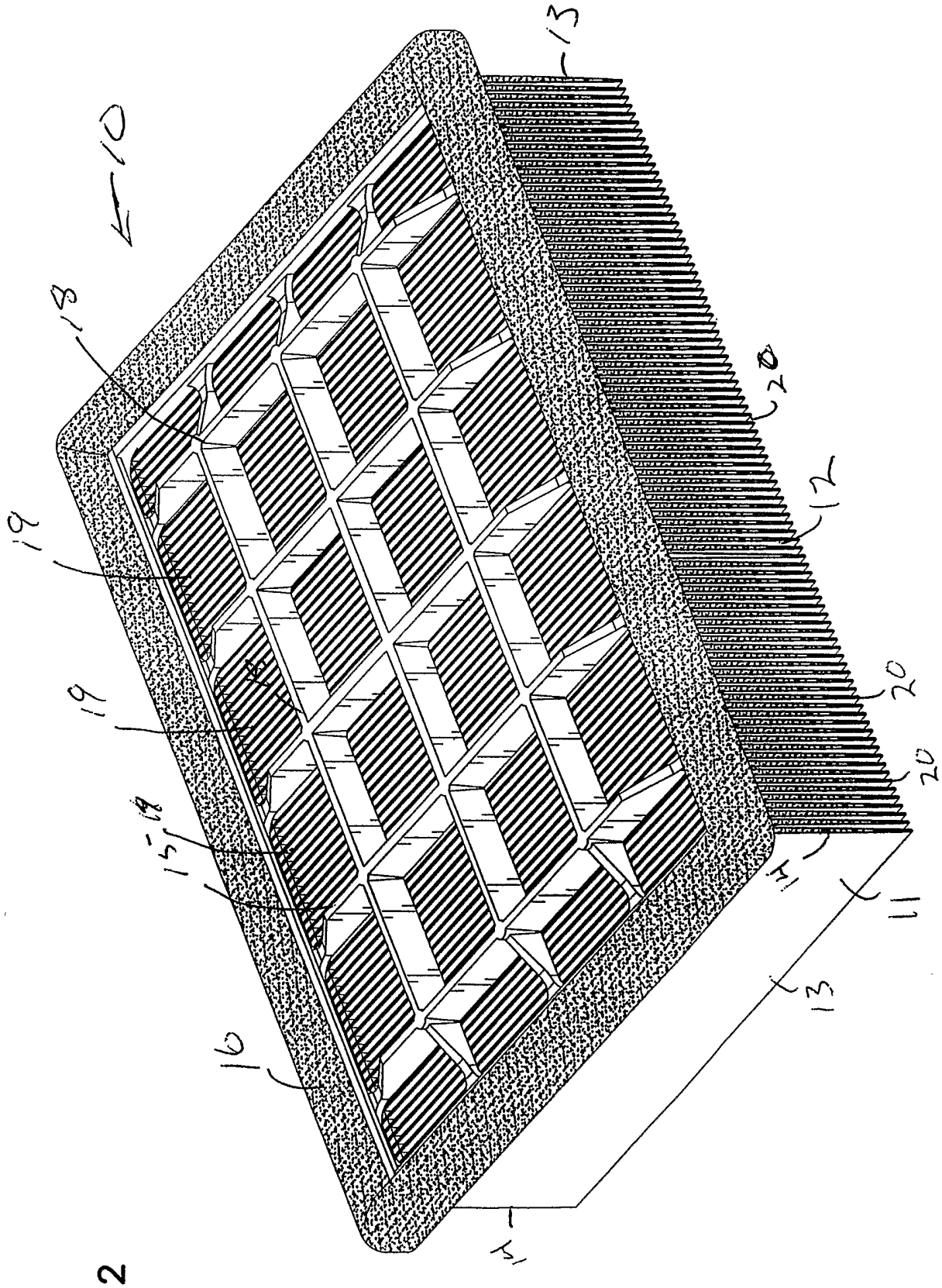


FIG. 2

FIG. 3

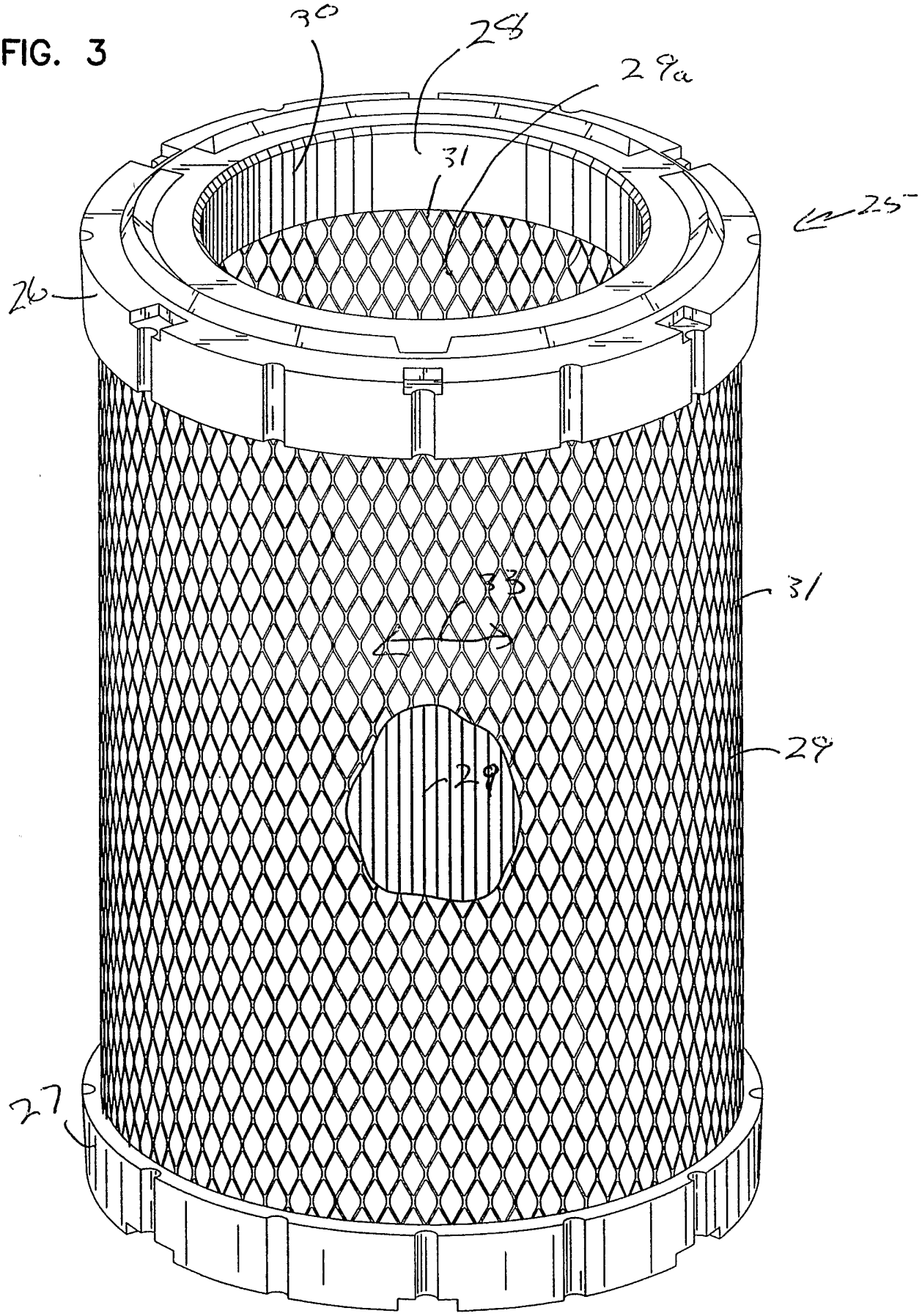
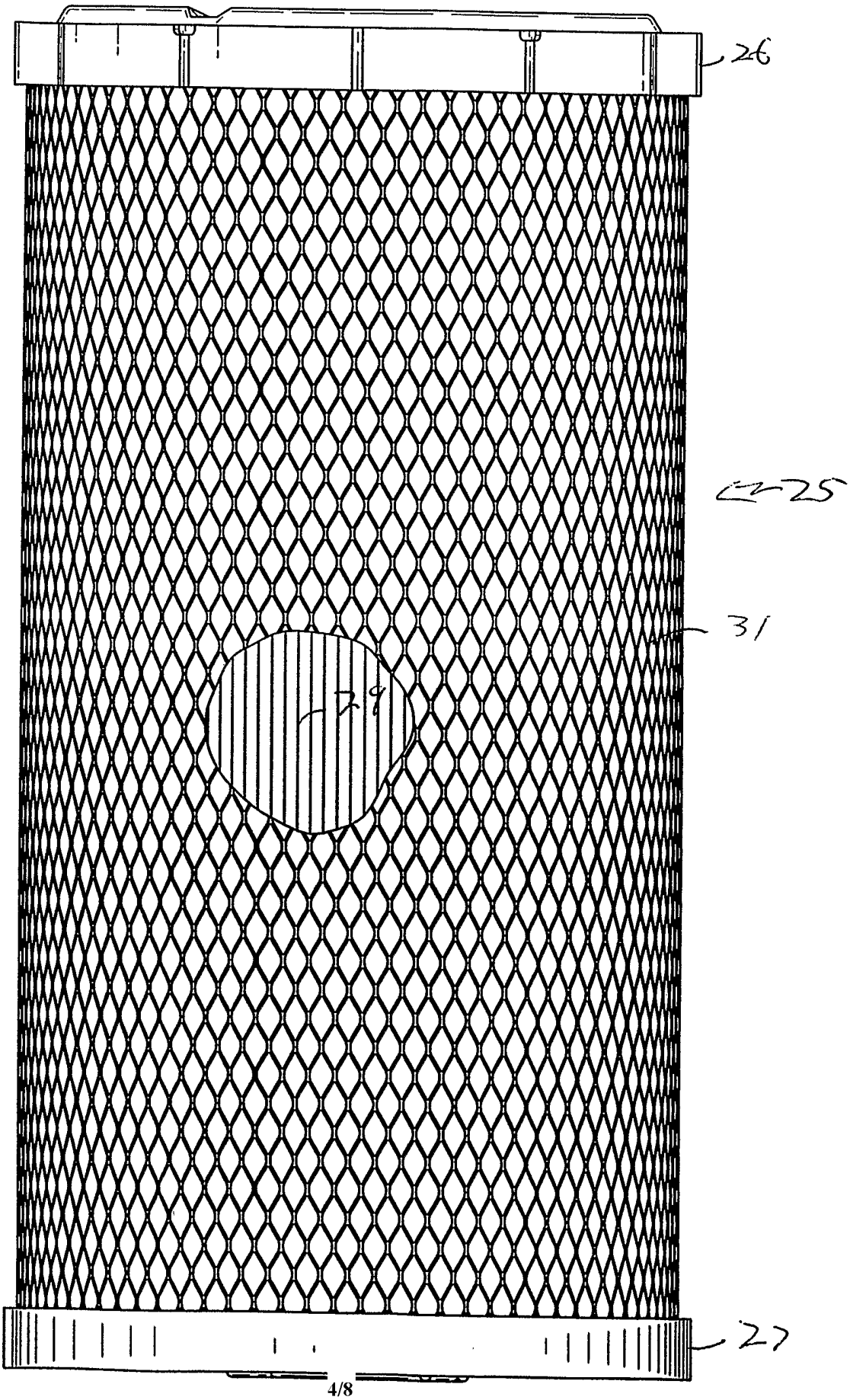


FIG. 4



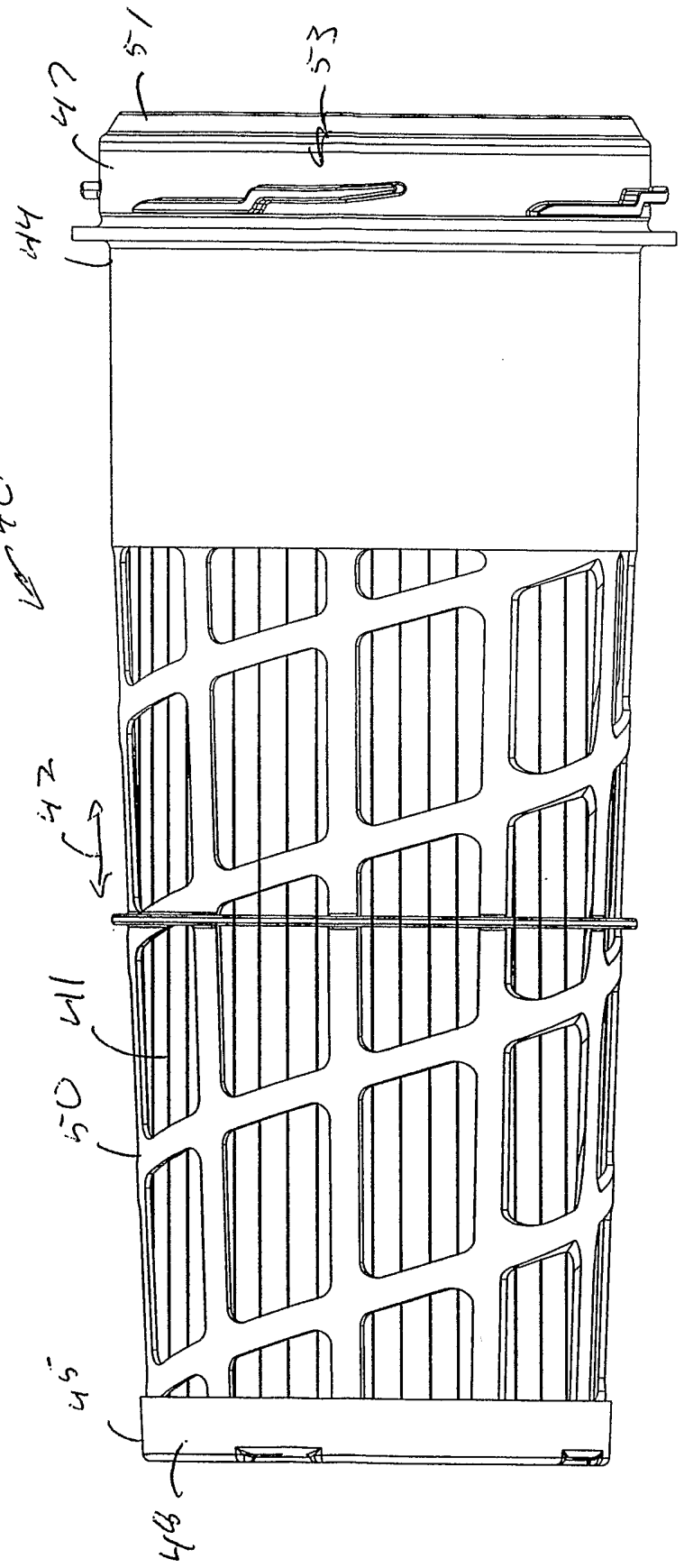


FIG. 5

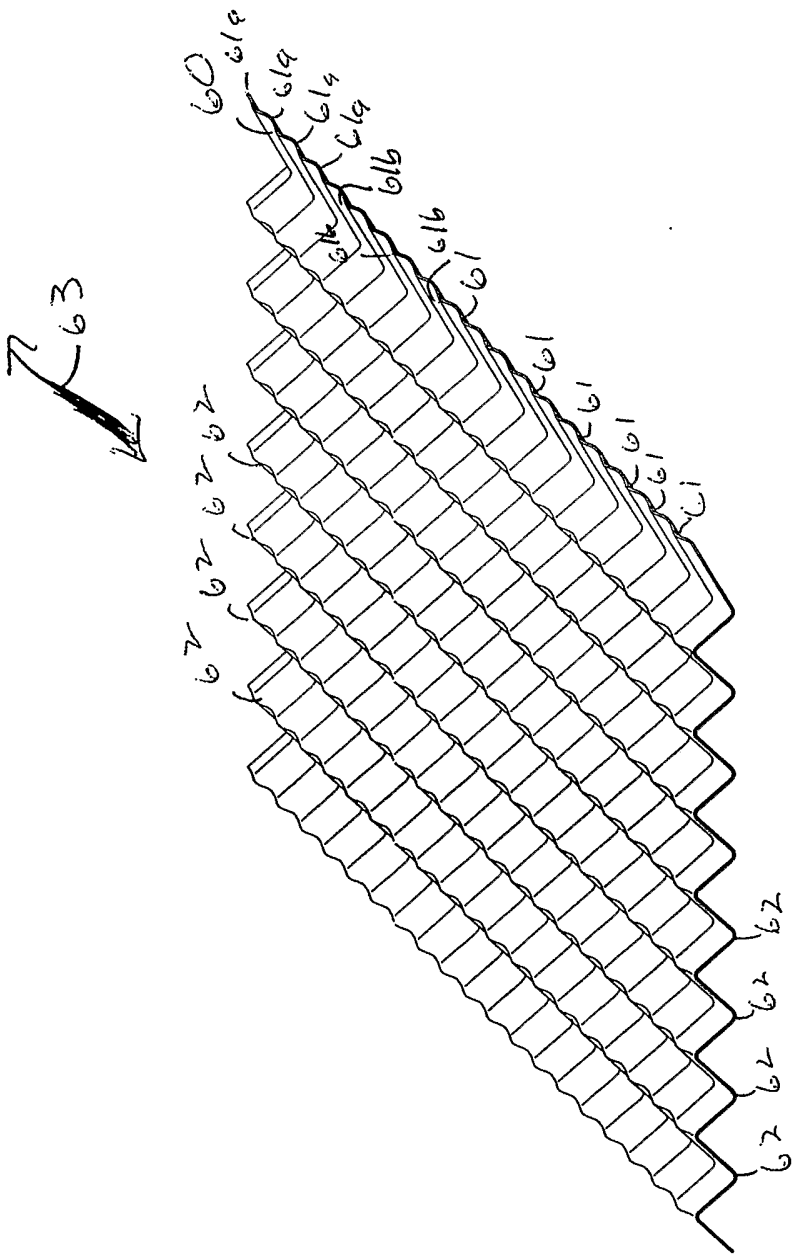
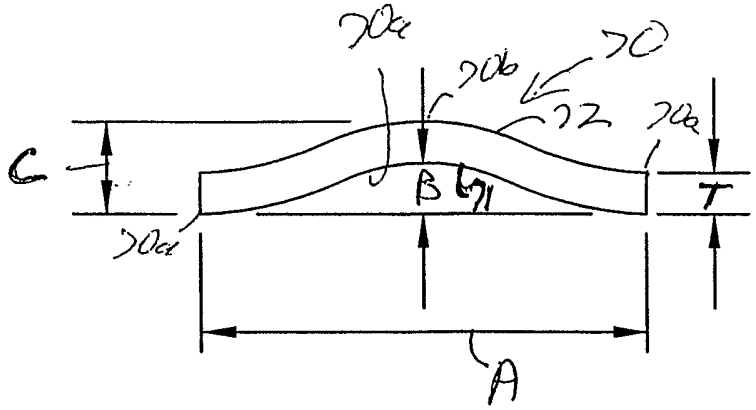


FIG. 6

FIG. 7



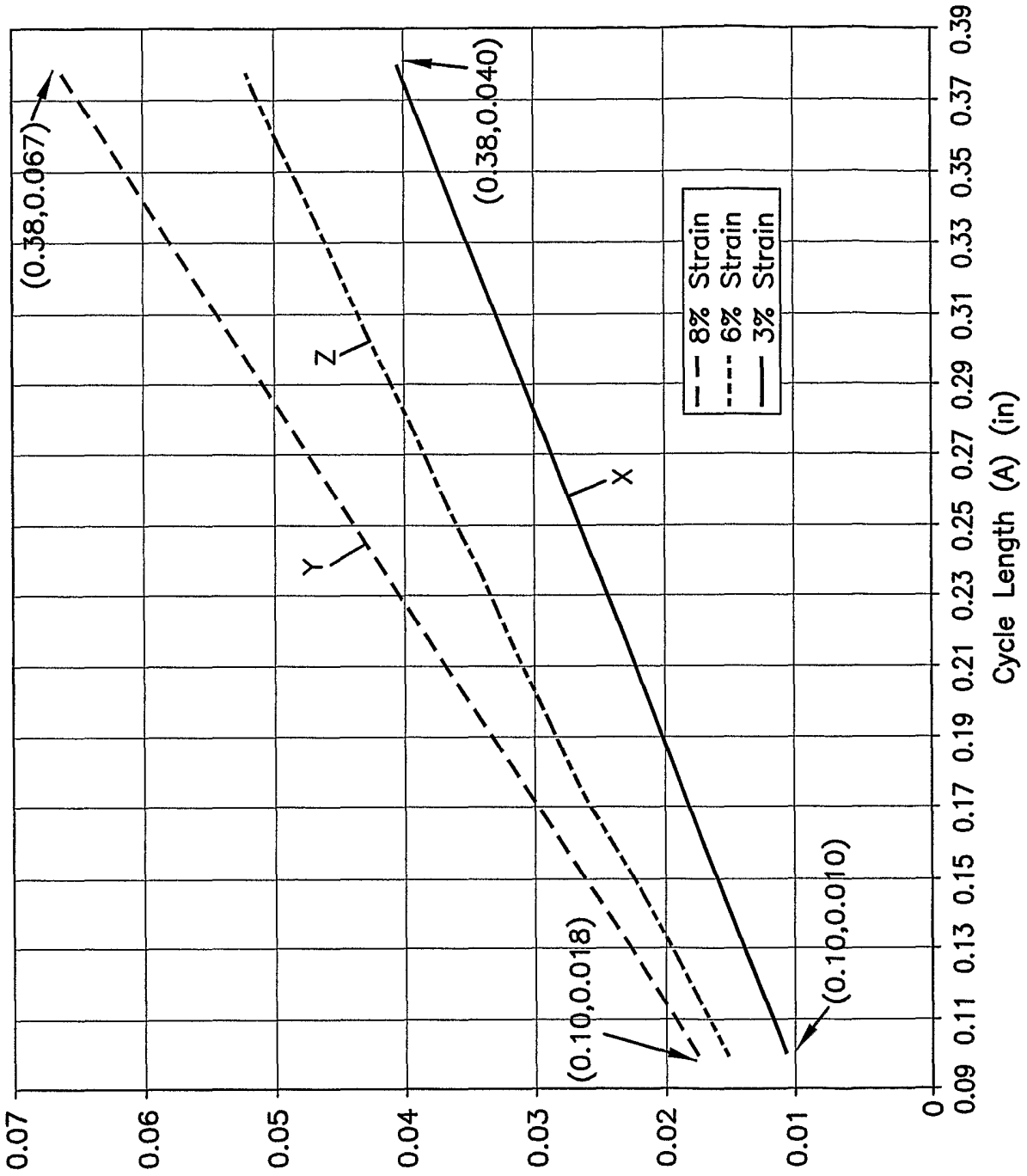

(0.38,0.067)
(0.38,0.040)
(0.10,0.018)
(0.10,0.010)
X
Y
Z
8% Strain
6% Strain
3% Strain
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0.09 0.11 0.13 0.15 0.17 0.19 0.21 0.23 0.25 0.27 0.29 0.31 0.33 0.35 0.37 0.39
Cycle Length (A) (in)
Corrugation Depth (B) (in)

FIG. 8

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/004073

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B01D29/01 B01D29/07 B01D29/21 B01D46/52

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)
IPC 7 B01D

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 practical, 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	US 5 024 870 A (JACKSON ET AL) 18 June 1991 (1991-06-18) abstract; figures 1-9 column 5, line 26 - column 6, line 27	1
A	EP 0 504 038 A (LABINAL; FILTRAUTO) 16 September 1992 (1992-09-16) abstract; figure 1	
A	US 3 802 169 A (MUGFORD C,US) 9 April 1974 (1974-04-09) abstract; figure 5 column 4, line 45 - line 49	
A	US 3 058 594 A (HULTGREN WILLIAM H) 16 October 1962 (1962-10-16) figures 4-6	

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

☒ Patent family members are listed in annex.

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"&" 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 April 2005	29/04/2005

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/US2005/004073

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