

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
27 December 2001 (27.12.2001)

PCT

(10) International Publication Number
WO 01/97946 A1

(51) International Patent Classification⁷: B01D 29/56, 46/12

(81) Designated States (*national*): AG, BA, BB, BG, BR, BZ, CA, CO, CR, CU, CZ, DM, EC, EE, GD, HR, HU, IS, LC, LV, MK, MX, NO, PL, RO, SK, TT, UA, YU.

(21) International Application Number: PCT/US01/40977

(84) Designated States (*regional*): European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

(22) International Filing Date: 14 June 2001 (14.06.2001)

(25) Filing Language: English

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for all designations
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations

(26) Publication Language: English

(30) Priority Data:
60/213,060 21 June 2000 (21.06.2000) US
60/249,949 20 November 2000 (20.11.2000) US
09/758,682 11 January 2001 (11.01.2001) US

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

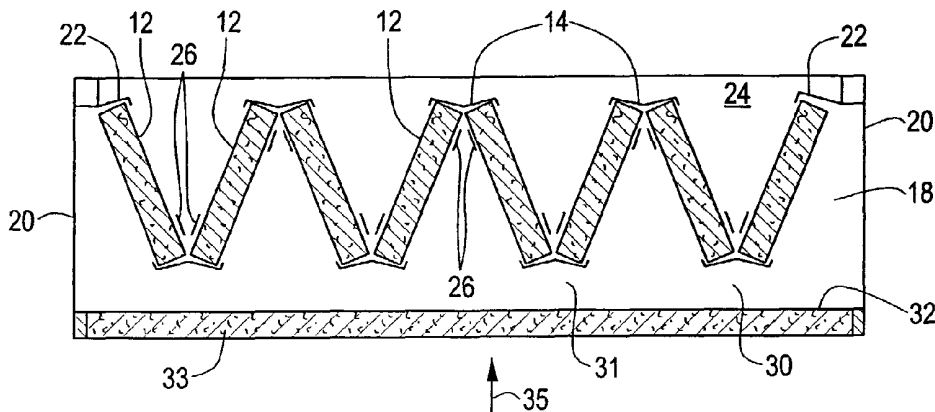
(71) Applicant: FREUDENBERG NONWOVENS LIMITED PARTNERSHIP [US/US]; 3440 Industrial Drive, Durham, NC 27704 (US).

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.

(72) Inventors: RIVERA, Samuel; 561 Lorie Lane, Clarksville, TN 37042 (US). LADD, Simon, D.; 232 Wildwood Drive, Hopkinsville, KY 42240 (US).

(74) Agents: HJORTH, Beverly, E. et al.; Weingarten, Schurgin, Gagnebin & Hayes, LLP, Ten Post Office Square, Boston, MA 02109 (US).

(54) Title: AIR FILTRATION SYSTEM WITH RECESSED FILTER AND EDGE BANDING



(57) Abstract: A filtration system comprising a main filter assembly having a frame (18, 20) and filter media (12) comprising pleated sections arranged in a row of V shapes within the frame (18, 20). The filter media (12) is spaced from an upstream face of the frame a distance sufficient to prevent blinding of the filter media (12) by an upstream filter media (33), thereby eliminating a filtration stage and reducing the volume of the filtration system. Filter media alignment members disposed within the frame (18, 20) assist in holding the filter media sections in alignment within the frame (18, 20). In another embodiment, flexible strips of edge banding, preferably of a filter material, are affixed to adjacent upper and lower longitudinal edges of the sections of the filter media (12). The edge banding minimizes pressure drop across the filter and is simpler and less costly to manufacture.

WO 01/97946 A1

Air Filtration System With
Recessed Filter and Edge Banding

5 CROSS REFERENCE TO RELATED APPLICATIONS

 This application claims the benefit under 35 U.S.C.
§ 119(e) of U.S. Provisional Application No. 60/213,060,
filed June 21, 2000, and U.S. Provisional Application No.
60/249,949, filed on November 20, 2000, the disclosures
10 of which are incorporated by reference herein.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR
DEVELOPMENT

N/A

15

BACKGROUND OF THE INVENTION

 Certain HVAC applications use air filtration systems
incorporating several stages of filtration. In a first
stage, a prefilter is used to trap particles in the range
20 of 5 microns and greater. In a second stage, a second or
main filter is used to trap smaller particles in the
range of 3 to 5 microns, and so on depending on the
application. The main filter assembly includes sections
of filter media that have been arranged in an accordion
25 fashion to form a row of aligned V shapes. Adjacent
sections are held in place by longitudinal bridging
strips that bridge adjacent end faces. The frame and
bridging strips are typically formed from a molded or
extruded plastic material. Other stages of filtration may
30 be provided downstream of the main filter assembly.

-2-

In these multi-stage filter systems, the prefilter cannot be butted directly against the main filter to prevent blinding off of the main filter, which would increase the resistance to air flow and decrease service life. The prefilter is thus typically provided as a separate assembly that is located upstream of the main filter assembly. The prefilter assembly accordingly takes up a whole stage of filtration.

10

SUMMARY OF THE INVENTION

The present invention provides a system for butting up filters together while keeping a sufficient separation, preferably 1 inch, between them necessary for optimum performance. The present invention accordingly eliminates a stage of filtration and reduces the volume taken by the additional stage of filtration.

15

In a further embodiment, the present invention also provides a filtration system incorporating edge banding on adjacent V-shaped sections of filter media in the main filter assembly. The edge banding comprises strips of a strong sheet media, for example, a nonwoven polyester material or extruded, calendered polymers or plastics. The strips are preferably adhesively bonded along the edges of adjacent V-shaped sections.

20

The edge banding eliminates the need for extruded plastic bridging strips, which increase the pressure drop across the filter. Accordingly, the present invention results in a lesser pressure drop across the filter and is simpler and less costly to manufacture.

25

30

-3-

DESCRIPTION OF THE DRAWING

The invention will be more fully understood from the following detailed description taken in conjunction with the accompanying drawings in which:

5 Fig. 1 is a cross-sectional view of a first embodiment of a filtration system of the present invention taken along line I-I of Fig. 3;

 Fig. 2 is a top plan view of the filtration system of Fig. 1;

10 Fig. 3 is an end view of the filtration system of Fig. 1;

 Fig. 4 is a bottom plan view of the filtration system of Fig. 1;

15 Fig. 5 is an exploded view of the filtration system of Fig. 1;

 Fig. 6 is a top plan view of a further embodiment of a filtration system of the present invention;

 Fig. 7 is an end view of the filtration system of Fig. 6;

20 Fig. 8 is a bottom plan view of the filtration system of Fig. 6;

 Fig. 9 is a top plan view of a prefilter for use with the filtration system of the present invention;

25 Fig. 10 is a side view of a clip for use with the prefilter of Fig. 9;

 Fig. 11 is an exploded view of the filtration system of Fig. 6;

 Fig. 12 is a top plan view of a prefilter extension frame according to the present invention;

30 Fig. 13 is a top plan view of a segment of the prefilter extension frame of Fig. 12;

-4-

Figs. 13A and 13B are partial enlarged views of ends of the segment of Fig. 13; and

Fig. 14 is a side view of the segment of Fig. 13.

Fig. 15 is an isometric exploded view of a further embodiment utilizing a filter media section and strip of edge banding according to the present invention;

Fig. 16 is an isometric view of a row of filter media sections and strips of edge banding according to the present invention;

Fig. 17 is a top plan view of a filtration system with edge banding according to the present invention;

Fig. 18 is an end view of the filtration system with edge banding of Fig. 17;

Fig. 19 is a bottom plan view of the filtration system with edge banding of Fig. 3; and

Fig. 20 is a side view of the filtration system with edge banding of Fig. 17.

DETAILED DESCRIPTION OF THE INVENTION

A filtration system of the present invention is illustrated in Figs. 1-9. The filtration system has a frame 10, preferably formed of a plastic material, in which sections 12 of filter media are placed. The filter media may be, for example, a non-woven polyester material. Each section of filter media comprises a sheet that has been pleated or folded in an accordion fashion and mounted in the frame adjacent to other sections at an angle to form a row of aligned V-shapes. Adjacent sections 12 are held in place by stiff longitudinal bridging strips 14 that bridge adjacent end faces 16 of the section. The bridging strips 14 may be bent along

-5-

their longitudinal length to accommodate the angled disposition of the end faces of adjacent sections. The bridging strips are relatively stiff structural members and they hold adjacent filter media sections spaced slightly apart (see Fig. 1).

In a first embodiment, illustrated in Figs. 1-5, the frame 10 includes two opposed end walls 18 and two opposed side walls 20 that are joined to form a rectangular, generally square, configuration. Two side bridging members 22 attach the outermost filter media sections to the side walls. The side bridging members 22 may be integrally formed with the side walls 20 or may be formed separately from the side walls and subsequently fastened to the side walls in any suitable manner.

The inside faces 24 of the end walls 18 include inwardly facing linear protrusions 26 angled to have the same orientation as the V-shapes of the aligned filter media sections 12. The filter media sections 12 are aligned and retained in place against these protrusions when the entire filter system is assembled. The inside faces also include inwardly facing lips 28 that receive the bridging strips. The end walls, side walls, and filter media sections are fixed together in any suitable manner. For example, the filter media sections may be glued to the side walls. The end panels are then filled with an adhesive, such as a polyurethane, and set onto the filter media sections. Any other suitable manner of assembling the filtration system, for example, with ultrasonic welding, may be used, as would be known in the art.

-6-

The side walls and end walls of the frame include extending wall portions 30 sized to form a recess 31. A prefilter assembly 33 (see Figs. 1 and 9) fits adjacent the recess. For example, the end or side walls may include inwardly facing lips 32. The prefilter assembly fits against the lips and is attached to the frame by clips, such as the clip 37 illustrated in Fig. 10. A variety of suitable clips are commercially available. In this configuration, the prefilter is retained upstream of the filter media in a spaced relation to the filter media, such that the filter media is not blinded by the prefilter. A recess depth, or spacing between the prefilter assembly and the filter media, of 1 inch is suitable. The direction of air flow is indicated by the arrow 35 in Fig. 1.

In a second embodiment, illustrated in Figs. 6-9, the frame 10' includes two opposed end walls 18' and two opposed side walls 20' that join the ends of the end walls to form a rectangular, generally square, configuration. Thus, the side walls 20' do not extend to the same depth as the end walls 18' as in the first embodiment. The end walls 18' of the second embodiment include protrusions 26' for aligning the filter media sections 12 and lips 28' for receiving the bridging sections 14, as discussed above in connection with the first embodiment.

The end walls 18' and side walls 20' of the frame 10' include extending wall portions 30' sized to form a recess 31', similar to the first embodiment. A recess depth of 1 inch is suitable. The extending wall portions 30' of the side walls 20' may be sloped, as best

-7-

indicated in Fig. 9, to aid in directing the air flow through the filtration system. The prefilter assembly rests on top of surfaces 32'. The end walls 18' and side walls 20' may include outwardly facing recesses 36 or
5 surfaces 38 for receiving clips or another suitable fastening device to attach the prefilter assembly.

In this manner, the prefilter does not constitute a separate filtration stage incorporating a large assembly maintained at the proper spacing from the main filter
10 assembly. The volume of the filtration system is concomitantly reduced.

In a further embodiment, a prior art main filter assembly may be retrofitted with a gasket 40, illustrated in Figs. 12-14. The gasket, formed for example of closed
15 cell neoprene, may comprise four linear segments 42 interlocked or otherwise attached at the corners in a square or rectangular configuration. One face 44 of the gasket is then attached, for example, with adhesive, or in any other suitable manner, to the upstream face of an
20 existing frame. The gasket has a suitable thickness, such as 1 inch, to space the prefilter assembly from the filter media in the existing frame. The prefilter assembly may be clipped to the gasket in any suitable manner, as discussed above.

25 A further embodiment of the filtration system of the present invention is illustrated in Figs. 15-20. As discussed above, the filtration system includes a main filter assembly having sections 112 of filter media that are arranged in accordion fashion to form a row of
30 aligned V shapes. The sections are mounted within a frame 114 that includes two opposed end walls 116 and two

-8-

opposed side walls 120 that are joined to form a square or rectangular configuration. The inside faces 122 of the end walls 116 typically include inwardly facing protrusions 124, which aid in the alignment and retention of the filter media sections 112 when the entire filter system is assembled.

Adjacent sections 112 of filter media are held in place by longitudinal strips of edge banding 128 that bridge adjacent end faces 130 of the sections 112. The edge banding is a flexible, thin, sheet material or media, for example, about 0.5 mm thick, although the exact thickness can vary. Preferably, the strips of edge banding are bonded using, for example, a polyurethane adhesive to the end faces. Any other suitable manner of affixing the edge banding to the end faces may be employed, as would be recognized by those of skill in the art. The edge banding allows the filter media sections to abut each other at adjacent corners. In contrast, the structural bridging strips hold adjacent sections spaced slightly apart. Also, the edge banding allows the sections to be held at a closer angle. Thus, the edge banding allows a denser spacing of the filter media sections within the frame, resulting in an increase in surface area.

The edge banding may be formed from a variety of sheet media. For example, a filter media material may be used, such as a nonwoven polyester, which may also comprise the material of the filter sections. The edge banding preferably, however, is stronger than the filter sections. For example, the edge banding may have a density of 450 g/cc. Typical filter sections have a

-9-

density of 115 g/cc. Alternatively, the edge banding may be formed of a flexible sheet material such as an extruded polyester sheet or a plastic material such as ABS. The sheet media may be breathable, which further
5 minimizes resistance to air flow therethrough. In this manner, the strips of edge banding are able to assist in stabilizing and retaining the sections within the frame while minimizing the pressure drop across the filter.

In typical filtration systems, three strips of edge
10 banding are provided on a first or top side and four strips of edge banding are provided on the opposite or bottom side. It will be appreciated, however, that any suitable number of strips of edge banding may be provided, depending on the configuration of the
15 particular filtration system. It will also be appreciated that the configuration of the filtration system may be different from the particular filtration system illustrated in the embodiment described herein.

It will be appreciated that the filtration system
20 with recess of Figs. 1-9 may incorporate the edge-banded filtration system of Figs. 15-20. The invention is not to be limited by what has been particularly shown and described, except as indicated by the appended claims.

-10-

CLAIMS

What is claimed is:

1. A filtration system comprising:

5 a frame having two opposed end walls and two opposed side walls arranged in a rectangular configuration, the end walls and side walls including edges that define an upstream face;

10 filter media comprising sections arranged in a row of V shapes, each section extending longitudinally between the opposed end walls and in alignment with the opposed side walls, the filter media fixedly retained within the frame and spaced from the upstream face a distance sufficient to prevent blinding of the filter
15 media by an upstream filter assembly.

2. The filtration system of claim 1, further comprising filter media alignment members disposed on the opposed end walls to hold the filter media sections in alignment
20 between the opposed end walls, the alignment members located to space the filter media from the upstream face.

3. The filtration system of claim 2, wherein the filter media alignment members comprise inwardly facing
25 protrusions formed on the opposed end walls.

4. The filtration system of claim 3, wherein the protrusions are oriented in alignment with the V shapes of the sections of the filter media.

30

-11-

5. The filtration system of claim 1, wherein the filter media is spaced from the upstream face by approximately one inch.
- 5 6. The filtration system of claim 1, wherein the side walls of the frame further include side bridging members disposed to retain outermost sections of the filter media within the frame.
- 10 7. The filtration system of claim 1, further comprising bridging members disposed over adjacent longitudinal edges of the sections of the filter media.
- 15 8. The filtration system of claim 1, further comprising flexible strips of edge banding affixed to adjacent longitudinal edges of the V-shaped sections of the filter media.
- 20 9. The filtration system of claim 1, wherein the end walls and the side walls extend above the filter media to form a recess.
- 25 10. The filtration system of claim 1, further comprising a prefilter attached to the upstream face of the frame.
- 30 11. The filtration system of claim 10, wherein the prefilter is attached to the frame by a clip mechanism.
12. The filtration system of claim 1, further comprising a gasket affixed to the upstream face of the frame.

-12-

13. A filtration system comprising:

5 a frame having two opposed end walls and two opposed side walls arranged in a rectangular configuration, the end walls and side walls including edges that define an upstream face;

filter media comprising sections arranged in a row of V shapes, each section extending longitudinally between the opposed end walls and in alignment with the opposed side walls; and

10 flexible strips of edge banding affixed to adjacent upper and lower longitudinal edges of the sections of the filter media.

14. The filtration system of claim 13, wherein the edge banding comprises a filter media material.

15 15. The filtration system of claim 13, wherein the edge banding has a greater density than the filter media comprising the V-shaped sections.

20 16. The filtration system of claim 13, wherein the edge banding comprises a non-woven polyester.

25 17. The filtration system of claim 13, wherein the edge banding comprises a flexible plastic material.

18. The filtration system of claim 12, wherein the edge banding comprises an extruded polyester sheet.

30 19. The filtration system of claim 13, wherein the edge banding is adhesively bonded to the sections.

-13-

20. The filtration system of claim 13, wherein the filter media is spaced from the upstream face a distance sufficient to prevent blinding of the filter media by an upstream filter media.

21. A filtration system comprising:
a frame having two opposed end walls and two opposed side walls arranged in a rectangular configuration, the end walls and side walls including edges that define an upstream face;

filter media comprising sections arranged in a row in V shapes, each section extending longitudinally between the opposed end walls and in alignment with the opposed side walls, the filter media fixedly retained within the frame; and

a gasket fixedly attached to the upstream face of the frame to define a recess separating the filter media and an upstream filter media.

22. The filtration system of claim 21, wherein the gasket comprises a rectangular frame formed of four linear segments interlocked at corners.

23. The filtration system of claim 21, wherein the gasket comprises rubber.

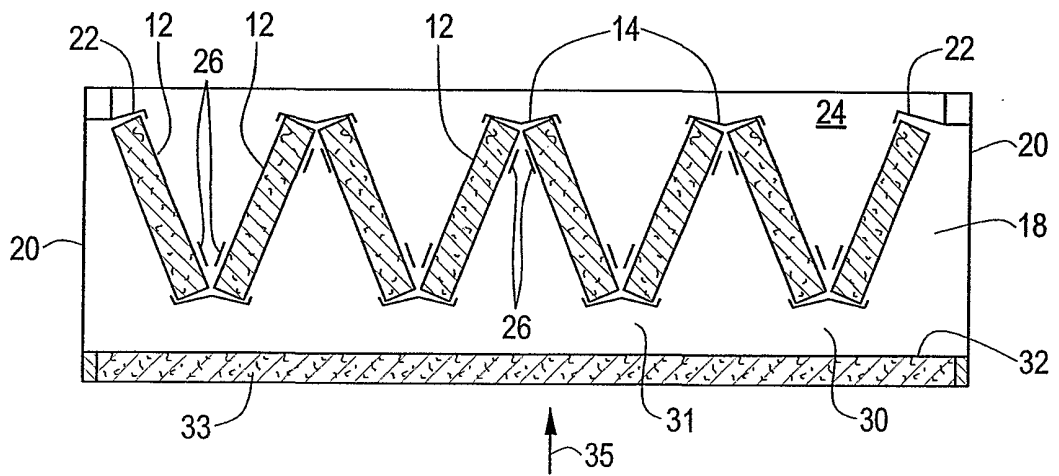


FIG. 1

2/9

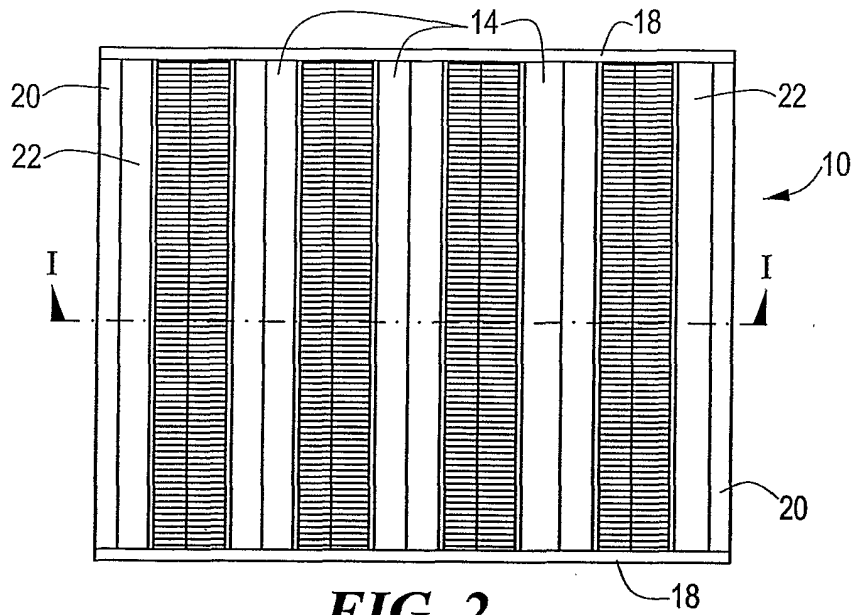


FIG. 2

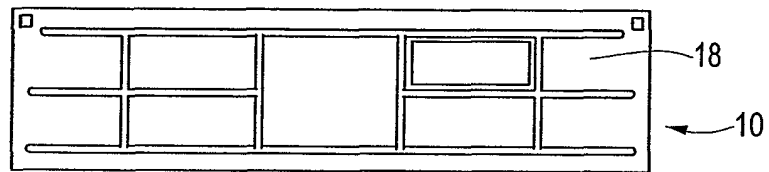


FIG. 3

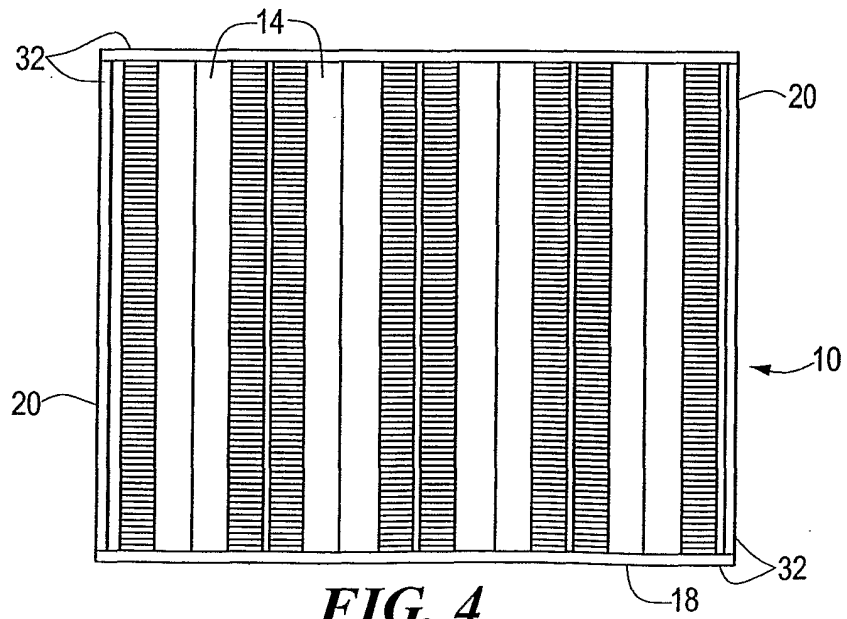


FIG. 4

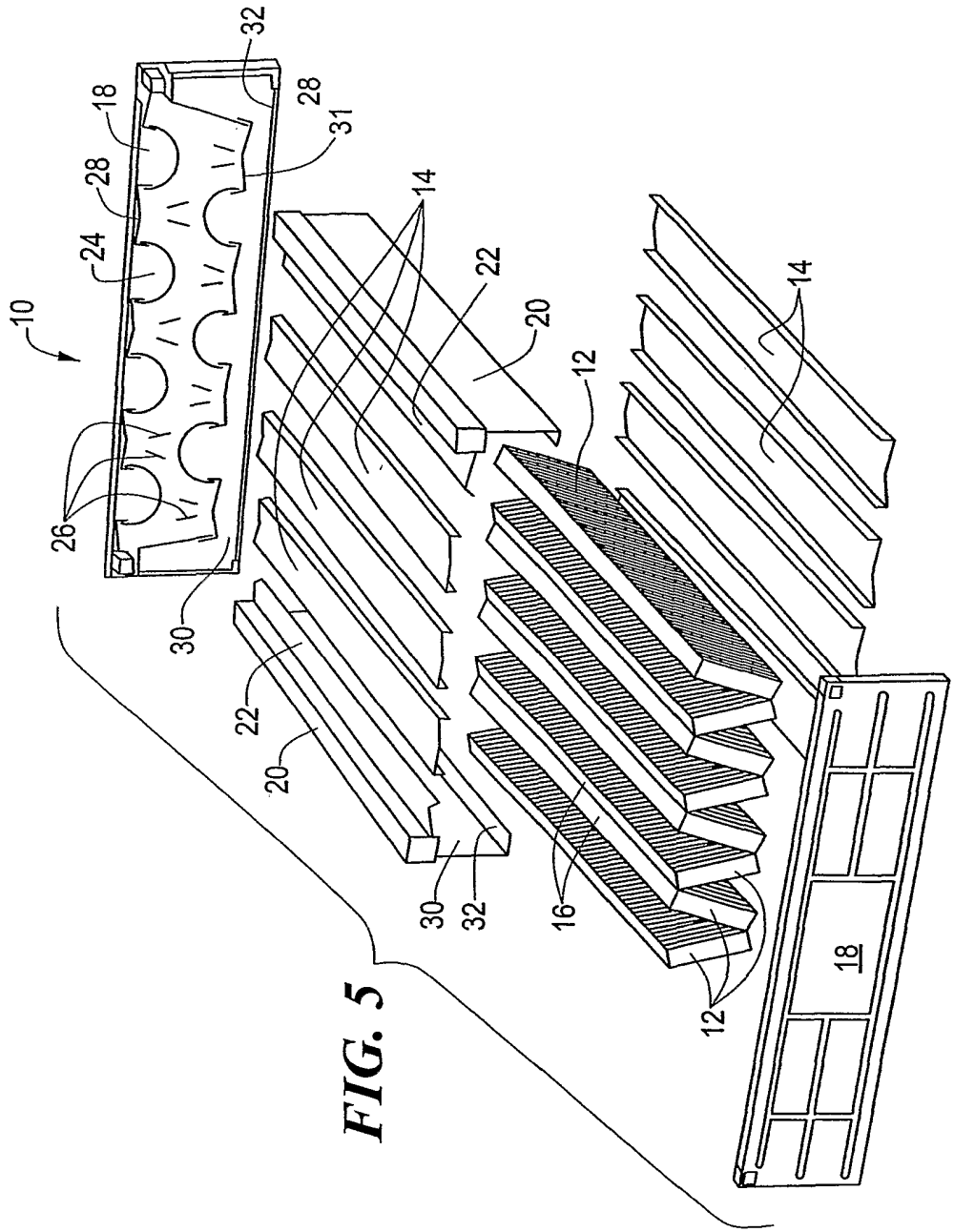


FIG. 5

4/9

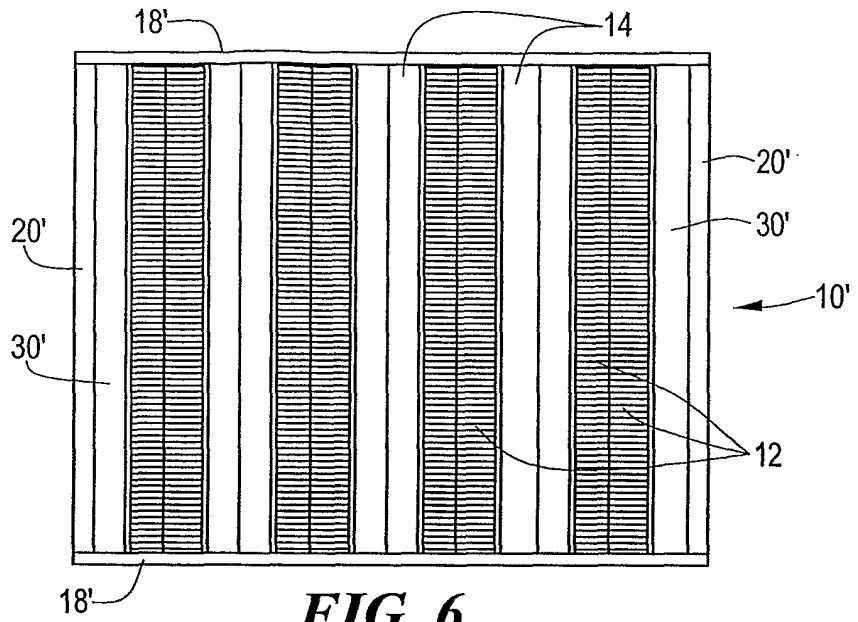


FIG. 6

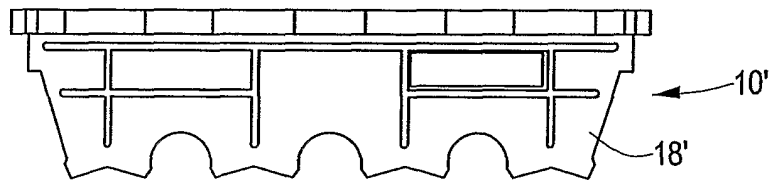


FIG. 7

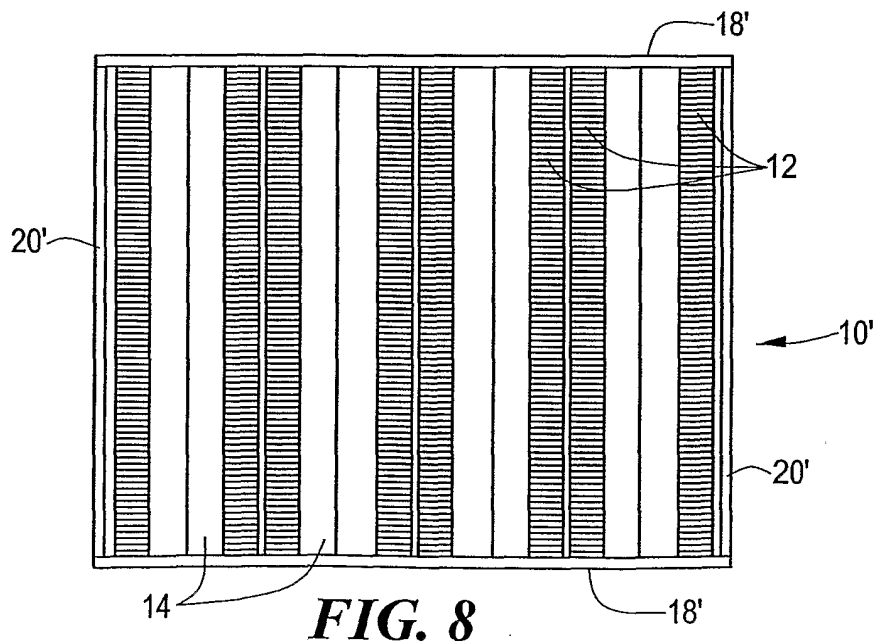


FIG. 8

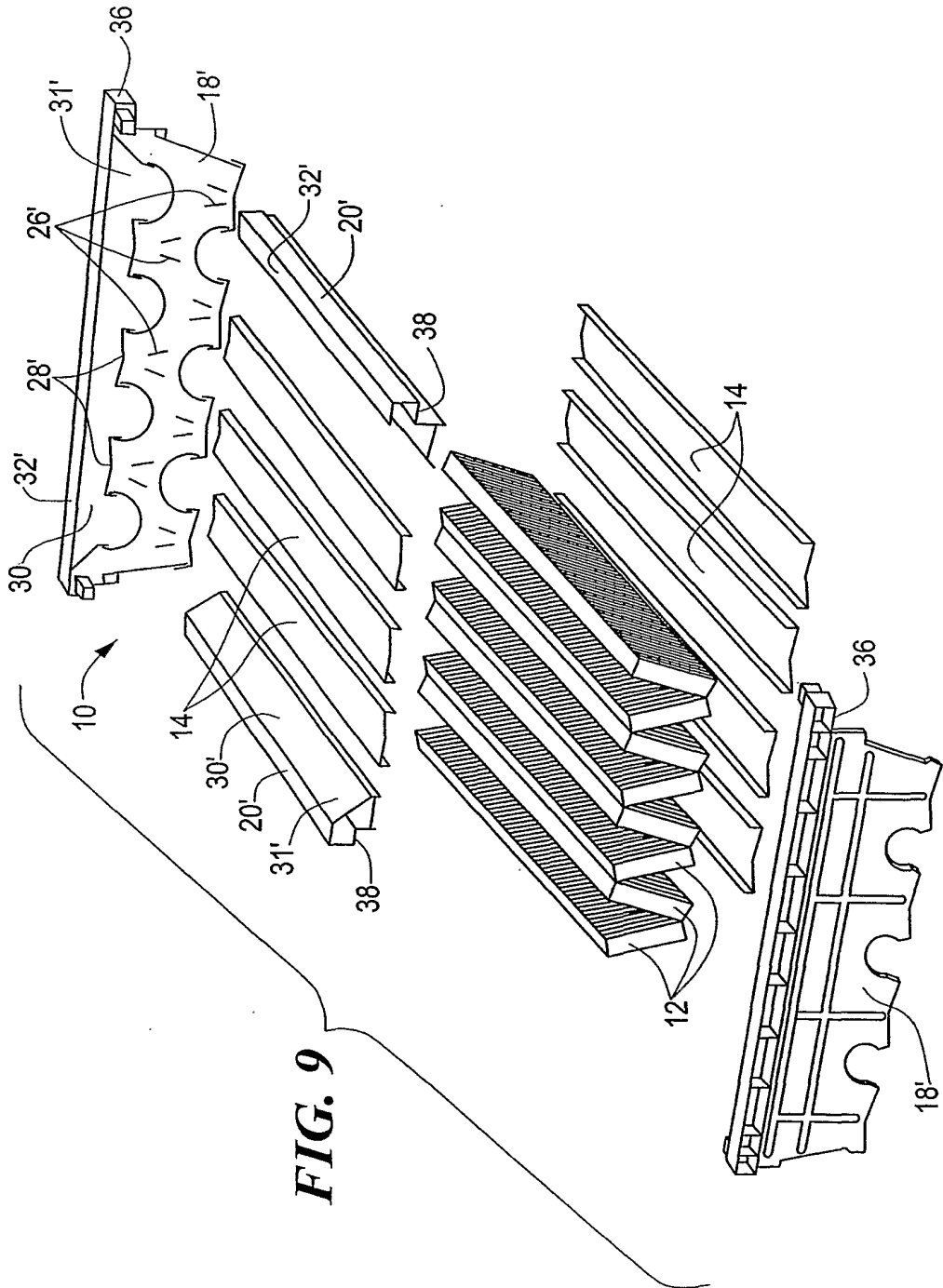


FIG. 9

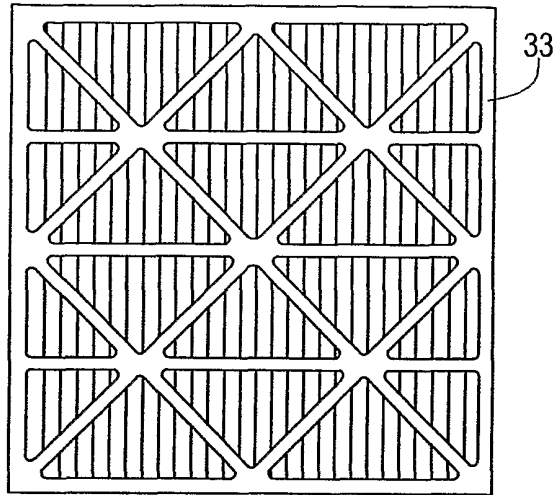


FIG. 10

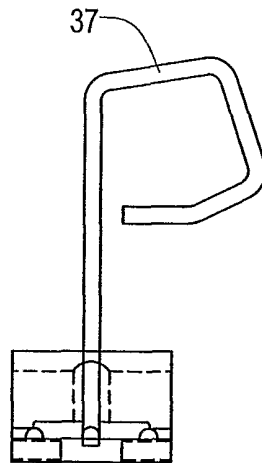


FIG. 11

7/9

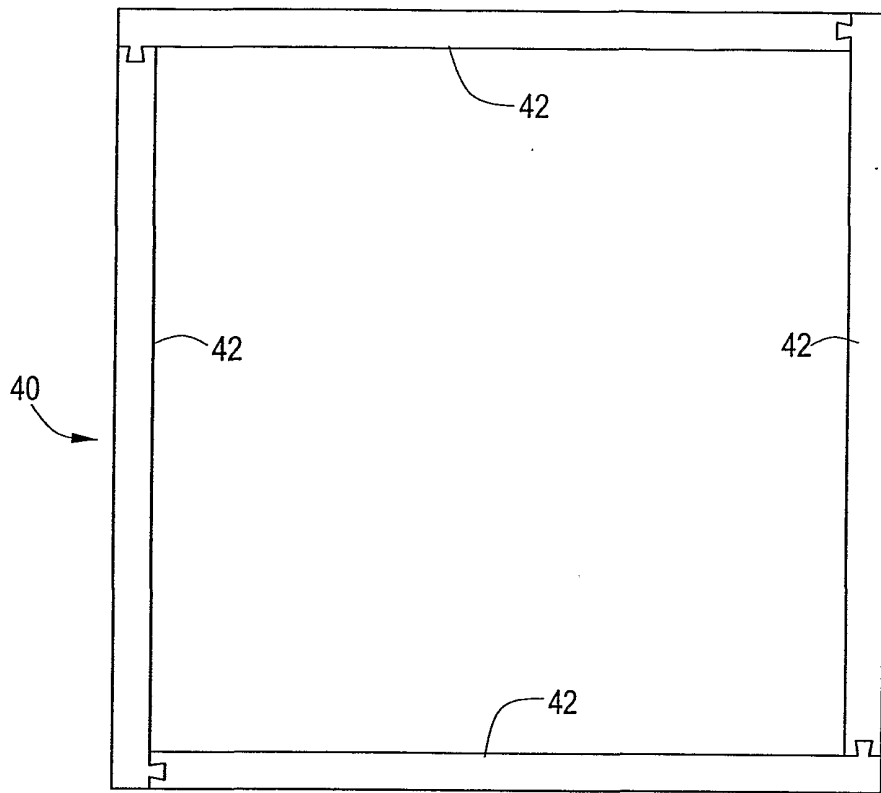


FIG. 12

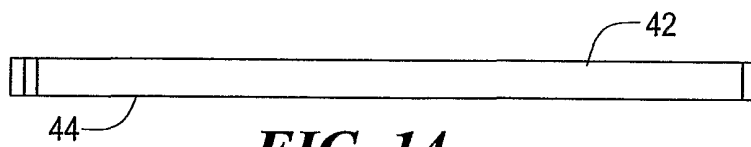


FIG. 14

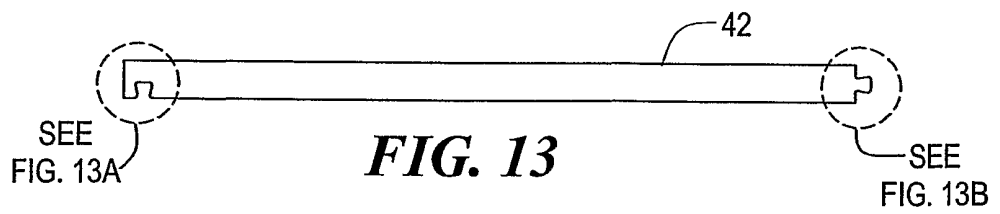


FIG. 13

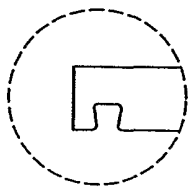


FIG. 13A

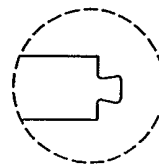


FIG. 13B

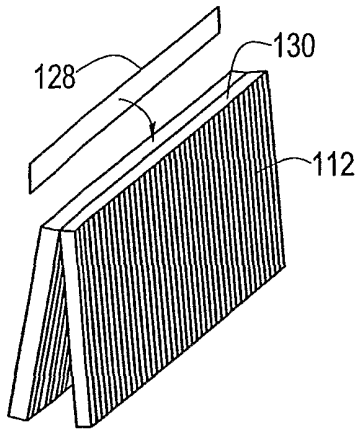


FIG. 15

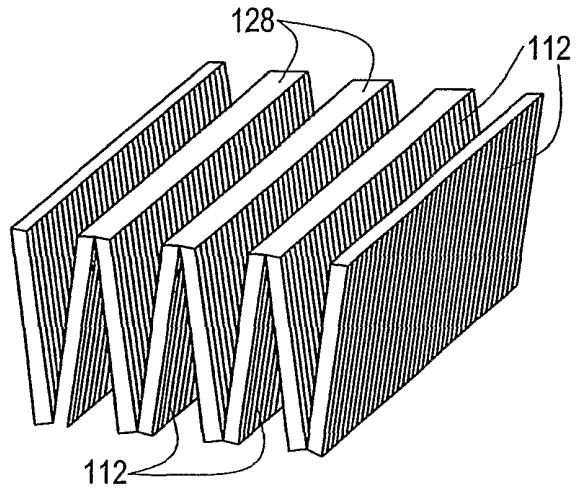


FIG. 16

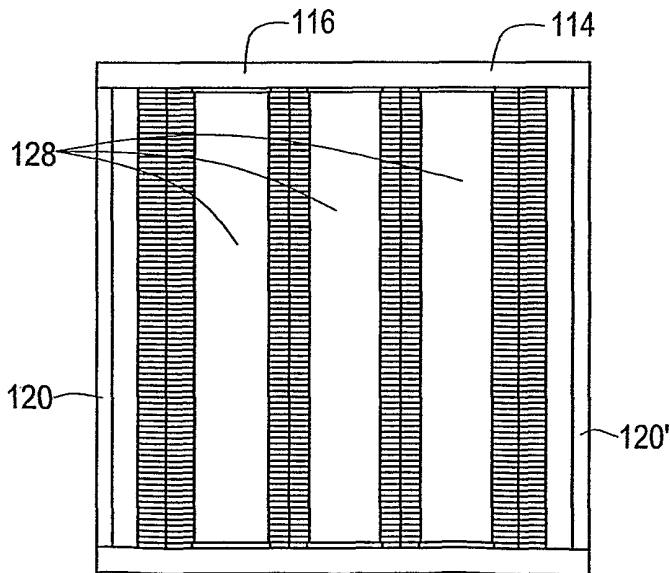


FIG. 17

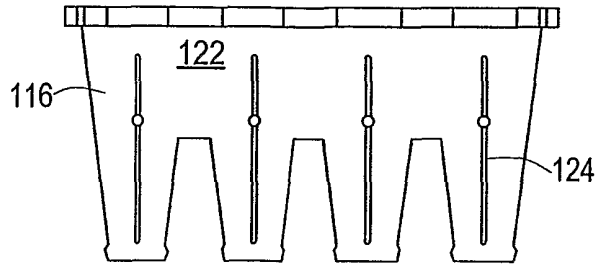


FIG. 18

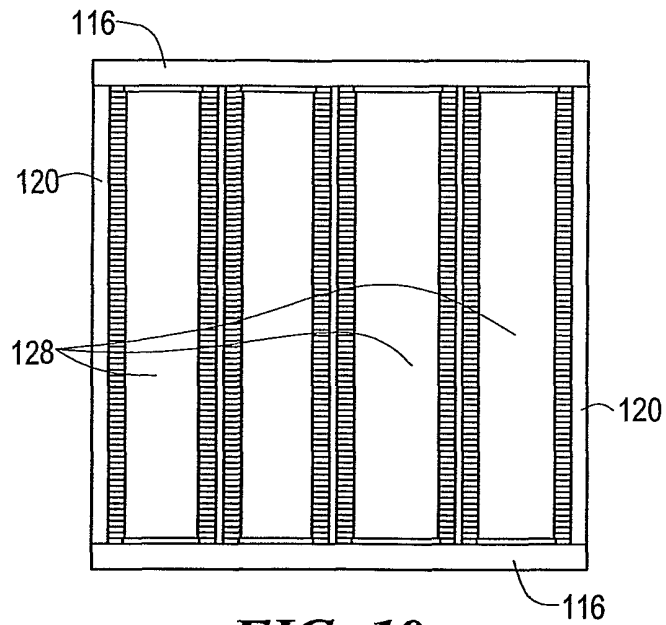


FIG. 19

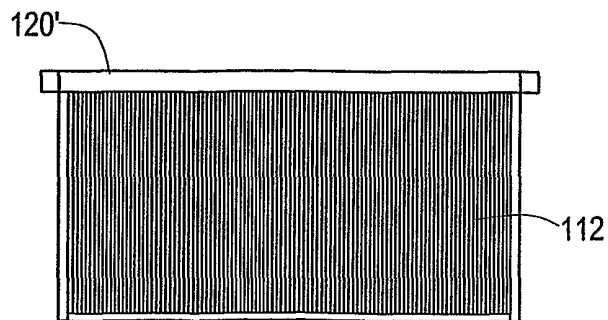


FIG. 20

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/40977

A. CLASSIFICATION OF SUBJECT MATTER		
IPC(7) : B01D 29/56, 46/12		
US CL : 55/482, 486, 495, 497, 499, 500, 502, 521, DIG. 31		
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) U.S. : 55/482, 485, 486, 487, 488, 489, 490, 495, 497, 499, 500, 501, 502, 509, 511, 521, 529, DIG. 31		
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)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P ---	US 6,224,655 B1 (MESSIER) 01 May 2001 (01.05.2001), Figures 3 and 4 and column 6, lines 16-33.	1, 5, 9, 10 -----
Y,P		2-4, 6-8, 11-20
X,P ---	US 6,156,089 A (STEMMER et al.) 05 December 2000 (05.12.2000), Figures 3, 5, and 6 and column 3, lines 26-48.	1, 5, 9, 10 -----
Y,P		2-4, 6-8, 11-20
X ---	US 5,853,445 A (WONG et al.) 29 December 1998 (29.12.1998), Figures 1-5 and column 2, line 30 to column 3, line 53.	1, 5, 9-12, 21-23 -----
Y		2-4, 6-8, 13-20
Y	US 3,494,113 A (KINNEY) 10 February 1970 (10.02.1970), Figure 3 and column 4, lines 17-75.	2-4
Y	US 3,354,622 A (MURPHY, JR.) 28 November 1967 (28.11.1967), Figures 2-4 and column 2, line 23 to column 3, line 29.	6-7
Y	US 3,631,582 A (LUCAS et al.) 04 January 1972 (04.01.1972), Figures 1-3 and column 2, lines 62-75.	7
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> 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	"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
"E"	earlier application or patent published on or after the international filing date	"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
"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)	"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
"O"	document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed	
Date of the actual completion of the international search		Date of mailing of the international search report
30 August 2001 (30.08.2001)		06 NOV 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230		Authorized officer B. Hander Jason M. Greene Telephone No. 703-308-0661

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/40977

C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 6-269624 B (NITTA IND CORP) 27 September 1994 (27.09.1994), Figures 1-5 and column 4, lines 1-7.	8, 13-19
Y	US 5,397,632 A (MURPHY, JR. et al.) 14 March 1995 (14.03.1995), Figure 1 and column 4, line 44 to column 5, line 7.	14-19
Y	US 5,824,394 A (KINOSHITA et al.) 20 October 1998 (20.10.1998), column 3, lines 3-7	18