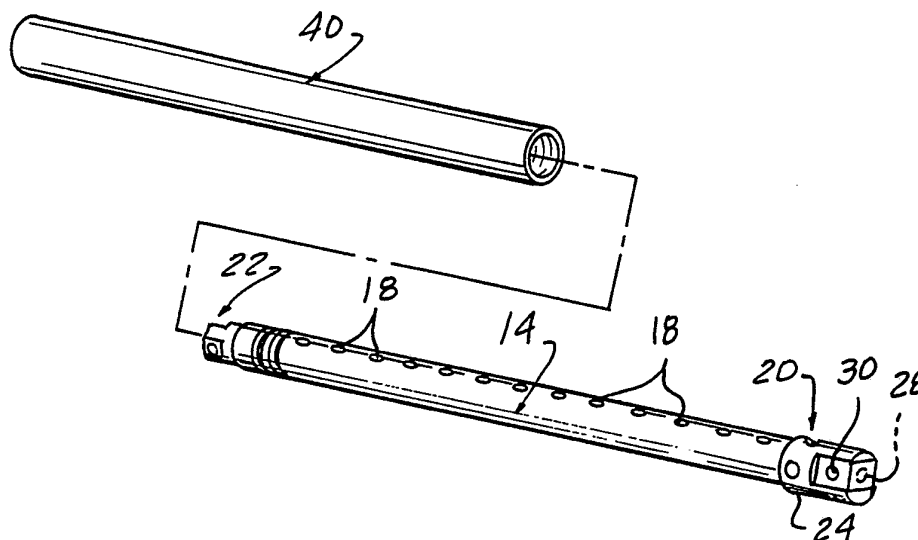




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(21) International Application Number: PCT/US91/03135 (22) International Filing Date: 6 May 1991 (06.05.91) (30) Priority data: 521,990 11 May 1990 (11.05.90) US (71)(72) Applicant and Inventor: LIEDTKE, Rudolph, J. [US/ US]; 1004 Yorkshire, Grosse Pointe Park, MI 48230 (US). (74) Agents: HANLON, William, M., Jr. et al.; Basile and Han- lon, 1650 West Big Beaver Road, Suite 210, Troy, MI 48084 (US).		(81) Designated States: AT (European patent), AU, BE (Euro- pean patent), CA, CH (European patent), DE (Euro- pean patent), DK (European patent), ES (European pa- tent), FR (European patent), GB (European patent), GR (European patent), HU, IT (European patent), JP, LU (European patent), NL (European patent), SE (Euro- pean patent). Published <i>With international search report.</i> <i>With amended claims.</i>

(54) Title: AIR BEARING FOR WEB MATERIAL**(57) Abstract**

An air bearing (10) supports and guides a moving web (12) with a linearly constant distribution of air between the bearing and the moving web (12). An exterior tubular member (40) is fixedly mounted over a first tubular member (14) having a central bore (16) connected to a pressurized air source. Air flow apertures (18) are formed in the first tubular member (14) in fluid flow communication with the central bore (16) in the first tubular member (14). The exterior tubular member (40) is formed of a porous, air permeable material to evenly distribute air flow from the air flow apertures (18) in the first tubular member (14) evenly about the periphery of the exterior tubular member (40) to form a linearly constant, even distribution of air across the length of the exterior tubular member (40) to evenly support a moving web (12).

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AIR BEARING FOR WEB MATERIAL

BACKGROUND OF THE INVENTION1. Field of the Invention:

5 The present invention relates, in general, to fluid bearings and, more specifically, to air bearings for supporting moving webs or substrates.

2. State of the Art:

 Moving webs or substrates, such as paper, cellophane
10 and foil that have printing formed thereon as the result of a printing operation, such as a web offset lithography, are guided and supported in a continuous path which may contain turns ranging between 0° and 180°. The direction of movement
15 of the web is changed to align the continuously moving web with devices that fold, cut or perforate the final product. In addition, a 180° re-orientation of the moving web to reverse the sides of the web (the bottom side becomes
20 uppermost) and allow both sides of the web to be printed without a "perfecting" printing press which prints both sides simultaneously is sometimes desirable.

 It is necessary to support the web a short distance above any bearing to prevent smearing of the fresh ink disposed on the web. A typical fluid or air bearing employed in web offset lithography is in the form of a hollow, chromed
25 metallic cylinder having apertures arranged in one or more spaced rows in the peripheral side walls thereof. A hollow bore is formed in the cylinder and is connected to an air source such that air flows through the bore and the apertures in the side walls of the cylinder outward from the cylinder
30 to create a thin cushion of air surrounding the cylinder. The cushion of air extends a short distance above the periphery of the cylinder to frictionlessly support and guide the web about the roller without contact between the web and the bearing.

35 One or more spaced rows of apertures are formed in the cylinder depending upon how much surface area of the web

or substrate passes over the cylinder. Typically, the apertures in the cylinder result in uneven air distribution across the length of the cylinder which causes high and low points across the width of the web. Each high point is located above an aperture in the cylinder and low points are formed between two spaced apertures in the cylinder. The web occasionally contacts the cylinder at the low points which smears the fresh ink deposited on the web by the printing process.

Various attempts have been made to overcome these problems with previously devised air bearings for use in web processes. Such attempts utilize rollers or bearings formed of porous, air permeable materials as disclosed in U.S. Patent Nos. 3,245,334 and 3,744,693. In U.S. Patent No. 3,245,334, a cylindrical member formed of a porous, air permeable material is stationarily mounted in a chamber through which a web passes. Air injected through a bore in the cylinder flows through the cylindrical member and forms a cushion of air a short distance above the periphery of the cylinder to support the web above the cylinder as the web moves past the cylinder. In one embodiment of U.S. Patent No. 3,744,693, a stationarily mounted, hemispherically shaped turning bar is provided with a plurality of spaced apertures which form air flow paths for air supplied to the interior of the turning bar. A flexible sheet of a porous material is stretched and clamped under tension over the periphery of the turning bar to disperse air flowing through the apertures in the turning bar evenly about the periphery of the turning bar.

However, in both of the above-described devices, the air flow cylinder or turning bar is stationarily mounted. This provides an even distribution of air only over a portion or one side of the cylindrical member and does not provide a full 360° cushion. This restricts such air bearings to applications where the web is redirected less than 180° from its original path.

Thus, it would be desirable to provide an air bearing which overcomes the above-identified problems encountered with previously devised air bearings. It would also be desirable to provide an air bearing which is simple

in construction. It would also be desirable to provide an air bearing which is usable with conventional, apertured air cylinders in new and retrofit applications. Finally, it would be desirable to provide an air bearing which provides a full
5 360° air cushion about the periphery of the bearing to enable the air bearing to redirect moving webs more than 90° from their original path.

SUMMARY OF THE INVENTION

The present invention is an air bearing for use in
10 moving web processes which provides a linear constant distribution of air across the length of the bearing to prevent contact between the moving web and the bearing, yet support the web as it passes over the bearing.

The air bearing includes a first tubular member
15 having a longitudinally extending, centrally located bore. A plurality of air flow apertures are formed in the first tubular member and are disposed in fluid flow communication with the longitudinal bore. A second tubular member having a longitudinally extending bore is slidably disposable over
20 the first tubular member. The second tubular member is formed of a porous, air permeable material to direct air from the apertures in the first tubular member through the second tubular member.

In a preferred embodiment, both of the first and
25 second tubular members have a circular cross section.

In a preferred embodiment, the second tubular member is formed of a porous plastic material. The plastic material is preferably polyethylene having a porosity hole diameter of approximately 25 microns and a void space between
30 substantially 40% and 50% of total volume.

The air bearing of the present invention overcomes many of the deficiencies encountered with previously devised air bearings in that it supplies a linearly constant distribution of air completely across the length of the
35 bearing. By constructing a tubular body formed of a porous, air permeable material which is slidably disposable over a conventional solid, rotary bearing having spaced air flow apertures formed therein, the air bearing of the present

invention may be used in retrofit applications with existing solid rollers or bearings as well as in new applications. The air bearing of the present invention is inexpensive and simple in construction. Further, the air bearing of the present invention uniquely provides a linearly constant distribution of air across the length of the bearing which prevents any damaging contact between the moving web and the bearing.

BRIEF DESCRIPTION OF THE DRAWING

The various features, advantages and other uses of the present invention will become more apparent by referring to the following detailed description and drawing in which:

Figure 1 is an exploded, perspective view of the air bearing of the present invention;

Figure 2 is an assembled, perspective view of the air bearing shown in Figure 1; and

Figure 3 is an enlarged, cross sectional view generally taken along line 3-3 in Figure 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Throughout the following description and drawing, an identical reference number is used to refer to the same component shown in multiple figures of the drawing.

Referring now to Figures 1, 2 and 3 of the drawing, there is illustrated an air bearing 10 which provides an evenly distributed, linearly constant cushion of air across its exterior length to support and guide a web or substrate above the bearing 10 as the web 12 passes thereover.

The air bearing 10 includes a first tubular member 14. The first tubular member 14 is preferably in the form of an elongated, hollow cylinder having a through bore 16 extending therethrough. The through bore 16 is open on one end of the first tubular member 14 and closed at the other end.

Preferably, the first tubular member 14 is formed of a suitable material, such as steel, etc. The exterior surface of the first tubular member 14 does not have to be specially coated, such as with a chrome layer as in the prior art.

A plurality of air flow apertures 18 are formed in the side wall of the first tubular member 14 and disposed in fluid flow communication with the bore 16 extending through the first tubular member 14. Preferably, the air flow apertures 18 are in the form of holes or milled slots which are spaced apart in a row. One or more rows of such air flow apertures 18 may be formed in the first tubular member 14 depending upon how much surface area of the web 12 passes over the air bearing 10.

By way of background, the web 12 may comprise any suitable material, such as paper, cellophane, foil, etc., which has printing formed on one or both sides as a result of printing processes, such as web offset lithography. Typically, during such printing processes, the web 12 must be redirected at least 90° from its original path to align the web or substrate 12 with devices the subsequently fold, cut or perforate the final product. In addition, two bearings, such as the air bearing 10, may be employed in a spaced pair to provide a 180° reorientation of the web 12 to reverse the sides of the web 12, such that the bottom side is disposed uppermost. This allows both sides of the web 12 to be printed without the need for a "perfecting" printing press which prints both sides of a web simultaneously.

As shown in Figures 1 and 2, the first tubular member 14 is provided with suitable end couplings 20 and 22. The end couplings 20 and 22 are described by way of example only as any suitable coupling may be employed to fixedly mount the first tubular member 14 to surrounding support structure, not shown. The first coupling 20 is mounted on one end of the first tubular member 14. The first coupling 20 includes an enlarged collar 24 and a fitting 26. A bore 28 extends through the fitting 26 and is disposed in fluid flow communication with the bore 16 in the first tubular member 14. A mounting aperture 30 is also formed in the fitting 26 to attach one end of the first tubular member to support structure by suitable means, such as welding.

The coupling means 22 is mounted on the opposite end of the first tubular member and includes a suitable fitting 32 having a transverse aperture 34 formed therein for mounting

to support structure.

Not shown in Figures 1 and 2 is as a fluid supply source which supplies pressurized fluid, such as air, through the bore 28 to the bore 16 in the first tubular member 14.

5 The air bearing 10 also includes a second tubular member 40. The second tubular member 40 is preferably in the form of an elongated cylinder having a centrally located, longitudinally extending, through bore 42 extending between opposite ends. The internal diameter of the bore 42 is sized
10 to enable the second tubular member 40 to be slidably disposed about the periphery of the first tubular member 14, with the interior surface of the bore 42 of the second tubular member 40 disposed in contact with the peripheral surface of the first tubular member 14. Either a press fit connection
15 between the first and second tubular members 14 and 40 may be employed or other fastening means, such as machined lands, captive nuts, etc., may be used to fixedly connect the second tubular member 40 to the first tubular member 14.

 The second tubular member 40 is preferably formed
20 of a porous, air permeable material which contains pores which disperse air flowing through the air flow apertures 18 in the first tubular member 14 evenly through the side wall or thickness of the second tubular member 40. The second tubular member 40 may be formed in the desired, cylindrical shape by
25 any suitable means, such as by extruding, molding, machining, etc.

 Preferably, the second tubular member 40 is formed of a porous, plastic material which is extruded to the desired shape. By way of example only, the plastic material is
30 preferably polyethylene and has a porosity of 25 microns and a void space of approximately 40% to 50% of total volume. The wall thickness of the second tubular member 40 is 0.25 inches in an exemplary application.

 In assembling and using the air bearing 10 of the
35 present invention, the second tubular member 40 is slid over the first tubular member 14 and fixed in place through a press fit or the use of separate fastening means, as described above. In this mounting arrangement, the pores in the second tubular member 40 are disposed in fluid flow communication

with the air flow apertures 18 and the bore 16 in the first tubular member 14. This allows pressurized air supplied to the bore 16 in the first tubular member 14 to pass through the air flow apertures 18 in the first tubular member 14 and be evenly dispersed through the pores in the second tubular member 40. Air exiting from the peripheral surface of the second tubular member 40, as shown in Figure 3, provides a linearly constant, evenly distributed cushion of air across the entire length of the second tubular member 40. This linearly constant, even distribution of air provides a cushion for supporting the web 12 at a constant distance above the peripheral surface of the second tubular member 40 as the web 12 passes over the air bearing 10. Further, since the cushion of air extends over the entire length of the second tubular member 40 for a predetermined angular portion of the exterior surface of the second tubular member 40, such as approximately 180°, the web 12 is prevented from damaging contact with the air bearing 10 even in applications where the web 12 is redirected a full 180° about the air bearing 10.

In summary, there has been disclosed a unique air bearing which provides a linearly constant, even distribution of air across the entire length of the bearing. This provides an even distribution or cushion of air which prevents damaging contact between a moving web and the air bearing.

What is Claimed is:

1 1. An air bearing for supporting and guiding a
2 moving web therepast by a cushion of air comprising:

3 a first tubular member having a longitudinal bore
4 extending therethrough;

5 a plurality of air flow apertures formed in the
6 first tubular member and disposed in fluid flow communication
7 with the longitudinal bore in the first tubular member; and

8 a second tubular member having a longitudinal bore
9 extending therethrough slidably disposable over and in contact
10 with the first tubular member substantially along the entire
11 surface of the longitudinal bore;

12 the second tubular member being formed of a porous,
13 air permeable material having three-dimensional air flow
14 passages extending therethrough to direct air from the air
15 flow apertures in the first tubular member evenly through the
16 second tubular member to form a linearly constant distribution
17 of air across the periphery of the second tubular member to
18 space the web from the second tubular member.

1 2. The air bearing of Claim 1 wherein the first
2 and second tubular members have a circular cross section.

1 3. The air bearing of Claim 1 wherein the second
2 tubular member is formed of a porous plastic.

1 4. The air bearing of Claim 3 wherein the plastic
2 is polyethylene having a porosity hole diameter of
3 substantially 25 microns and a void space between 40% and 50%
4 of total volume.

1 5. An air bearing sleeve for use in an air bearing
2 having a first member with a hollow bore extending
3 therethrough and air flow apertures formed in the side walls
4 thereof disposed in fluid flow communication with the hollow
5 bore, the sleeve comprising:

6 a tubular body having a through bore extending
7 therethrough slidably disposable over and in contact with t'
8 first member substantially along the entire surface of

9 through bore;
10 the tubular body being formed of a porous material
11 to direct air from the air flow apertures in the first member
12 evenly through the tubular member to form a linearly constant
13 distribution of air about the entire length of the tubular
14 member to evenly support a web about and spaced from the
15 periphery of the tubular member.

1 6. The air bearing sleeve of Claim 5 wherein the
2 tubular body has a circular cross section exterior surface.

1 7. The air bearing sleeve of Claim 5 wherein the
2 tubular body is formed of a porous plastic.

1 8. The air bearing sleeve of Claim 7 wherein the
2 plastic is polyethylene having a porosity hole diameter of
3 substantially 25 microns and a void space between 40% and 50%
4 of total volume.

1 9. The air bearing of Claim 1 wherein the
2 plurality of air flow apertures in the first tubular member
3 are co-linearly arranged in at least one row.

AMENDED CLAIMS

[received by the International Bureau on 11 September 1991 (11.09.91)
original claims 1 and 5 amended; other claims unchanged (2 pages)]

1 1. An air bearing for supporting and guiding a
2 moving web therepast by a cushion of air comprising:
3 a first tubular member having a longitudinal bore
4 extending therethrough;
5 a plurality of air flow apertures formed in the
6 first tubular member and disposed in fluid flow
7 communication with the longitudinal bore in the first
8 tubular member, the air flow apertures extending only over
9 a predetermined angular portion of the first tubular
10 member; and
11 a second tubular member having a longitudinal
12 bore extending therethrough slidably disposable over and in
13 contact with the first tubular member substantially along
14 the entire surface of the longitudinal bore;
15 the second tubular member being formed of a
16 porous, air permeable material having air flow passages
17 extending therethrough to direct air from the air flow
18 apertures in the first tubular member evenly through the
19 second tubular member to form a linearly constant
20 distribution of air across the length of the second tubular
21 member for a predetermined angular portion of the periphery
22 of the second tubular member to space the web from the
23 second tubular member.

1 2. The air bearing of Claim 1 wherein the first
2 and second tubular members have a circular cross section.

3. The air bearing of Claim 1 wherein the
second tubular member is formed of a porous plastic.

1 4. The air bearing of Claim 3 wherein the
2 plastic is polyethylene having a porosity hole diameter of
3 substantially 25 microns and a void space between 40% and
4 50% of total volume.

1 5. An air bearing sleeve for use in an air
2 bearing having a first member with a hollow bore extending
3 therethrough and air flow apertures formed in and extending

4 through only a predetermined angular portion of the side
5 walls thereof and disposed in fluid flow communication with
6 the hollow bore, the sleeve comprising:

7 a tubular body having a through bore extending
8 therethrough slidably disposable over and in contact with
9 the first member substantially along the entire surface of
10 the through bore;

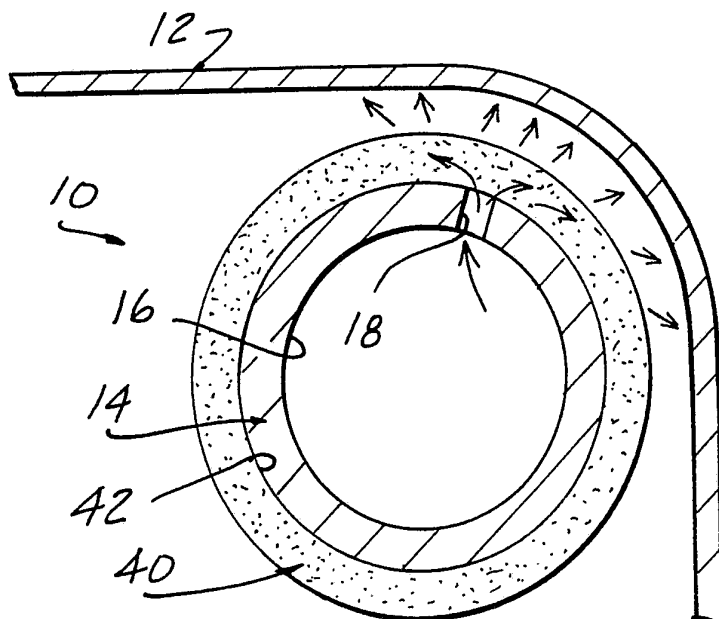
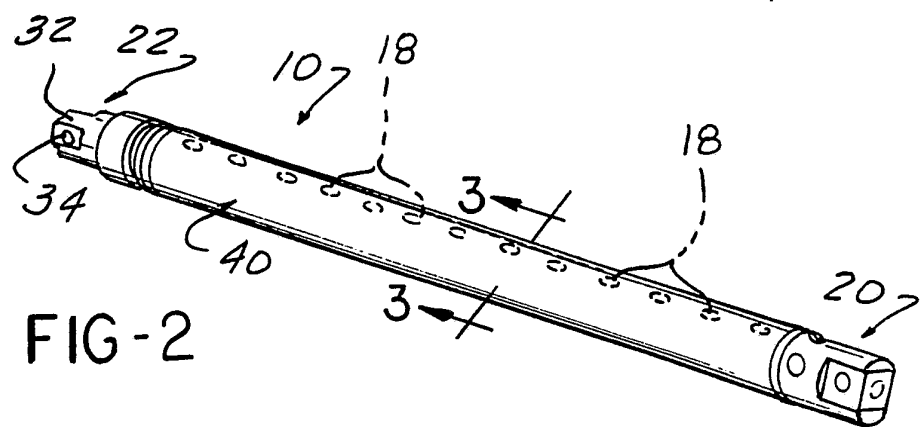
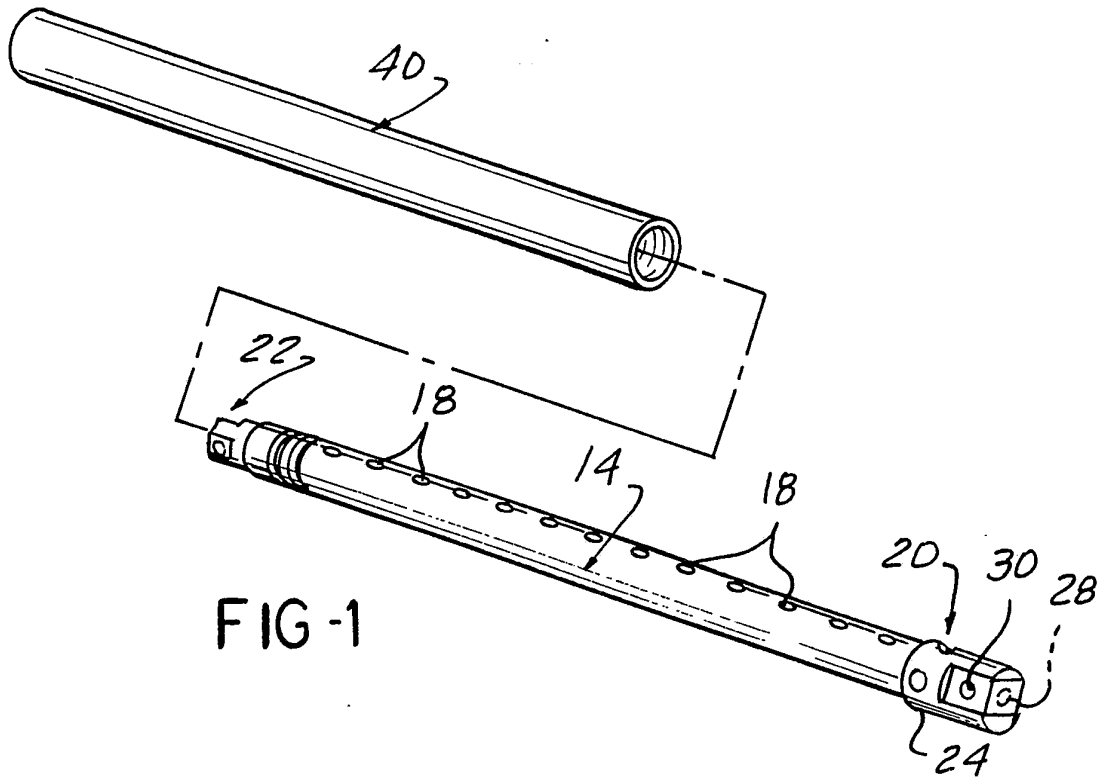
11 the tubular body being formed of a porous
12 material to direct air from the air flow apertures in the
13 first member evenly through a predetermined angular portion
14 of the periphery of the tubular member to form a linearly
15 constant distribution of air across the entire length of
16 the tubular member to evenly support a web about and spaced
17 from the predetermined angular portion of the periphery of
18 the tubular member.

1 6. The air bearing sleeve of Claim 5 wherein
2 the tubular body has a circular cross section exterior
3 surface.

1 7. The air bearing sleeve of Claim 5 wherein
2 the tubular body is formed of a porous plastic.

1 8. The air bearing sleeve of Claim 7 wherein
2 the plastic is polyethylene having a porosity hole diameter
3 of substantially 25 microns and a void space between 40%
4 and 50% of total volume.

1 9. The air bearing of Claim 1 wherein the
2 plurality of air flow apertures in the first tubular member
3 are co-linearly arranged in at least one row.



INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/03135

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC (5): B65H 20/00 U.S. CL: 226/097		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
U.S. CL.	226/7, 97, 196	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
Y	US, A, 4,506,841 HOOD 26 March 1985 (Note figure 3).	1-9
Y	JP, A, 63-267,648 TEIJIN, LTD, 04 October 1988 (Note sheath 4 Surrounding and in contact with roller 5).	1-9
A	US, A, 3,744,693 GREINER, 10 July 1973	1-9
A	US, A, 3,245,334, LONG 12 April 1966	1-9
A	US, A, 3,156,399, WADEY 10 November 1964	1-9
<p>* Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"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</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"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.</p> <p>"&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
18 JUNE 1991	10 JUL 1991	
International Searching Authority	Signature of Authorized Officer - <i>Paul T. Bowen</i>	
ISA/US	PAUL T. BOWEN	