



(51) International Patent Classification:

F16L 11/08 (2006.01)

(21) International Application Number:

PCT/US2019/047636

(22) International Filing Date:

22 August 2019 (22.08.2019)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

16/118,866 31 August 2018 (31.08.2018) US

(71) Applicant: CATERPILLAR INC. [US/US]; 510 Lake Cook Road, Suite 100, Deerfield, Illinois 60015 (US).

(72) Inventor: SCHOENAU, William T.; 114 Brookwood Court, Washington, Illinois 61571 (US).

(74) Agent: FISHER, Bart A. et al.; Caterpillar Inc., 100 NE Adams Street - AH9510, Peoria, IL 61629-9510 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,

DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: FLUID HOSE

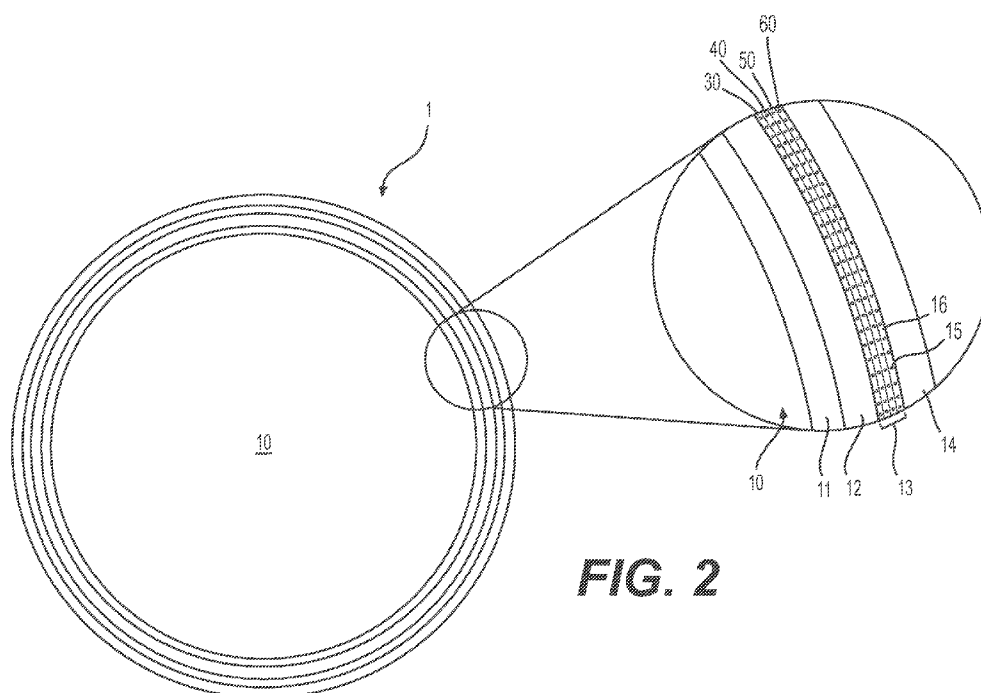


FIG. 2

(57) Abstract: A fluid hose (1) comprising an inner liner (11), a reinforcement layer (13) located radially outside of the inner liner, and a cover (14). The reinforcement layer includes one or more preformed ribbons (20) having a plurality of wires (15) formed in a strip of cushioning material (16).



Description

FLUID HOSE

Technical Field

The present disclosure relates generally to fluid hoses, such as
5 hydraulic hoses, and methods of manufacturing the same.

Background

Fluid hoses, such as hydraulic hoses, typically include an inner
liner, wire reinforcement layers with alternating cushion layers, and an exterior
layer or cover. U.S. Patent No. 4,175,992 A (“the ’992 patent”) to Grawey
10 discloses a process of manufacturing a hydraulic hose that includes sequentially
wrapping a mandrel with a fabric layer, an uncured elastomer layer, a bond stock
layer, and a plurality of reinforcement wires. The plurality of reinforcement
wires are applied in a side-by-side series of convolutions on the surface of a bond
stock layer by means of a winding deck that rotates about the mandrel.
15 Reinforcement layers are formed by winding separate reinforcement wires at the
same time from spools of reinforcement wires onto the formed layers of the
hydraulic hose (i.e., a built-up core structure). The number of reinforcement wires
could, for example, range from fifty (50) to one-hundred and fifty (150),
depending on the diameter of the layer and the winding angle of the
20 reinforcement wire.

During this hydraulic hose manufacturing process, control of the
reinforcement wires may lead to tension differences as the wires are wound about
the hose. Such tension differences can cause the reinforcement wires to have
radial variations that can cause a rubbing friction between adjacent hose layers,
25 and eventual failure of the hose. Also, tension differences in applying the
reinforcement wires can create gaps between adjacent reinforcement wires that
can lead to a rupture failure of the hose when conveying highly pressurized fluid.
Finally, the different reinforcement wire tensions may cause the wires to overlap

and become twisted, which may also cause rubbing friction between the hose layers, and possibly cause premature failure of the hose.

The systems and methods of the present disclosure may solve one or more of the problems set forth above and/or other problems in the art. The scope of the current disclosure, however, is defined by the attached claims, and
5 not by the ability to solve any specific problem.

Summary of the Disclosure

According to one aspect, the present disclosure includes a fluid hose. The fluid hose may include an inner liner, a reinforcement layer located
10 radially outside of the inner liner, and a cover. The reinforcement layer including one or more preformed ribbons having a plurality of wires formed in a strip of cushioning material.

According to another aspect, the present disclosure includes a ribbon for use in forming a hydraulic hose. The ribbon may include a plurality of
15 wires and a strip of cushioning material, the plurality of wires being formed in the strip of cushioning material.

According to yet another aspect, the present disclosure includes a method of making a fluid hose. The method may include forming an inner liner, forming a reinforcement layer radially outside the inner liner, and forming a
20 cover radially outside the reinforcement layer. The forming of the reinforcement layer includes helically winding one or more ribbons radially outside the inner liner, the ribbons including a plurality of wires arranged in a strip of cushioning material.

Brief Description of the Drawings

25 FIG. 1 is a perspective view of an exemplary fluid hose according to the present disclosure.

FIG. 2 is a cross-sectional view of the hose of FIG. 1.

FIG. 3 is a perspective view of a preformed ribbon of the hose of FIG. 1.

FIG. 4 is a flow chart for a process of manufacturing the ribbon of FIG. 3.

FIG. 5 is a perspective view of the hose of FIG. 1 during a step in the manufacturing process.

5 FIG. 6 is a flow chart of a process of manufacturing the hose of FIG. 1.

Detailed Description

Both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the features, as claimed. As used herein, the terms “comprises,” “comprising,”
10 “having,” “including,” or other variations thereof, are intended to cover a non-exclusive inclusion such that a process, method, article, or apparatus that comprises, has, or includes a list of elements does not include only those elements, but may include other elements not expressly listed or inherent to such
15 a process, method, article, or apparatus.

In this disclosure, relative terms, such as, for example, “about,” “substantially,” “generally,” and “approximately” are used to indicate a possible variation of $\pm 10\%$ in the stated value. The term “exemplary” is used in the sense of “example” rather than “ideal.” As used herein, the singular forms “a,” “an,”
20 and “the” include plural reference unless the context dictates otherwise.

FIG. 1 is a perspective view of an exemplary fluid hose 1 according to the present disclosure. Hose 1 may be, for example, a hydraulic hose 1 that includes a lumen 10 for conveying hydraulic liquids through the hose 1. While this disclosure will be described with reference to a hydraulic hose 1,
25 the disclosure is not limited to only hoses that convey hydraulic fluid. Hose 1 can convey any type of fluid (liquid or gas). Hose 1 may be used with any type of system, such as, for example, hydraulic systems for industrial or mobile heavy machinery, or any other system that uses a hose.

FIG. 2 is a cross-sectional view of the hydraulic hose 1 taken
30 along line 2-2 in FIG. 1. Hydraulic hose 1 may include, from the hose lumen 10 radially outward, an inner liner 11, a cushion layer 12, a ribbon reinforcement

layer 13, and a cover 14. While the hydraulic hose 1 will be described with these layers, it is understood that hose 1 may include more or less layers, and the arrangement (radial position) of the layers may be modified.

The inner liner 11 of hydraulic hose 1 may be a barrier between a
5 pressurized fluid in lumen 10 and the exterior layers (i.e., cushion layer 12, ribbon reinforcement layer 13, and cover 14) so that the exterior layers do not come into contact with the pressurized fluids. The inner liner 11 may be formed of materials providing the desired flexibility and appropriate compatibility with the conveyed fluid to protect against any corrosive effects of the conveyed fluid.
10 The inner liner 11 may also be formed of a material that includes a flow-facilitating surface to reduce friction and material build-up. For example, inner liner 11 may be formed of a synthetic rubber, thermoplastic, or PTFE (Teflon), and may include any appropriate coating.

The cushion layer 12 of hydraulic hose 1 may be a barrier between
15 the inner liner 11 and the ribbon reinforcement layer 13, to help ensure that the inner liner 11 does get detrimentally worn due to rubbing friction from the ribbon reinforcement layer 13. The cushion layer 12 may be formed of, for example, a synthetic rubber and/or fabric. Cushion layer 12 may be omitted entirely in hose 1, or additional cushion layers 12 may be included in hose 1.

20 Cover 14 of hydraulic hose 1 may be a barrier between the external environment and the inner layers (i.e., ribbon reinforcement layer 13, cushion layer 12, and inner liner 11). Cover 14 may be formed of a material that is abrasion resistant and flexible across a wide range of temperatures. For example, cover 14 may be a synthetic rubber such as neoprene, or a plastic such
25 as polyurethane.

Ribbon reinforcement layer 13 may include one or more preformed ribbons 20. Referring to FIGs. 2 and 3, each ribbon 20 of reinforcement layer 13 may include a plurality of wires 15 formed in a strip of cushioning material 16. Wires 15 may be formed of a high tensile strength steel
30 or other conventional wire material, and may have any appropriate gauge. Cushioning material 16 may be formed of, for example, a synthetic rubber.

Wires 15 may be arranged along the ribbon 20 so as not to contact one another, so that cushioning material 16 separates the wires 15. For example, wires 15 may be arranged longitudinally along ribbon 20, generally evenly spaced, and parallel to one another, and parallel to a longitudinal side edge 18 of the ribbon 20. Wires 15 may extend to a surface of the ribbon 20, for example being flush or coplanar with a top surface 22 or a bottom surface of ribbon 20. Alternatively, wires 15 may be completely encased within the cushioning material 16 so that the wire does not form a portion of any surface of the ribbon 20. While only exemplary, ribbon 20 may be 5/8 inches wide, having 20 wires, and each wire 15 may have a gauge of 22.

FIG. 4 is a flow chart for a process 400 of manufacturing ribbon 20 of the hydraulic hose 1 of FIG. 1. The ribbon 20 may be preformed - formed prior to assembly on hose 1. Process 400 may include a first step 402 of joining wires 15 with cushioning layer 16. The joining step 402 may be accomplished by using an alignment tool, such as a grooved rolling wheel (not shown), to arrange and urge the wires 15 into an uncured cushioning layer 16. The uncured nature of the cushioning layer allows the wires 15 to engage and be partially or fully encased by the cushioning layer 16. In step 404, the joined wires 15 and cushioning material are cured or vulcanized by any appropriate curing or vulcanization process to form the final ribbon 20. Alternatively, ribbon 20 could be formed by laying wires 15 between layers of cushioning material and curing or vulcanizing the cushioning layers together thereby securely encasing the wires 15 with cushioning material.

Referring back to FIG. 2, ribbon reinforcement layer 13 may include multiple layers of ribbon 20, such as ribbon layers 30, 40, 50, and 60. FIG. 2 illustrates four ribbon layers (30, 40, 50, 60), but it is understood that more or less layers could be used depending on the desired reinforcement (pressure rating) of hose 1. Further, while not shown, it is understood that each ribbon layer may be separated by a cushion layer, such as a cushion layer 12 as discussed above. For example, ribbon reinforcement layer 13 may include two layers, four layers, eight layers, etc. As shown in FIG. 5, ribbon layer 30 may be

formed by a plurality of helically wound ribbons 20A-20D that are arranged edge-to-edge in a helical manner to form a uniform layer 30. While FIG. 5 shows ribbon layer 30 formed of four ribbons 20A-20D, more or less ribbons could be used, e.g., one, two, three, or more than four.

5 Also as shown in FIG. 5, ribbon layers 40, 50, and 60 may be formed on top of layer 30, with adjacent outer layers helically wound in opposite directions than the immediately adjacent inner layer. For example, layer 30 may be wound in a clockwise direction, and layer 40 (with ribbons 20A-20D) may be wound in a counterclockwise direction. Further, ribbon layer 50 may be formed
10 in a clockwise direction, and ribbon layer 60 in a counterclockwise direction.

FIG. 6 is a flow chart for a process 600 of manufacturing the hydraulic hose 1 of FIG. 1. The process 600 may start by extruding the inner liner 11 about a mandrel (step 602). Next, a cushioning layer 12 may be wrapped around the inner liner 11 (step 604). The reinforcement layer 13 may then be
15 formed by helically wrapping ribbons 20 into individual layers 30-60 in clockwise and counterclockwise directions (step 606) about the cushioning layer 12. As mentioned above, the first ribbon reinforcement layer 30 may have four ribbons 20A, 20B, 20C, and 20D that are helically wound in a clockwise direction, while the second ribbon reinforcement layer 40 may have four ribbons
20 20A-20C that are helically wound in a counterclockwise direction. Ribbons 20A-20D of layers 30-60 may be wound at any appropriate angle, for example, a winding angle θ of approximately 55° (FIG. 5). The cover 14 may then be extruded over the reinforcement layer 13 (step 608) to form a hose assembly. The hose assembly may then be labeled and cured (step 610). The wrapping of
25 the inner liner 11 and the ribbons 20 about the hose 1 can be done in any conventional manner, such as with the use of a winding machine that feeds the mandrel through the winding machine as the layers are wound about hose 1.

Industrial Applicability

The present disclosure may find application in the production and use of hoses for fluid systems, such as hydraulic hoses for use in hydraulic systems.

5 The present disclosure may help to ensure that the wires 15 of the hose 1 are uniformly distributed about the hose 1, and of the appropriate tension on the hose 1. By combining the cushioning material 16 and the wires 15 to form a ribbon 20 prior to forming the hose, the wires 15 can be accurately positioned and set before they are applied to the hose 1. This can help avoid wire alignment
10 problems (i.e., high wires, low wires, twisted wires, and gaps between wires). This may increase the life and safety of the hose 1, as the likelihood of failure of the hydraulic hose due to high wires, low wires, twisted wires, and gaps between wires, may be reduced. This may also reduce costs associated with hoses that fail prematurely (e.g., warranty costs, replacement costs, and down time of the
15 machine/system using the hydraulic hose).

 Another aspect of the above disclosure is that the hydraulic hose 1 may be more simple to manufacture by reducing the complexity of wrapping numerous wires about the hydraulic hose. For instance, by using ribbons 20 to create the ribbon reinforcement layer 13, instead of individually positioning
20 hundreds of individual wires 15, manufacturing parts, set-ups, and system coordination may be reduced. This may reduce cost in maintenance and down time of the manufacturing facility.

 It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed system without
25 departing from the scope of the disclosure. Other embodiments of the system will be apparent to those skilled in the art from consideration of the specification and practice of the method disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope of the disclosure being indicated by the following claims and their equivalents.

8
Claims

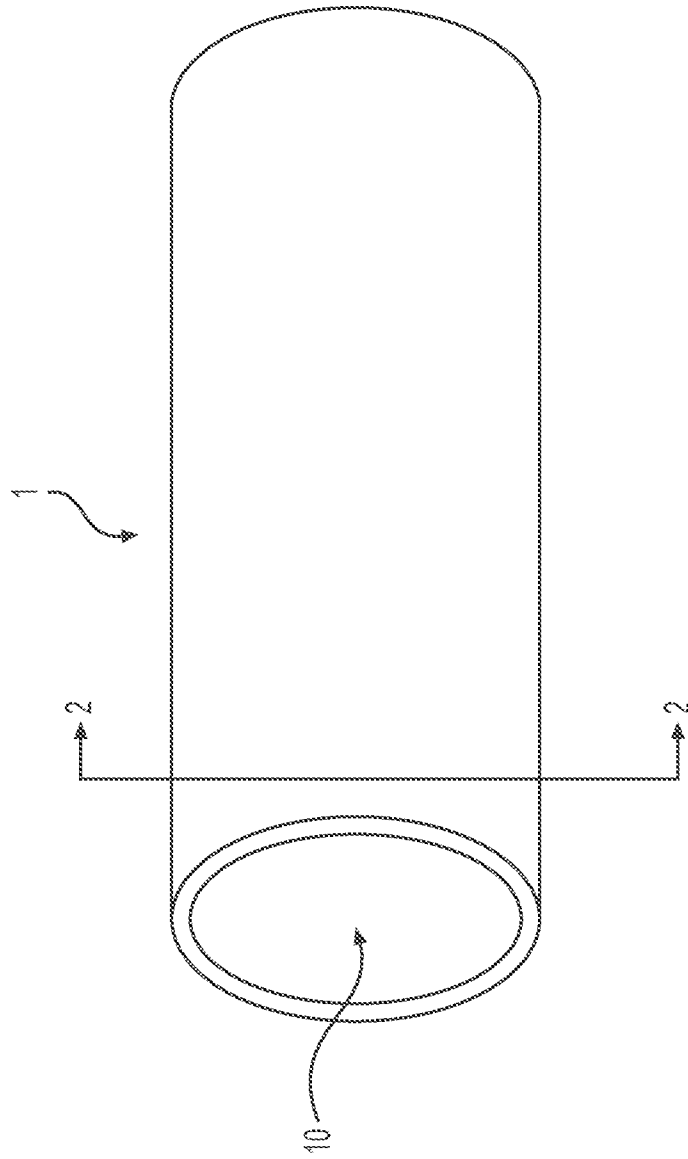
1. A fluid hose (1), comprising:
an inner liner (11);
a reinforcement layer (13) located radially outside of the inner
5 liner; and
a cover (14);
the reinforcement layer including one or more preformed ribbons
(20) having a plurality of wires (15) formed in a strip of cushioning material (16).
- 10 2. The fluid hose of claim 1, wherein the plurality of wires
(15) are generally evenly spaced apart from each other.
3. The fluid hose of claim 2, wherein the ribbon (20) has a
longitudinal edge (18), and the plurality of wires (15) are generally parallel to
15 each other and generally parallel to the longitudinal edge of the ribbon.
4. The fluid hose of claim 3, wherein the plurality of wires
(15) are completely encased within the strip of cushioning material (16).
- 20 5. The fluid hose of claim 3, wherein the plurality of wires
(15) are exposed at a surface (22) of the strip of cushioning material (16).
6. The fluid hose of claim 3, wherein the wires (15) are
formed of steel, and the cushioning material (16) is formed of a synthetic rubber.
25
7. The fluid hose of claim 6, wherein the wires (15) and
cushioning material (16) are cured together prior to joining with the hose.
8. The fluid hose of claim 3, wherein the reinforcement layer
30 (13) includes a plurality of helically wound ribbons (20) arranged side-to-side.

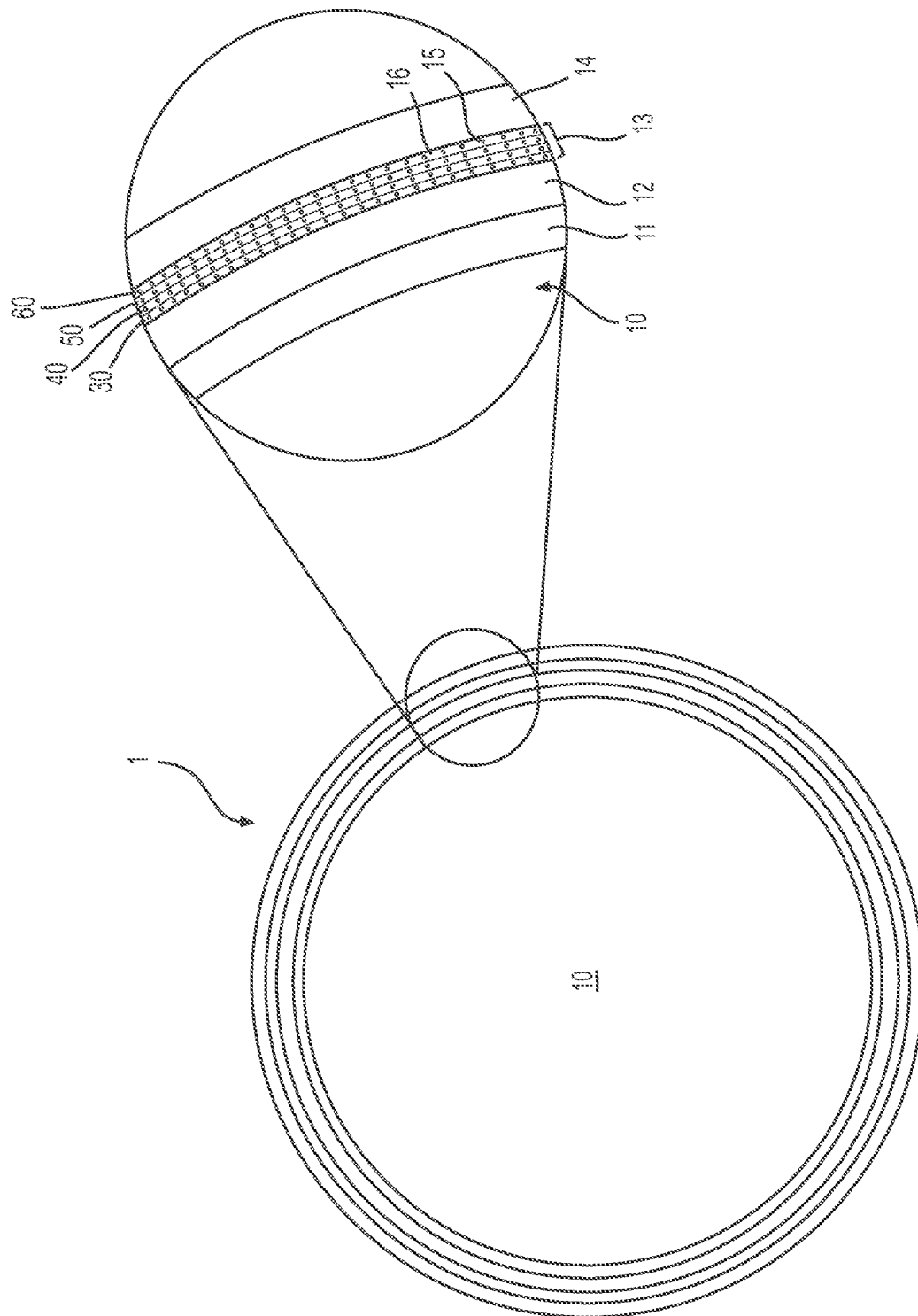
9

9. The fluid hose of claim 8, wherein the reinforcement layer (13) includes multiple layers (30, 40, 50, and 60), each formed of a plurality of helically wound ribbons (20) arranged side-to-side.

5

10. The fluid hose of claim 9, wherein the multiple layers (30, 40, 50, and 60) includes one layer (30) arranged in a clockwise direction, and another layer (40) arranged in a counterclockwise direction.

**FIG. 1**

**FIG. 2**

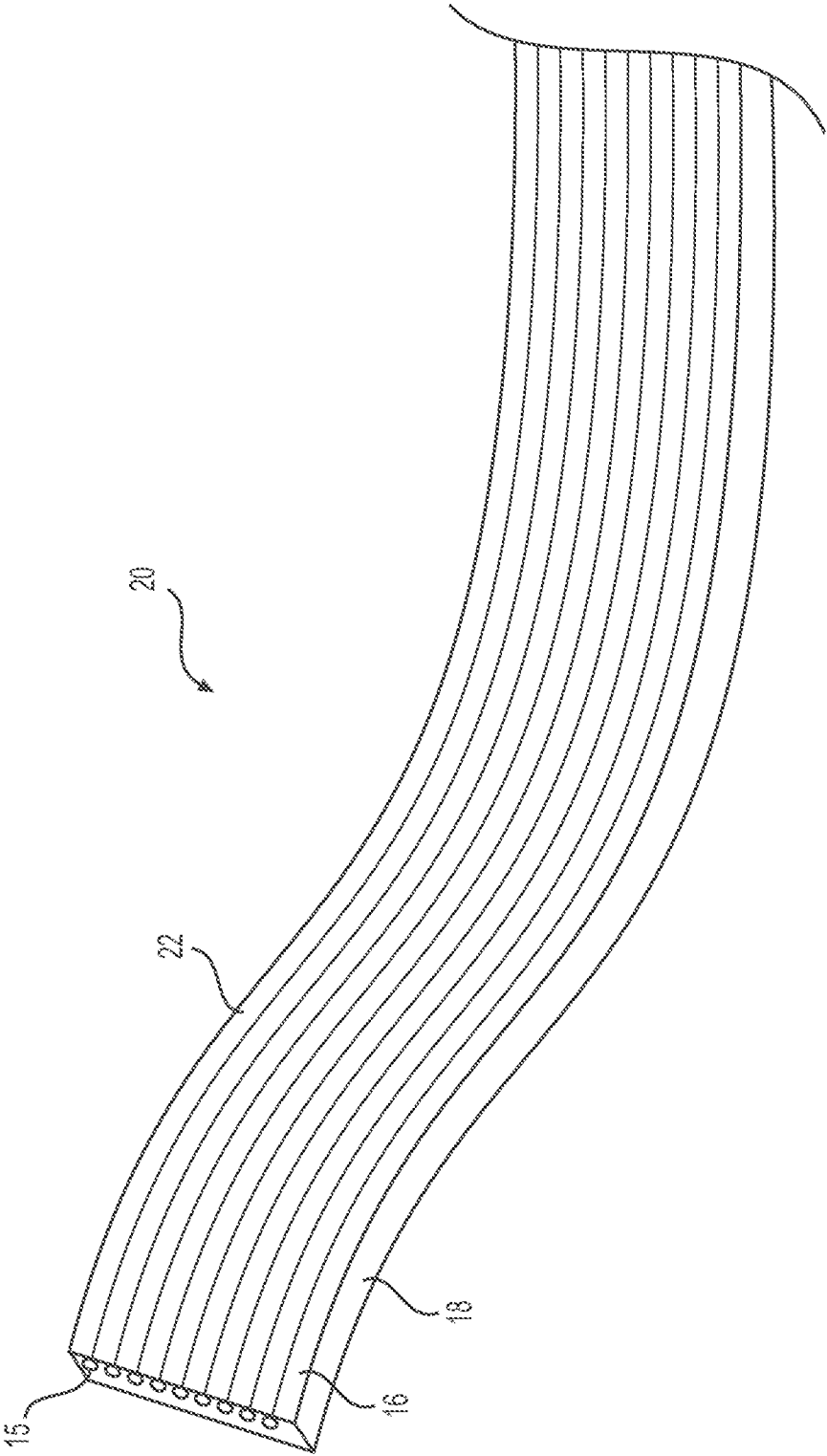


FIG. 3

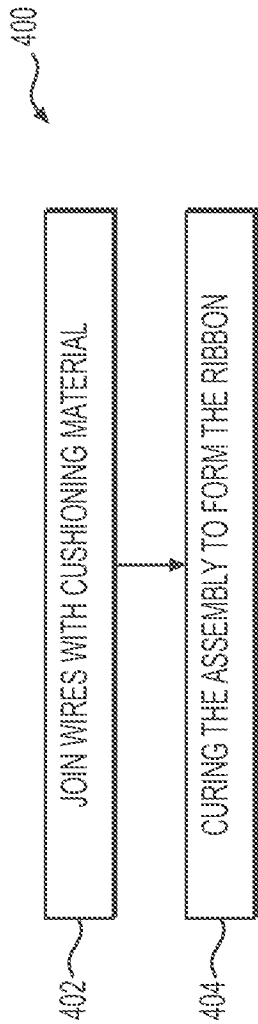


FIG. 4

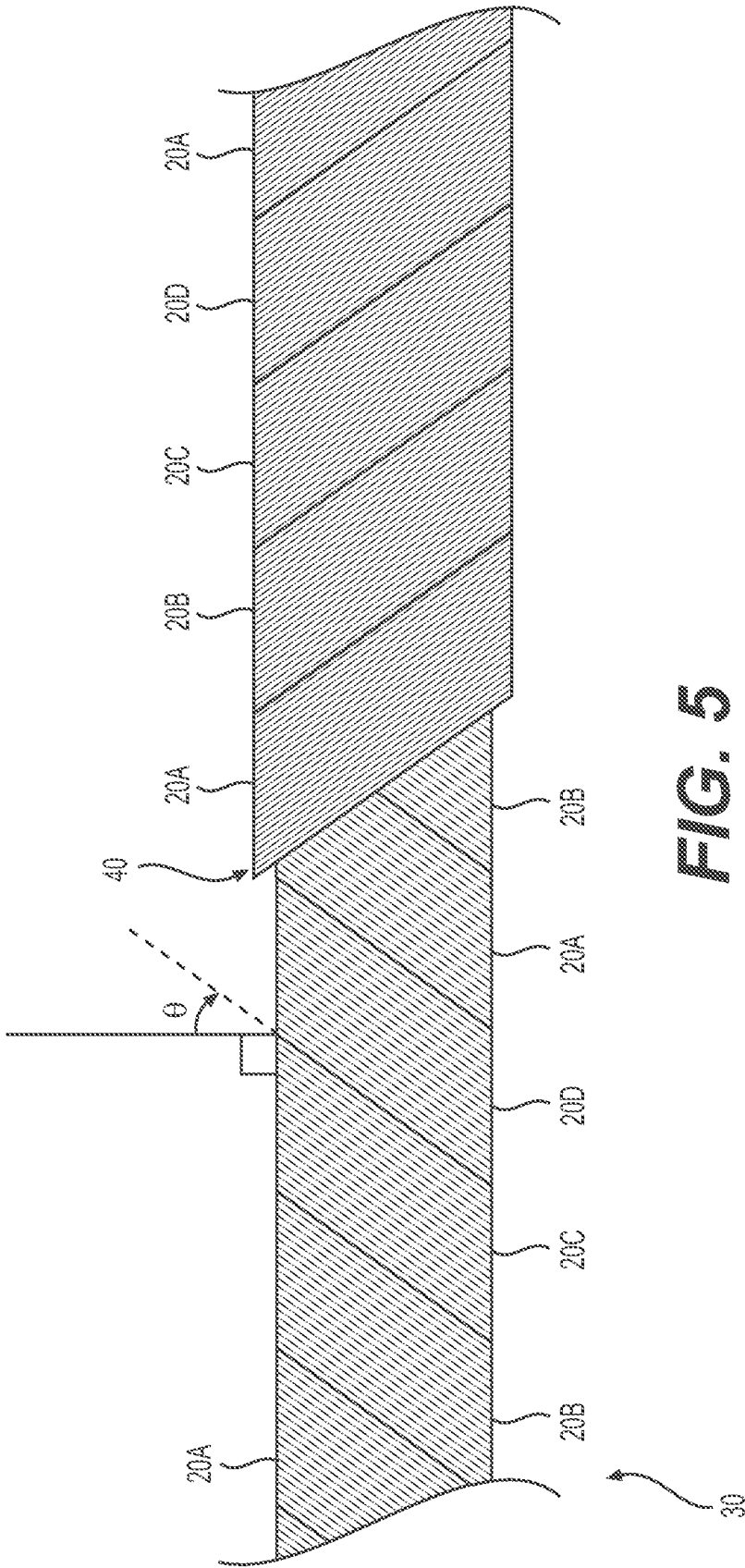
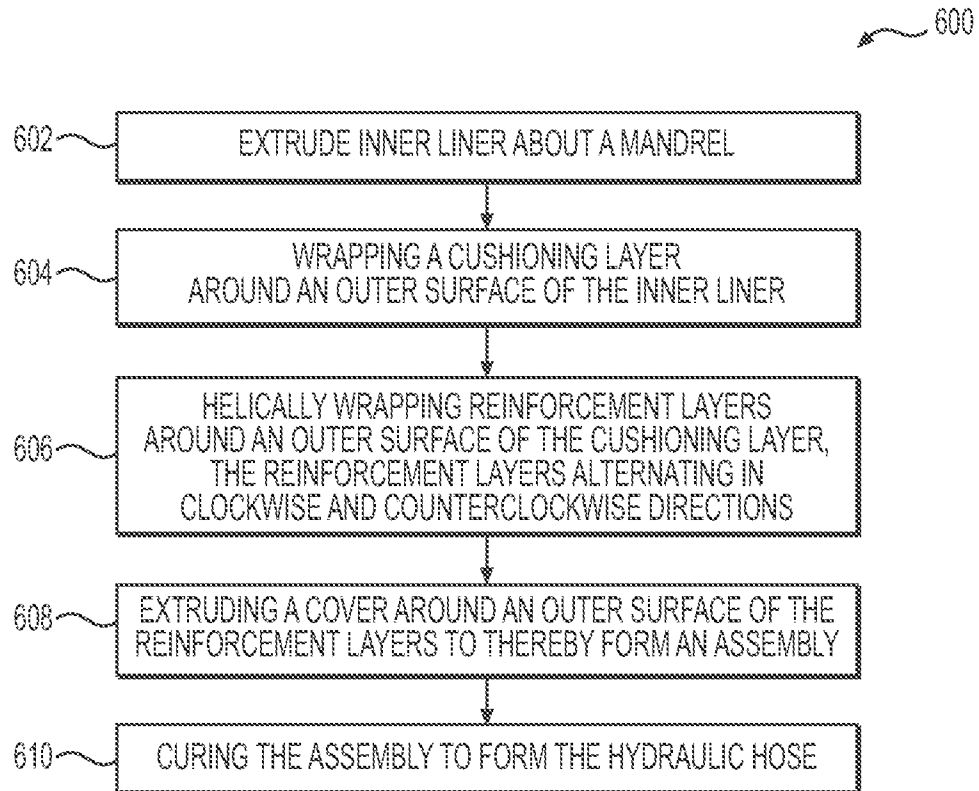


FIG. 5

**FIG. 6**

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2019/047636

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16L11/08
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16L

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 1 450 127 A (WHITWORTH B F) 22 September 1976 (1976-09-22) page 1, line 9 - line 17 page 1, line 47 - line 72 page 2, line 5 - line 121 page 3, line 27 - line 60; figures -----	1-10
X	US 2011/214773 A1 (HAMACHI YOUSUKE [JP] ET AL) 8 September 2011 (2011-09-08) paragraph [0001] paragraph [0006] - paragraph [0016] paragraph [0052] - paragraph [0058] paragraph [0067] - paragraph [0078]; figures 1A-5C ----- -/-	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

18 November 2019

Date of mailing of the international search report

26/11/2019

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Cross, Alexandra

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2019/047636

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2017/005805 A1 (BEKAERT SA NV [BE]) 12 January 2017 (2017-01-12)	1-7
A	paragraph [0001] paragraph [0011] - paragraph [0013] paragraph [0018] - paragraph [0023] paragraph [0033] - paragraph [0034] paragraph [0041] - paragraph [0046] paragraph [0062] - paragraph [0071] paragraph [0087]; figures 1-5 -----	8-10
X	WO 01/61230 A2 (DIXON ROCHE KEITH [GB]; BOURGEOIS LUC JULIEN PIERRE AL [BE]) 23 August 2001 (2001-08-23)	1-4,6
A	page 1, line 3 - line 8 page 11, line 21 - page 15, line 18 page 18, line 6 - line 17; figures 1-3 -----	5,7-10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2019/047636

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 1450127	A	22-09-1976	NONE
US 2011214773	A1	08-09-2011	CN 102143834 A 03-08-2011 DE 112009002153 T5 07-07-2011 US 2011214773 A1 08-09-2011 WO 2010026751 A1 11-03-2010 WO 2010026753 A1 11-03-2010
WO 2017005805	A1	12-01-2017	BR 112017028021 A2 28-08-2018 CN 107735611 A 23-02-2018 EA 201890242 A1 31-05-2018 EP 3320246 A1 16-05-2018 KR 20180030078 A 21-03-2018 US 2019003619 A1 03-01-2019 WO 2017005805 A1 12-01-2017
WO 0161230	A2	23-08-2001	AT 349644 T 15-01-2007 AU 3386801 A 27-08-2001 BR 0108434 A 07-01-2003 DE 60125511 T2 04-10-2007 DK 1255943 T3 21-05-2007 EP 1255943 A2 13-11-2002 EP 1760380 A1 07-03-2007 ES 2279800 T3 01-09-2007 PT 1255943 E 30-03-2007 US 2003121595 A1 03-07-2003 US 2005241772 A1 03-11-2005 US 2007163700 A1 19-07-2007 US 2008105365 A1 08-05-2008 WO 0161230 A2 23-08-2001