



(51) International Patent Classification:
H01B 7/18 (2006.01)

(21) International Application Number:
PCT/SE20 10/050789

(22) International Filing Date:
6 July 2010 (06.07.2010)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant (for all designated States except US): TELEFONAKTIEBOLAGET L M ERICSSON (PUBL) [SE/SE]; S-164 83 Stockholm (SE).

(72) Inventors; and

(75) Inventors/ Applicants (for US only): JOHNSEN, Ulf Fridtjof [SE/SE]; Östera 72, S-791 91 Falun (SE). EFRAIMSSON, Lars [SE/SE]; Haraldsbogvagen 3C, S-791 43 Falun (SE).

(74) Agent: SJÖBERG, Mats; Ericsson AB, Patent Unit IMS, Platforms and Broadband Access, Box 1505, S-125 25 Älvsjö (SE).

(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, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, 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, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, 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, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

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

(54) Title: SELF-SUPPORTING CABLE

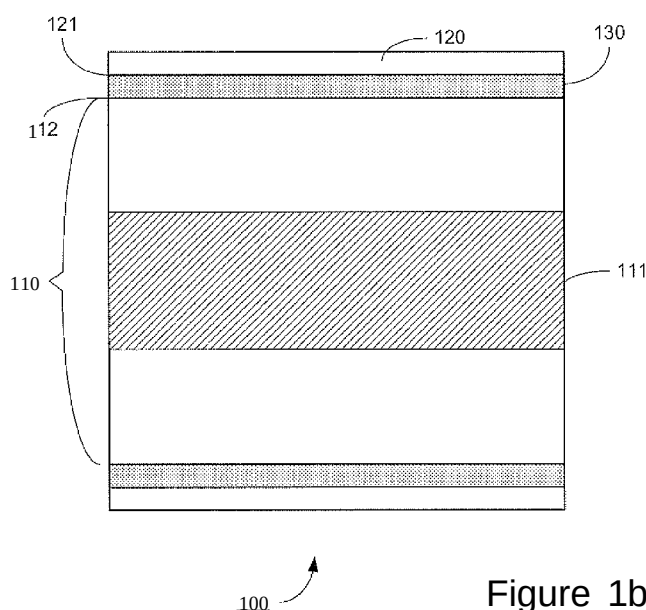


Figure 1b

(57) Abstract: The current invention relates to self-supporting cables that often are aerial mounted between cable fixing points (800) and where the conductors in the cables act as the bearing elements. In this type of cables, slippage between the surfaces of different layers in the cable is undesirable. On the other hand, it must be possible to easily bend the cable, even for larger dimensions. Both these requirements are difficult to meet with the solutions from prior art. The present invention overcomes this by introducing an intermediate layer (130) between the surfaces (112, 121) comprising at least on tape (511) with friction particles (512) where the friction obtained by the friction particles (512) is low enough to allow the two surfaces (112, 121) to slip relatively each other in longitudinal direction enough so that the cable 100 can be bent but prevents the two surfaces (112, 121) from slipping in response to an inwardly directed radial pressure force (F) at the cable fixing points (800).

SELF-SUPPORTING CABLE**TECHNICAL FIELD**

The present invention relates to a self-supporting cable.

5 BACKGROUND

It is known from prior art to make aerial cables self-supporting by using separate supporting elements. These could for example be a separate messenger wire of steel. This wire could be mounted along the cable as illustrated in
10 the European patent EP0461794. The cable could also be twisted around the messenger wire in a spiral.

It is also known to provide cables of improved tensile strength by embedding supporting elements in the cable insulation as described in US patent 4,956,523.

15 A disadvantage of using these supporting elements is that the cables become expensive to produce. A cable with a supporting element also becomes heavier and for steel messengers there is often a demand that the messenger wire should be grounded for safety reasons which complicates the
20 mounting in cable fixing points.

An electrical cable comprises one or several conductors that are made out of aluminum or copper. One solution is therefore to let the conductor itself act as the supporting element.

25 The conductors are normally surrounded by a plurality of different layers or shields, conductor shields, insulation shields, screen etc. If the different layers and/or conductors within the cable are not adhered to each other it becomes easy to bend the cable as the layers/conductors can
30 stretch and slip relatively each other. This slippage is however undesirable for self-supporting cables. To overcome the slippage an inwardly directed radial pressure force to

the cable in the cable fixing points can be applied so that the slippage is avoided. This force needs however to be very strong and has the disadvantage of damaging the outermost layers of the cable.

5 A solution to avoid the slippage is to simply make the different layers/conductors adhere to each other (for example by gluing or melting) . This has however the disadvantage that the cable will become difficult to bend and it will also be very difficult to separate the different
10 layers/conductors from each other without damaging the cable when jointing or terminating.

In US patent 6,288,339 layers with undulations are disclosed. This solution has the effect that the layers can slip relative each other to some extent when the cable is
15 bent, but in response to a relatively low inwardly directed radial pressure force the undulated layers cam into each other whereby the slippage is avoided. However, the flexibility becomes somewhat limited for large dimension cables .

20 SUMMARY

It is the object of the invention to obviate at least some of the above disadvantages and to provide an improved self-supporting cable.

The problems and disadvantages are in the invention solved
25 by an intermediate portion in the cable positioned between the outer surface of an inner portion {e.g. a core with conductors) and the inner surface of an outer portion (e.g. a shield and/or a sheath) and where the intermediate portion comprises at least one tape made of a non-woven material and
30 comprising friction particles adhered to at least one side of the tape and where the friction between the friction particles and any of the two surfaces is allowing the two surfaces to slip relatively each other in longitudinal

direction enough so that the cable can be bent but prevents the two surfaces from slipping in response to an inwardly directed radial pressure force at cable fixing points.

5 The tension forces and the gravitational force acting on the cable between said fixing points can now be transmitted into the conductors and the cable will become self-supporting.

As an option, the intermediate portion is further arranged so that in response to an outwardly directed radial force applied to the outer portion, the outer portion can easily
10 be separated from the inner portion.

An advantage with the invention is that the cable is both easy to bend and can be mounted in cable fixing points such as dead end spirals without slippage between the layers. This applies also to large diameter cables.

15 Another advantage is that the orientation of the structure of the intermediate portion is not critical which makes the cable easier and less expensive to produce.

Yet another advantage is that the intermediate portion also reduces vibrations and oscillations when the cable is
20 subject to strong winds.

The invention will now be described in more detail and with preferred embodiments and referring to accompanying drawings .

BRIEF DESCRIPTION OF THE DRAWINGS

25 Figures 1a and 1b are block diagrams illustrating a radial and a longitudinal cross section of one embodiment of a cable according to the invention.

Figures 2 and 3 are block diagrams illustrating a longitudinal cross section of two additional embodiments of
30 a cable according to the invention.

Figures 4a and 4b are block diagrams illustrating a bent cable and a cable subject to an inwardly directed radial pressure force.

Figures 5a, 5b and 5c are block diagrams illustrating three
5 embodiments of the intermediate portion.

Figure 6 is a block diagram illustrating a longitudinal cross section of a cable according to the invention with a separated outer portion.

Figure 7a is a block diagram illustrating a 3-core high
10 voltage power cable comprising the present invention.

Figure 7b is a block diagram illustrating a 1 kV power cable comprising the present invention.

Figure 8 is a block diagram illustrating a cable fixing point .

15 DETAILED DESCRIPTION

Figures 1a and 1b illustrates a radial and a longitudinal cross-section of a cable 100 according to the present invention. The cable 100 in Figures 1a and 1b comprises an inner portion 110 with an outer surface 112, an outer
20 portion 120 with an inner surface 121 and an intermediate portion 130. The inner portion 110 comprises one or several conductors 111. Each conductor 111 often consists of a plurality of metal wires 115 (normally aluminum or copper) . The inner portion 110 and the outer portion 120 can consist
25 of one or several layers of different types, plastic isolating layer, metal shield, semi conductive shield, sheath etc. An example on a cable 200 with an outer portion 210 comprising a metal shield 211 and a plastic layer 212 is illustrated in Figure 2. The plastic layer 212 has
30 penetrated between the wires of the metal shield 211 by melting in the extrusion process.

The embodiments of the invention illustrated by Figures 1a, 1b and 2 comprise only one intermediate portion 130. The inventive concept is however not limited to one intermediate portion 130 only but several intermediate portions can be used. This is illustrated in Figure 3. What in Figure 2 comprises a cable 200 with an outer portion 210 can in principle be regarded as the inner portion 310 of a cable 300 with yet another intermediate portion 330 and yet another outer portion 320.

10 The main principle of the invention is for example illustrated in Figures 4a and 4b. The intermediate portion 130 comprises a tape 411 with friction particles 412 on one of its sides. In Figures 4a and 4b the tape 411 is adhered to the surface 121 and the side with the friction particles 15 412 is facing the other surface 112. The friction between the friction particles 412 and the surface 112 is allowing the two surfaces 112, 121 to slip relatively each other in longitudinal direction enough so that the cable 100 can be bent (Figure 4a) but prevents the two surfaces 112, 121 from 20 slipping in response to an inwardly directed radial pressure force F at cable fixing points (Figure 4b). The tension forces and the gravitational force acting on the cable 100 between said fixing points can be transmitted into the conductors 111 and the cable 100 will become self- 25 supporting.

Three embodiments of the invention are illustrated in Figures 5a, 5b and 5c.

In a preferred embodiment illustrated in Figure 5a the intermediate portion 130 comprises a tape 511 adhered to the 30 inner surface 121 of the outer portion 120. On the tape 511 friction particles 512 are adhered to the side facing the outer surface 112 of the inner portion 110. The friction particles 512 are preferably sand-blasting sand that has been glued to the tape 511. Optionally, the band 511 is

adhered to the surface 121 by using an adhering tape 513 that has become adhesive on both sides in response to heating above a predetermined temperature (for example during the extrusion process of the outer portion 120). In
5 Figure 5a the friction is between the friction particles 512 and the outer surface 112 of the inner portion 110.

The same technical effect is obtained if the band 511 is adhered to the outer surface 112 of the inner portion 110 instead and where the friction particle 512 are adhered to
10 the side of the band 511 facing the inner surface 121 of the outer portion 120.

In Figure 5b the intermediate portion 130 comprises a first tape 521 adhered to the inner surface 121 of the outer portion 120 and a second tape 522 adhered to the outer
15 surface 112 of the inner portion 110. Friction particles 523, 524 are adhered to the sides of the tapes 521, 522 facing each other. Similar as in Figure 5a the friction particles 523, 524 are preferably sand-blasting sand that has been glued to the tapes 521, 522. The tapes 521, 522 are
20 optionally adhered to the surfaces 121, 112 using adhering tapes 525, 526. In Figure 5b the friction is between the two sides with friction particles 523, 524 that are facing each other.

In Figure 5c the intermediate portion 130 comprises a single
25 tape 531 that is not adhered to any of the surfaces 112, 121. Instead, friction particles 532, 533 are adhered to both sides of the tape 531. Here the friction is between the two sides with friction particles 532, 533 and the two surfaces 112, 121.

30 Again, the friction is low enough to allow the two surfaces 112, 121 to slip relatively each other in longitudinal direction enough so that the cable 100 can be bent but

prevents the two surfaces 112, 121 from slipping in response to the inwardly directed radial pressure force (F).

The band 411 with friction particles 412 further allows the outer portion 120 to be easily separated from the inner
5 portion 110 by applying an outwardly directed radial force S to the outer portion 120. This is illustrated in Figure 6.

Yet another feature of the invention is that the intermediate portion 130 also reduces vibrations and oscillations of the cable 100. Vibrations and oscillations
10 can occur when the cable 100 is subject to strong winds and can cause the cable 100 to come loose from its fixing points. The frictional structure of the intermediate portion 130 reduces the vibrations and oscillations as it transforms the kinetic energy from the relative movement between the
15 two surfaces 112, 121 to thermal energy (heat) due to the friction.

Although the Figures 1 to 6 only illustrate cables with one conductor 111, the inner portion 110 of the cable 100 can comprise a plurality of conductors. Two examples of this are
20 illustrated in Figures 7a and 7b.

The cable 700 in Figure 7a is a high voltage AXCES type of cable for 12 kV where the inner portion comprises three conductors 701, 708, 709 made of aluminum. Around each conductor 701 an inner conductive layer 702 of polyethylene,
25 PE is extruded. Around the inner conductive layer 702 an insulation layer 703 of cross-linked polyethylene, PEX or XLPE is triple extruded. Around the insulation layer 703 a second conductive polyethylene layer 704 is extruded.

Around this inner portion, comprising the three conductors
30 701, 708, 709 each with its conductive and insulating layers 702, 703, 704, the intermediate portion 705 is mounted. For high-voltage cables, the intermediate portion 705 can be conducting. The outer portion comprises screen wires or foil

normally of copper or aluminum (not shown) wrapped around the intermediate portion 705. Finally, a black LLD PE (linear low density polyethylene) sheath 706 is extruded over the screen.

5 The cable 710 in Figure 7b is a N1XE type of cable for 1 kV with four conductors 711, 717, 718, 719. As this cable 710 is made for lower voltage the dimensions of the conductors 711, 717, 718, 719 are smaller. The four conductors 711, 717, 718, 719 can for example be of solid round copper (as
10 in Figure 7b), stranded round copper or of stranded sector shaped aluminum depending on cross section area. In this cable 710, the inner portion comprises the four conductors 711, 717, 718, 719 each having an insulation layer 712 of cross-linked polyethylene. Around the four conductors 711, 717, 718, 719 an inner covering 713 is extruded. Around this
15 inner covering 713 the intermediate portion 714 is mounted and the outer portion of the cable comprises a black polyethylene sheath 715 extruded over the intermediate portion 714.

20 An example of a cable fixing point used for self-supporting cables is a so called dead end spiral. An example of a dead end spiral is illustrated in Figure 8. In the fixing point 800, a metal wire 810 is twisted around the cable 100 in a spiral 811. The other end of the wire 810 is fixed to a pole
25 820. In order to not damage the outer layers of the cable 100 in the fixing point 800, the radial pressure forces F applied to the cable 100 must be relatively low. Therefore the spiral 811 extends up to two meters along the cable in order to distribute the radial pressure forces F to the
30 cable. By applying relatively weak forces F to a cable 100 according to the present invention, tension forces T and the gravitational force G acting on the cable 100 are transmitted into the conductors 111 without slippage between the layers in the cable 100.

Although the embodiments described above mainly address electrical cables, the inventive concept can also be used for optical cables having an inner portion with a sufficient mechanical strength that allows the cable to be self-supporting.

5

CLAIMS

1. A self-supporting cable (100) comprising
- an inner portion (110) comprising at least one conductor (111) ;
 - 5 - an outer portion (120);
 - an intermediate portion (130) positioned between the outer surface (112) of the inner portion (110) and the inner surface (121) of the outer portion (120) and where the intermediate portion (130) comprises at least one tape (511)
 - 10 made of a non-woven material and comprising friction particles (512) adhered to at least one side of the tape (511) and where the friction between the friction particles (512) and any of the two surfaces (112,121) is allowing the two surfaces (112,121) to slip relatively each other in
 - 15 longitudinal direction enough so that the cable (100) can be bent but prevents the two surfaces (112,121) from slipping in response to an inwardly directed radial pressure force (F) at cable fixing points (800) so that tension forces (τ) and the gravitational force (G) acting on the cable (100)
 - 20 between said fixing points (800) can be transmitted into the conductors (111) wherewith the cable (100) becomes self-supporting by virtue of the intrinsic mechanical strength of the conductors (111).
2. A cable (100) as in claim 1 where the intermediate
- 25 portion (130) comprises a first tape (511) with friction particles (512) and adhered to one of the two surfaces (112, 121) and where the side with the friction particles (512) is facing the other surface (112, 121).
3. A cable (100) as in claim 1 where the intermediate
- 30 portion (130) comprises a first tape (522) with friction particles (524) and adhered to the outer surface (112) of the inner portion (110) and a second tape (521) with

friction particles (523) and adhered to the inner surface (121) of the outer portion (120), and where the sides with the friction particles (523, 524) are facing each other.

4. A cable (100) as in any of the preceding claims where the
5 tape (511, 521, 522) is adhered to the surface (112, 121) by an adhering tape (513, 525, 526) that has become adhesive on both sides in response to heating above a predetermined temperature .

5. A cable (100) as in claim 1 where the intermediate
10 portion (130) comprises a tape (531) having friction particles {532, 533} adhered to both sides of the tape (531) .

6. A cable (100) as in any of the preceding claims where the
friction particles (512, 523, 532) consist of sand-blasting
15 sand that has been adhered to the tape (511, 521, 531) by gluing .

7. A cable (100) as in any of the preceding claims where the
structure of the intermediate portion (130) is further
arranged so that in response to an outwardly directed radial
20 force (s) applied to the outer portion (120), the outer portion (120) can be easily separated from the inner portion (110) .

8. A cable (100) as in any of the preceding claims where the
frictional structure of the intermediate portion (130) is
25 adapted to transform kinetic energy to thermal energy when the two surfaces (112,121) move relative each other.

9. A cable (100) as in any one of the preceding claims being
an electrical cable and where the conductors (111) comprise
at least one metal wire (115) .

1 / 8

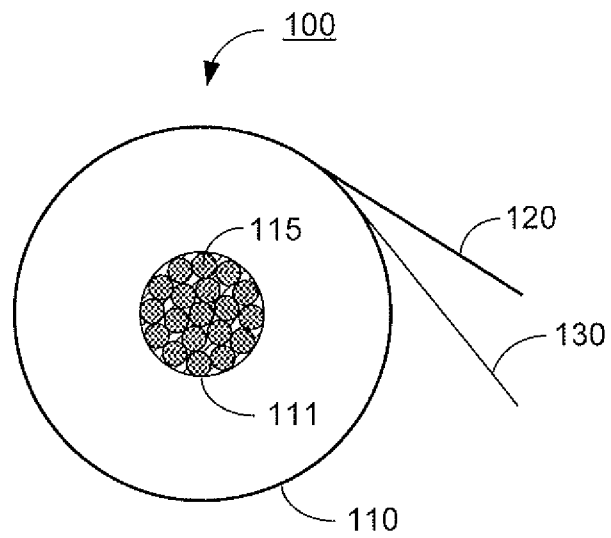


Figure 1a

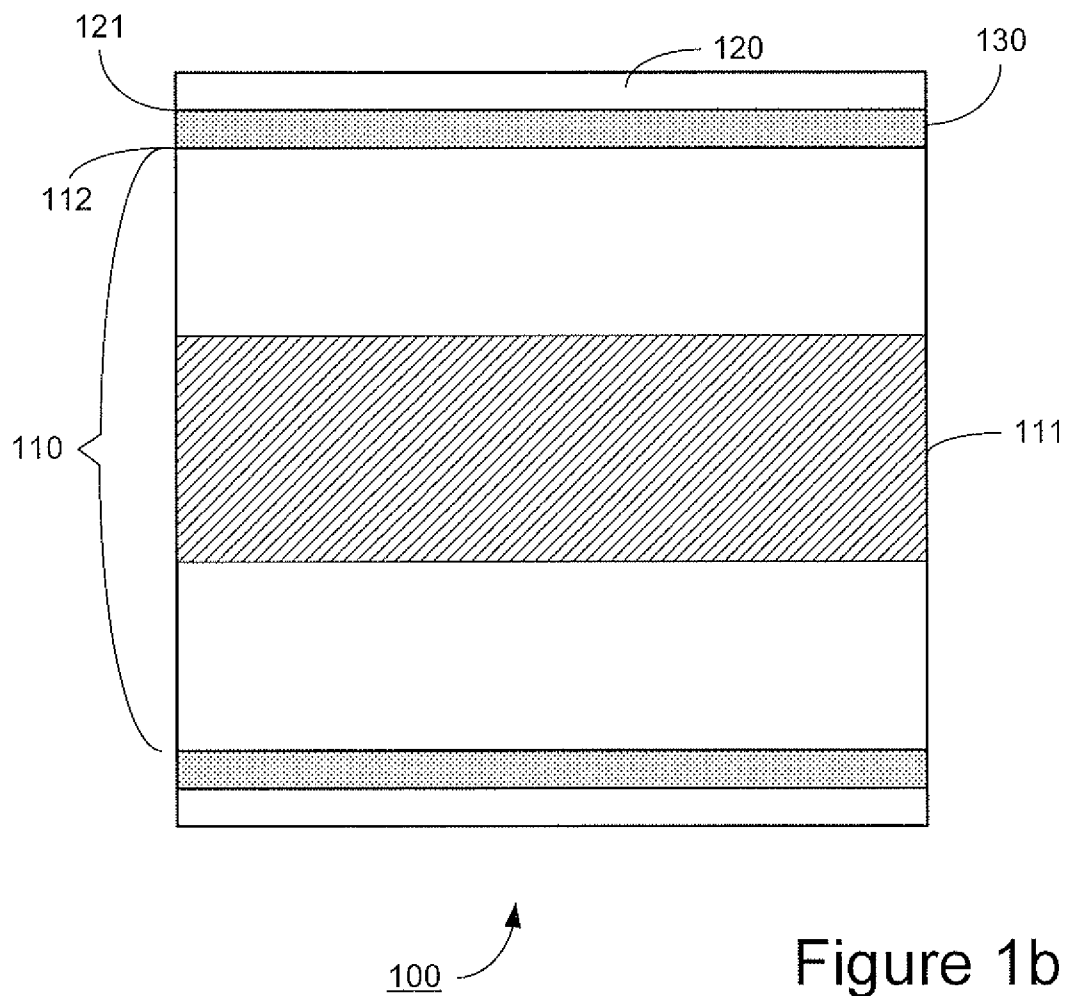


Figure 1b

2 / 8

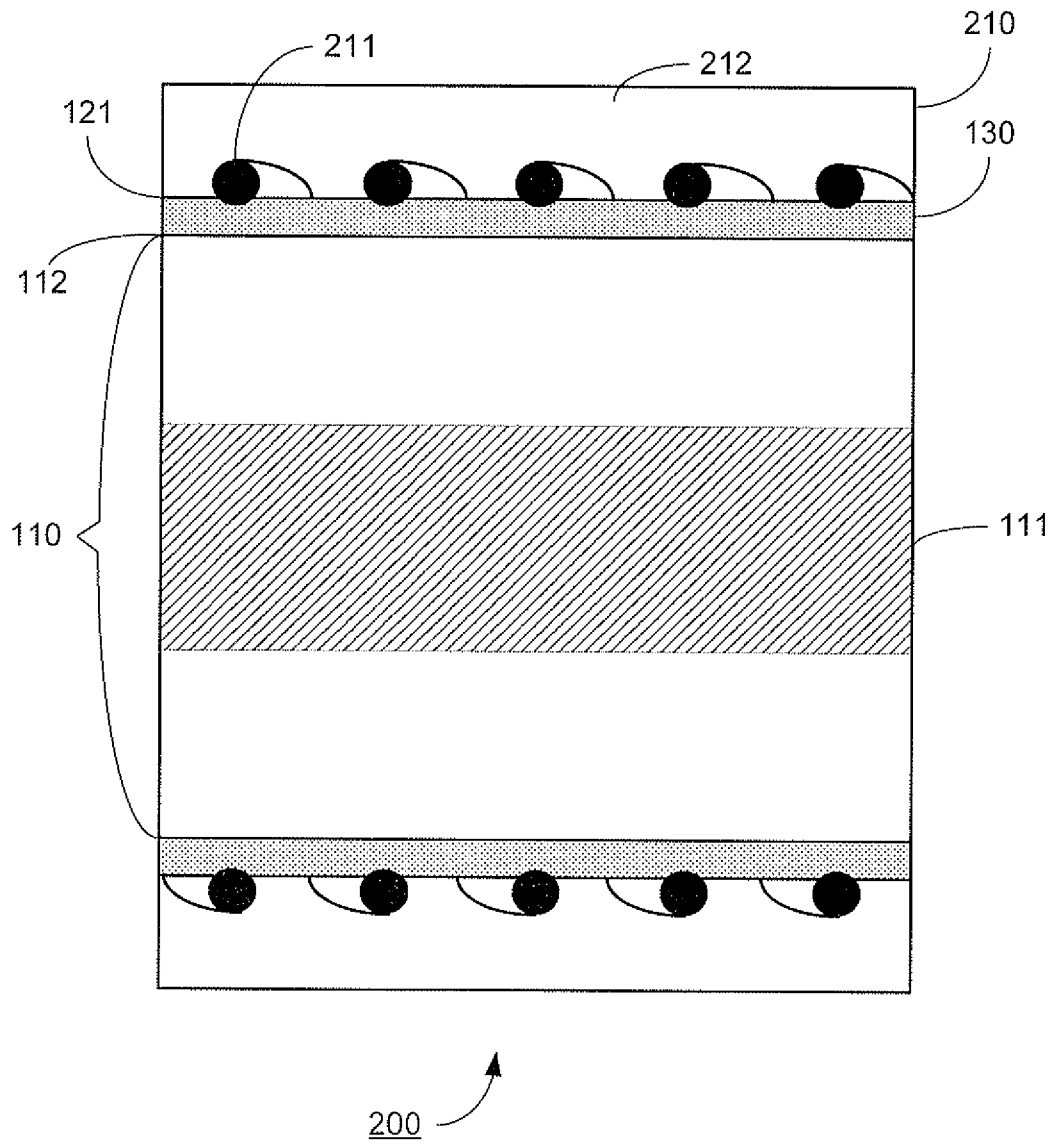


Figure 2

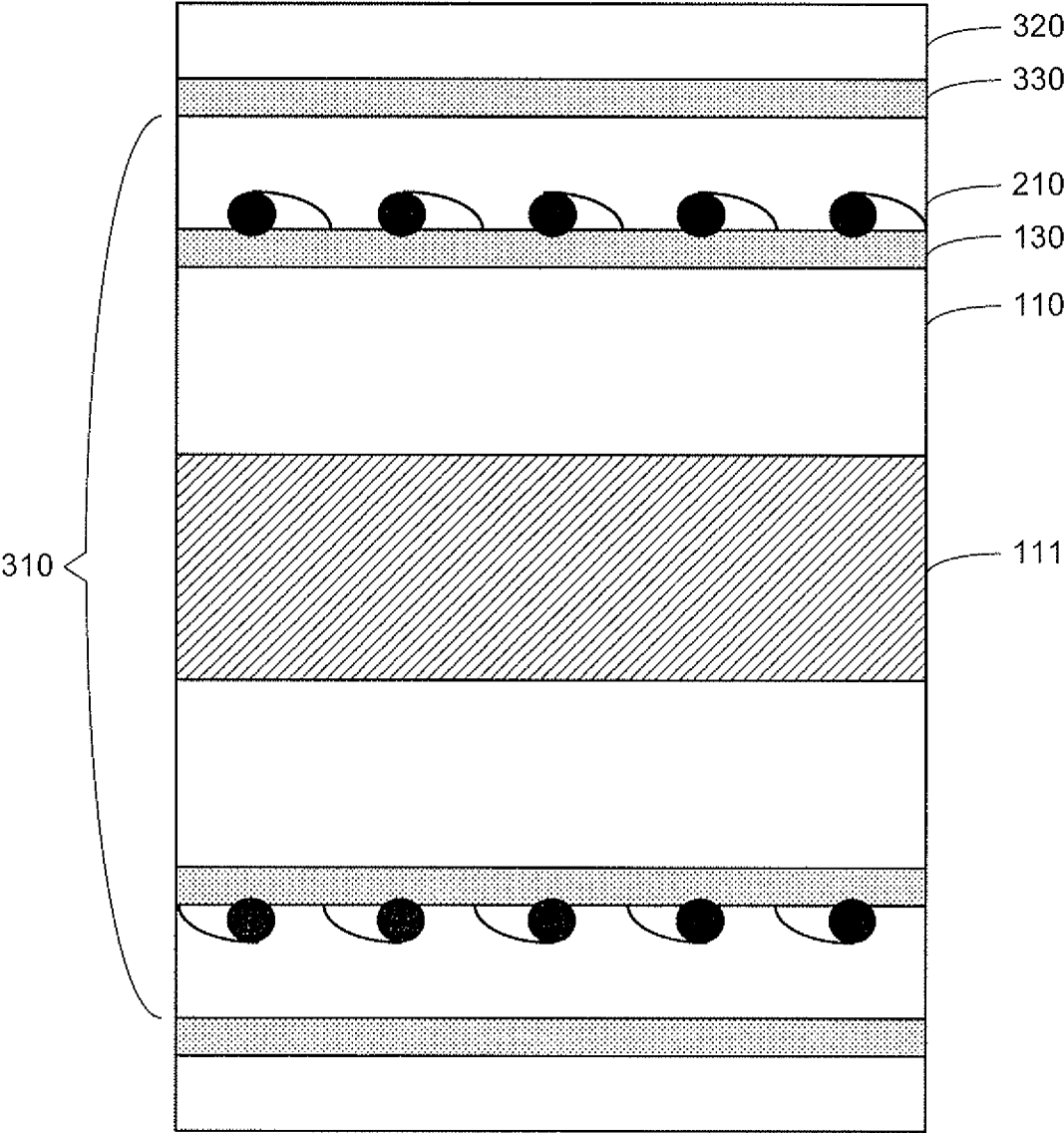


Figure 3

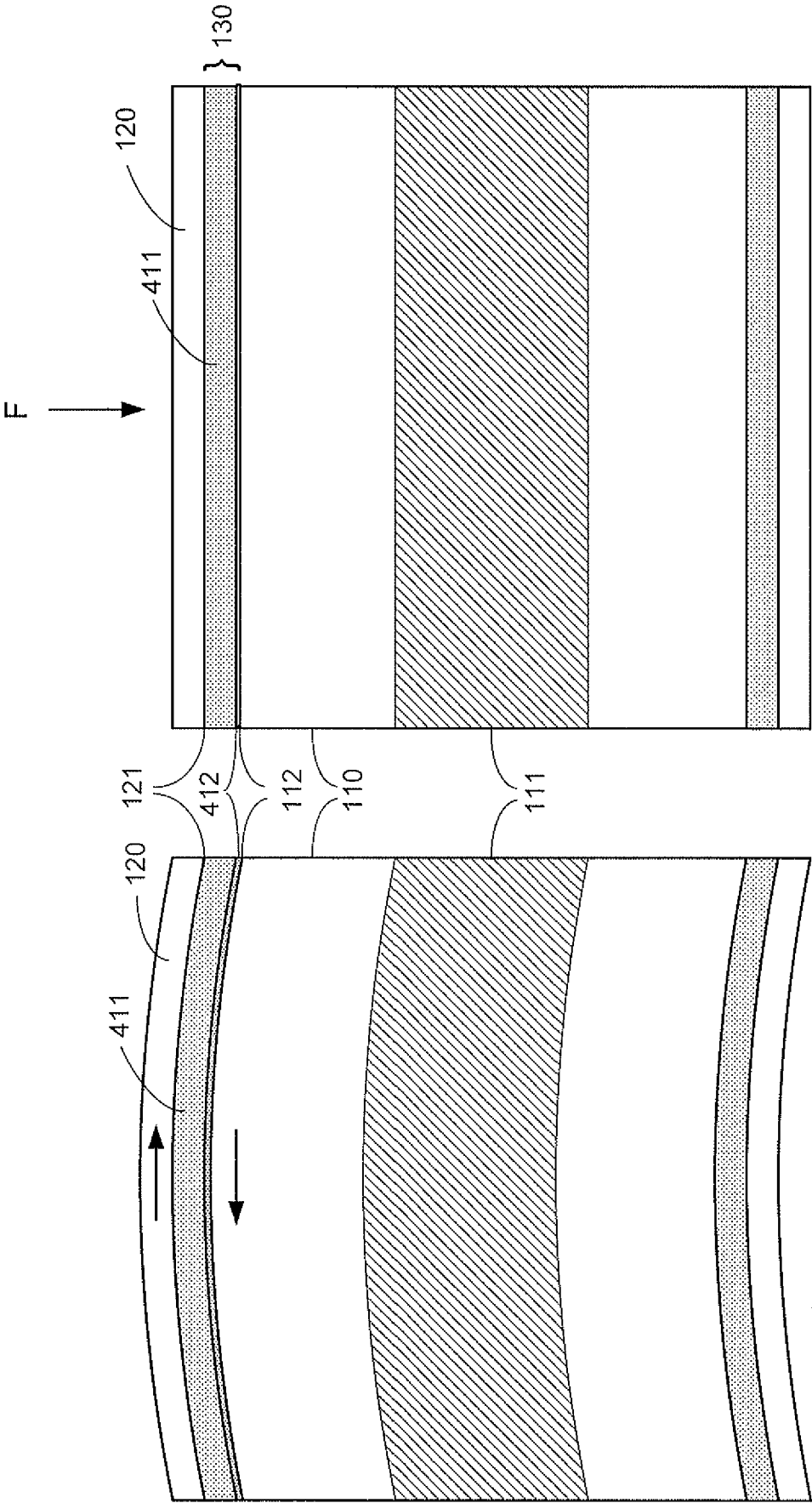


Figure 4a

Figure 4b

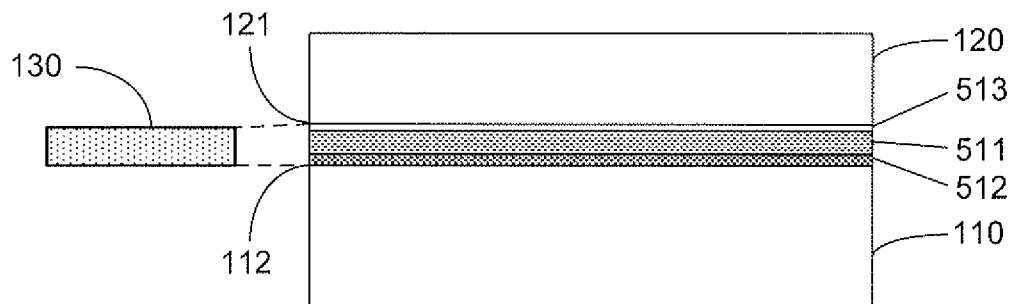


Figure 5a

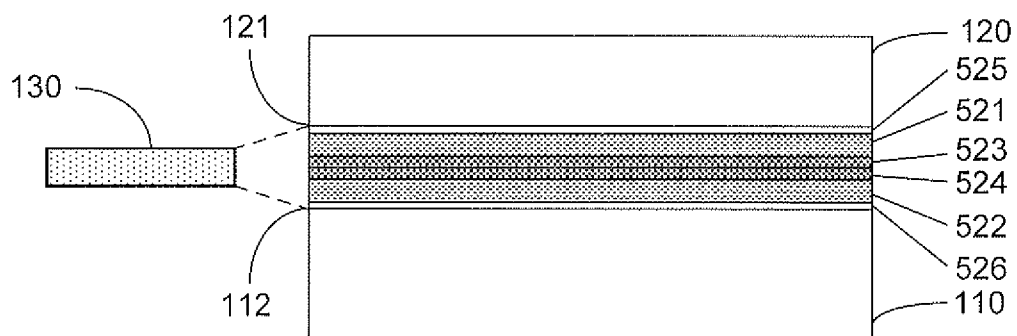


Figure 5b

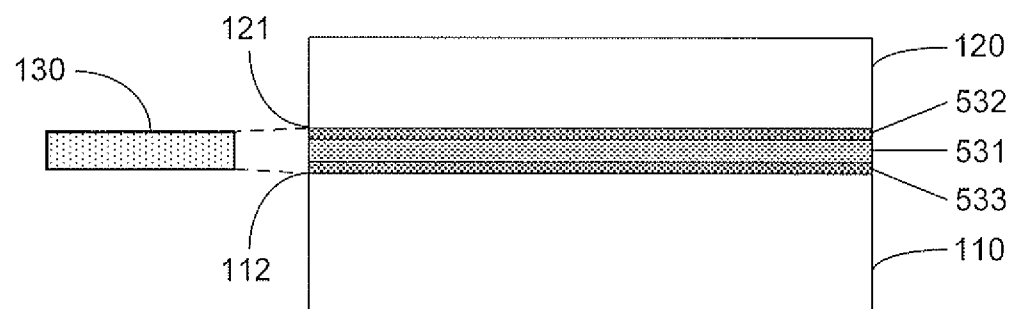


Figure 5c

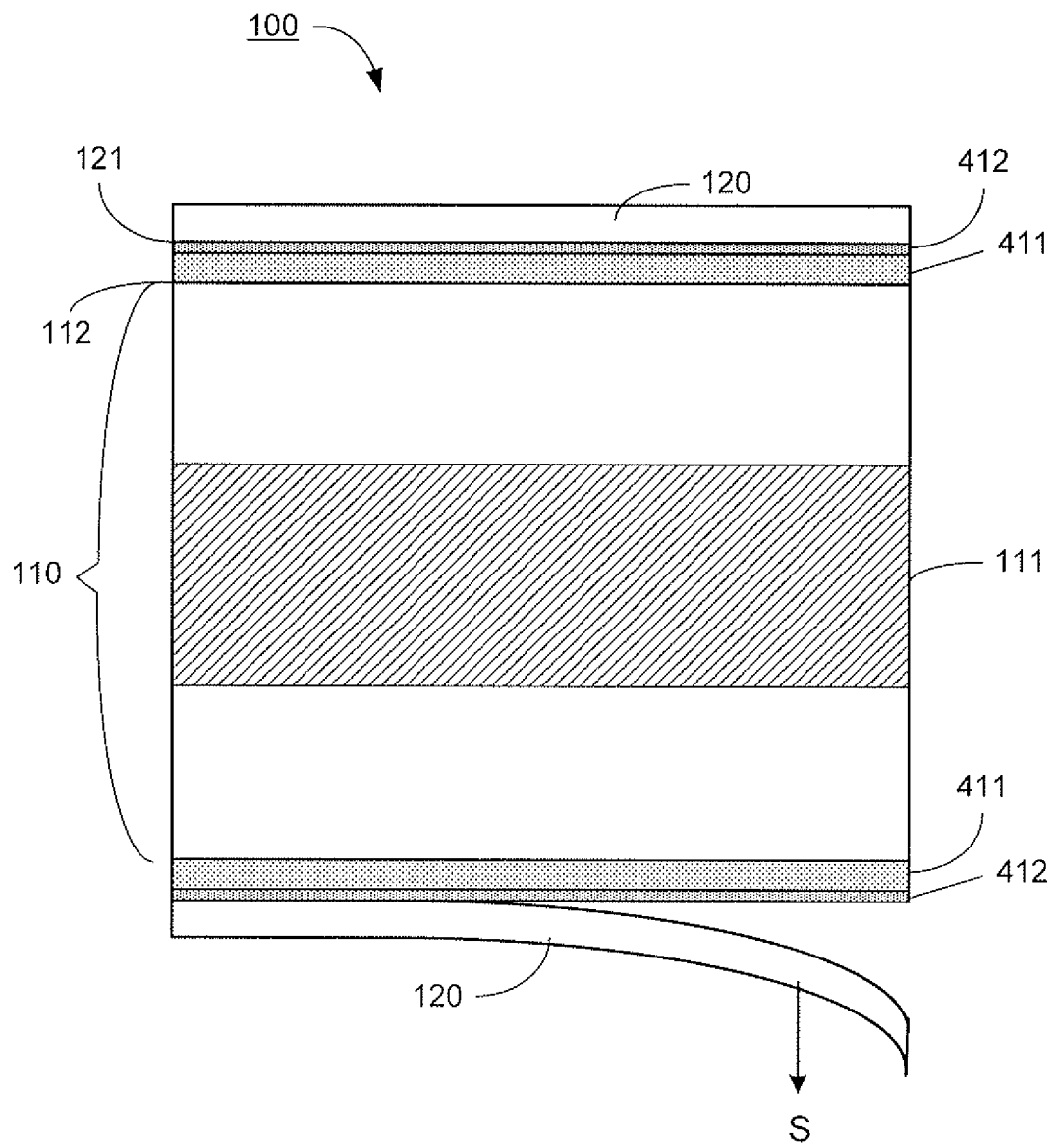


Figure 6

7 / 8

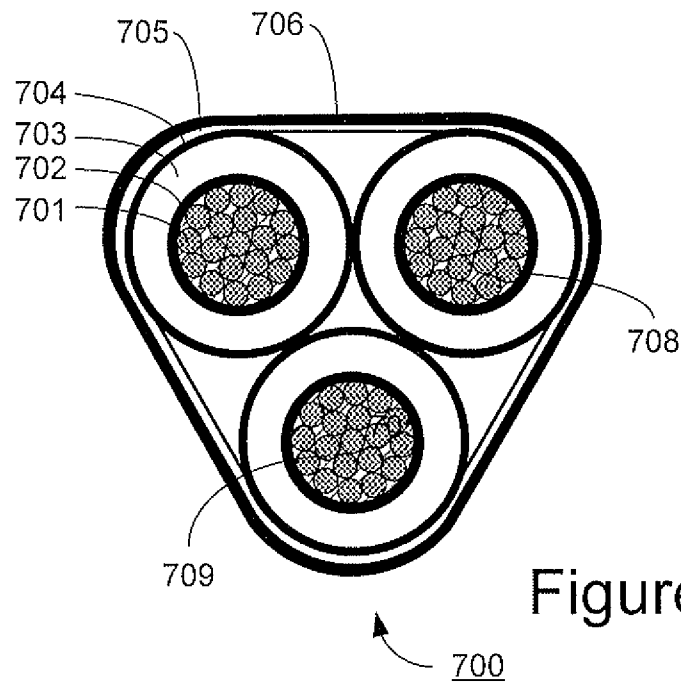


Figure 7a

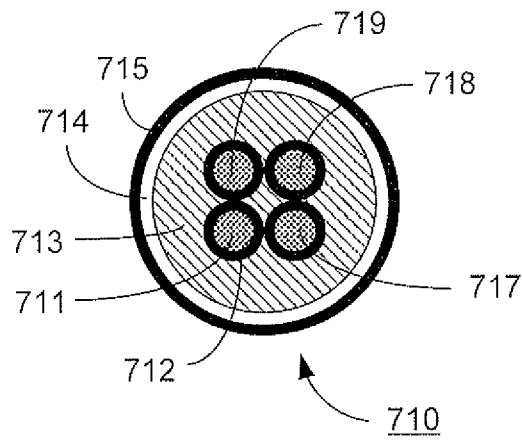


Figure 7b

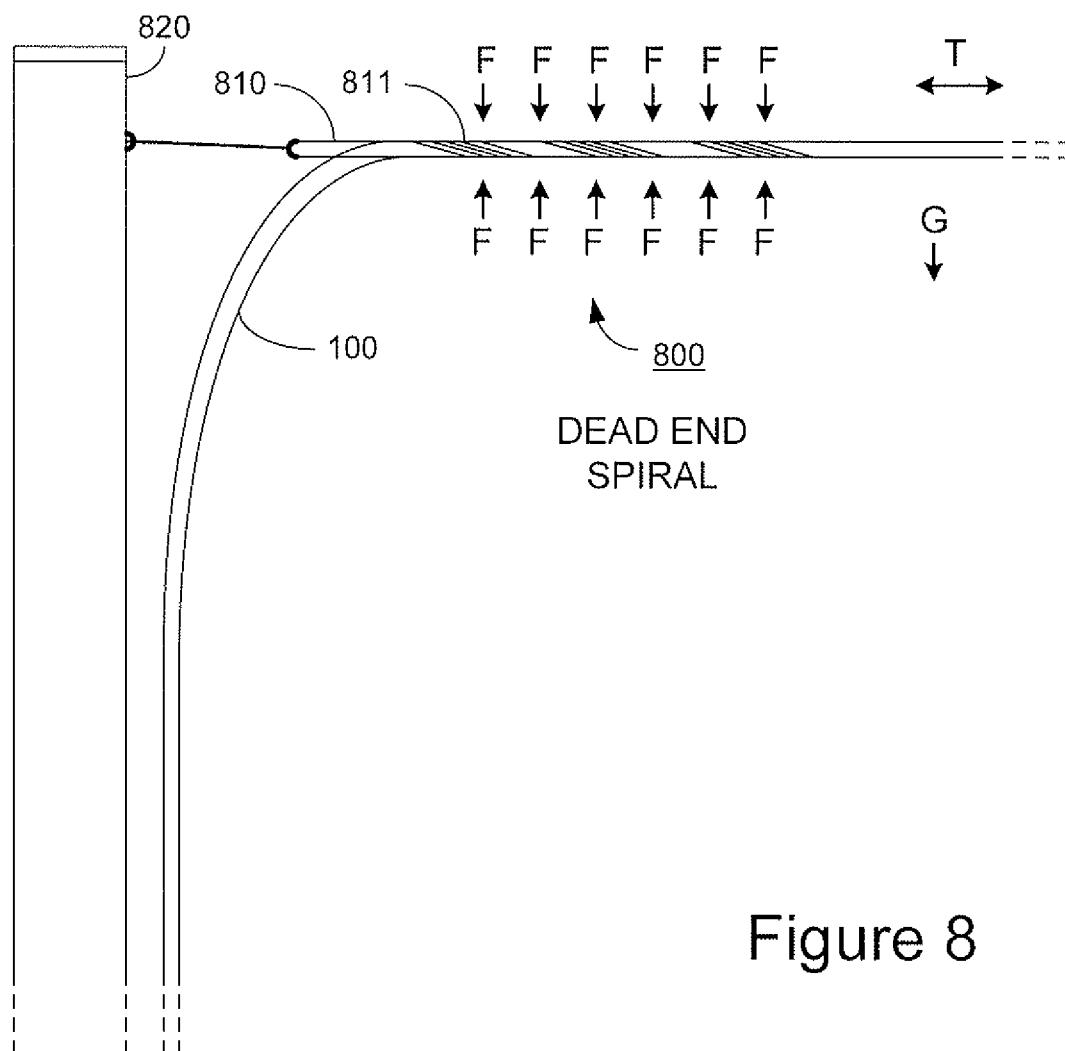


Figure 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE201 0/050789

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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: H01 B

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

SE, DK, FI, NO classes as above

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

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6288339 B 1 (EFRAIMSSON LARS-OLOF ET AL), 11 September 2001 (2001-09-11); abstract; figure 3 --	1-9
A	EP 0177475 A2 (KVAERNER SUBSEA CONTRACT AS), 9 April 1986 (1986-04-09); abstract -- -----	1-9



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

15-02-2011

Date of mailing of the international search report

15-02-2011

Name and mailing address of the ISA/SE

Patent- och registreringsverket

Box 5055

S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Magnus Westoo

Telephone No. +46 8 782 25 00

Continuation of: second sheet

International Patent Classification (IPC)

H01B 7/18 (2006.01)

Download your patent documents at www.prv.se

The cited patent documents can be downloaded:

- From "Cited documents" found under our online services at www.prv.se
(English version)
- From "Anforda dokument" found under "e-tjanster" at www.prv.se
(Swedish version)

Use the application number as username. The password is **FGEKKXIBKY**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE201 0/050789

US	6288339	B 1	11/09/2001	AT	203625	T	15/08/2001
				AU	271 9097	A	12/1 1/1997
				AU	714094	B2	16/1 2/1999
				CA	2252619	C	02/1 1/2004
				CN	12 16630	A	12/05/1999
				CN	1089934	C	28/08/2002
				DE	69705833	T2	04/04/2002
				EE	03359	B 1	15/02/2001
				EP	0895640	A 1	10/02/1999
				ES	2 160953	T3	16/1 1/2001
				GR	3036756	T3	31/1 2/2001
				HK	10 19814	A 1	17/04/2003
				HU	9901 753	A2	28/09/1999
				HU	222644	B 1	29/09/2003
				JP	20005091 88	T	18/07/2000
				NO	984897	A	04/1 2/1998
				NO	321 10 1	B 1	20/03/2006
				PL	329564	A 1	29/03/1999
				PL	182520	B 1	31/01/2002
				PT	895640	E	30/01/2002
				RU	2 183874	C2	20/06/2002
				SE	9601 538	L	24/1 0/1997
				SE	506366	C2	08/1 2/1997
				TR	98021 29	T2	21/08/2000
				WO	9740504	A 1	30/1 0/1997
EP	0177475	A2	09/04/1 986	AU	4793985	A	10/04/1986
				AU	577621	B2	29/09/1988
				BR	8504969	A	22/07/1986
				CA	1258038	A 1	01/08/1989
				CN	851 07230	A	10/03/1986
				CN	1008781	B	11/07/1990
				DE	3577226	D 1	23/05/1990
				DK	160898	B	29/04/1991
				DK	444785	A	05/04/1986
				ES	289850	U	01/03/1986
				JP	6 1091 804	A	09/05/1986
				JP	5070884	B	06/1 0/1993
				JP	1860913	C	27/07/1994
				NO	843991	A	07/04/1986
				NO	155826	B	23/02/1987