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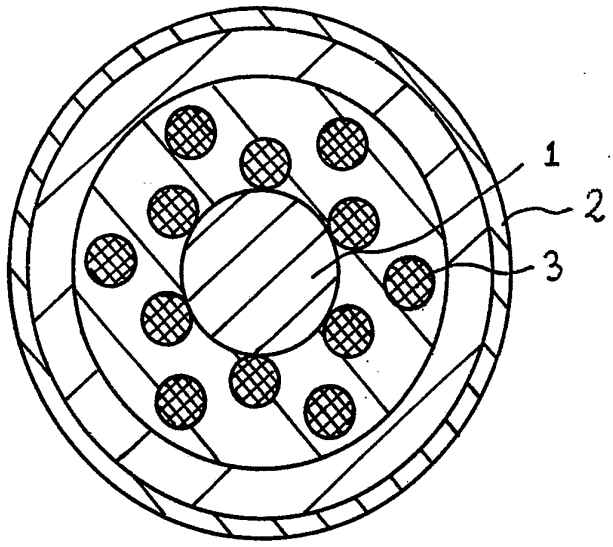

(57) Abstract

A towed streamer including buoyant core (1), and strength members (3) to transmit tension along the streamer. Strength members (3) are arranged so that the streamer is compliant for a predetermined elongation of the streamer. Members (3) are embedded in an inner jacket (5) surrounded by an outer jacket (6). The assembly is encased in an extruded outer jacket (2). Braided data bearers (4) can be provided between the inner jackets (5, 6). Strength members (3) can be braided with interstices impregnated with gel. Where the strength members (3) are of non-compliant material, the braid is initially compliant where the streamer is slightly elongated but becomes non-compliant as the streamer elongates further. Alternatively a combination of compliant (3) and non-compliant members (14) can be used where the compliant members (3) only become engaged after a predetermined elongation of the streamer.

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VIBRATION ISOLATION MODULES (VIM) FOR TOWED ARRAY STREAMERS

BACKGROUND OF THE INVENTION

This invention relates to the construction of towed streamers suitable for use as vibration isolation modules and the method of manufacture of such towed sections.

Streamers are generally of one of two types. One such type are liquid filled and have been used as a prior art, and generally have strength members, the pay load and data transmission means within a liquid core with a jacket encapsulating these components. Such streamers are generally less robust than streamers of a generally solid nature.

Towed streamers usually comprise an elongate buoyant streamer having spaced along its length the required payload. Streamers are generally made from several shorter modules which are joined together to form the full length, and the modules used along the length have varying structures and are designed to perform different functions. The reason for positioning more than one type of module along the length of the streamer is in part because prevailing ambient conditions and forces associated with towing vary along the length.

Towed streamers are usually of considerable length and are subject to quite high towing strains and are consequently provided with rigid, high tensile or non-compliant strain members longitudinally to transmit tension along the streamer.

It is necessary for towed streamers to be constructed to withstand towing tensions whilst also allowing sufficient flexibility for winching onto a bollard or the like and problems are generally encountered in maintaining the spacing and/or position of strength members during such winching.

When using towed streamers consisting of a towing section, active section and tail sections, vibrational energy is generated from both the towing and the tail end. The forward end energy arises from ships' motor, machinery and propeller vibration, and flow induced vibration from normal and tangential flow over the towing section. The tail end energy arises from tangential and

normal flow over the tail end sections, especially where the tail end is attached to a surface buoy. Where the tail has a free end, vortex sledding from the tail produces lateral motion which translates into axial vibration.

The vibration energy is picked up by the sensors in the active section of the streamer, from two mechanisms (a) physical movement of the sensor and (b) through pressure generated in the fluid which normally surrounds the sensor.

Towed streamers by their nature are deployed from and recovered into the towing vessel and the usual method is to stow the streamer on a winch. This provides a compact method of stowing the streamer. The recovery cycle can be achieved by directly winching the streamer onto the drum or by detensioning the streamer prior to stowage on the drum. If short recovery times are to be achieved, it is essential that all streamer sections are robust and are capable of being stowed on the winch under tension.

One aspect of this invention is that the towed streamers can be deployed and recovered during streamer operations at a load which permits the towing vessels to proceed slowly, rather than have to stop, during recovery. This is a major advantage if several streamers are towed from a single vessel. Recovery of the VIMs can be achieved by direct winching or by a combination of direct winching and some form of detensioning unit. This is in contrast to other forms of VIM, such as liquid filled VIMs, which have very little capability in regards to mechanical winching.

In addition to the features already mentioned it is necessary to be able to transmit data to the towing vessel from the sensors through the towing section in all cases and where a tall buoy is attached, it may be necessary to communicate data to and from the tall buoy.

Active sections of the towed streamer are generally designed to be towed horizontally, this being achieved by ensuring that the density is close to being equal to that of the water. It is also preferably that the towing sections close to, both fore and aft of the sensor section are also close to neutral buoyancy to reduce the effects of cross flow and thus limit vibrational noise generation.

A further requirement for the tow section may be to depress the active section to the required working depth. This can be achieved by attaching a heavy

body to the tail end of the tow section, or body with planes attached which can be angled to provide a downwards force or if necessary an upwards force in special circumstances. Alternatively the depression can be achieved by using a heavy tow section which has a density greater than water.

In some applications it is necessary that the streamer is operated in two modes, an operational mode where the streamer is towed at a relatively slow speed to allow data to be gathered by the active sections, and a sprint mode where the streamer is towed at a high speed to enable the tow ship to transit rapidly between operational areas.

The main problem with the high speed mode is that excessive elongation of the towing sections can occur thus imposing strain on the data carriers.

Generally therefore such towed streamers are provided with high tensile, non-compliant strength members extending longitudinally to transmit tension along the streamer. However a problem with the use of such non-compliant strain members is that whilst their rigidity is satisfactory for taking towing strain, the rigidity amplifies undesirable noise especially during the operational mode.

SUMMARY OF THE INVENTION

One object of this invention is to provide a towed streamer that will obviate or minimize any one or more of the disadvantages of streamers of the prior art in a simple yet effective manner or at least provide the public with a useful choice.

It is a further object of this invention to reduce the vibrational energy at the sensors by damping the energy in the tail or the towing sections, whilst still retaining the ability to withstand a load. This damping can achieved by the use of highly damped load bearing members in the tail of towing sections which also have a low elastic modulus, which makes such sections elastic when compared with the active section. The difficulty with this however is that if a load is applied as for example in the sprint mode, the towed streamer elongates far more than the data bearers are designed to withstand and this difficulty is more evident with towing modules rather than with the trailing modules.

The above objects can be met in solid towed streamers having a buoyant core by providing the streamer with a strength means adapted to transmit tension

along the streamer which strength member is compliant to a predetermined level.

This enables for sufficient strength to be imparted for given sections of the towed streamer over the range of compliance required. Thus where a lesser strain is exhibited such as at the the trailing module of the streamer, the compliance can be far greater than for example the leading module of the streamer. In the former case the strain may be adequately transferred through compliant strain members, and thus for example, nylon strain members might be used. In the latter case however it might be desired to use a combination of compliant members and non-compliant members. For example the compliant and the non-compliant strain members might be arranged longitudinally along the streamer, the non-compliant members being for example accommodated within a groove and able to move relative to the groove, so that in a resting position the non-compliant members might have some slack, which slack determines the extent to which the compliant members can stretch before the more rigid non-compliant strain members take up the strain.

Braiding of the strain members whether of compliant or non compliant material can also meet the object of this invention. In this form the strain members can be braided around the centrally located core. The strength members are braided to surround the core, and can themselves be enveloped by a layer of resilient material. Once a predetermined amount of elongation of the streamer occurs individual strength member becomes less compliant.

The extent of the non-compliance of such a braided arrangement can depend to some extent on the nature of the core. Thus where an easily deformable core is made the angle to which the braid strain members move will be somewhat greater than where a less deformable core exists so that individual strain members making up the braid will act frictionally upon adjacent members to co-operatively cause the braid to become non-compliant. The extent to which the streamers can be stretched before the non-compliant state is reached is dependent *inter alia* on the angle of the braid relative to the longitudinal axis of the streamer.

Thus if very compliant members are desired strain members of a compliant material, for example nylon, can be used and braided, so that once the braiding contacts the buoyant core the strain means is still relatively compliant, if

compared to more rigid strain members such as might be formed from material such as that sold under the trade mark KEVLAR or sold under the trade mark VECTRAN.

Preferably in the above embodiments the strength members are embedded within a solid layer of the streamer. It is however also possible to have such strain members within a gel filled layer. Such a gel filled layer can for example be positioned surrounding a central buoyant core and encased by an elastomeric inner jacket, which inner jacket is surrounded by an outer jacket. The non-compliant strength members are positioned within gel filled layer and around the buoyant core. In this way the non-compliant strength members can be positioned so as to have some slack when the streamer is in its resting position. Compliant strength members can be arranged to lie parallel with the non-compliant strength members to take the lower range of strain.

The invention also include a construction where axially non-compliant and compliant members are incorporated into the streamer section by the use of controlled tensions during the laying operations.

The invention also includes streamer sections whereby the load is required to be carried by different members as the speed of the streamer is varied.

It can be understood that by applying excessive strain to compliant members prior to application of the non-compliant, high tensile members, the non-compliant members can be arranged to be off loaded during low towing loads.

The above feature makes these sections useful in preventing tow induced vibration reaching sections with motion sensitive sensors fitted.

In one form the invention could be said to reside in a towed streamer including an inner portion,

said inner portion including a central core 1, and strength members 3 positioned to transit tension along the streamer, arranged to render the streamer compliant for a predetermined elongation of the streamer,

said streamer including an outer jacket encasing the inner portion

BRIEF DESCRIPTION OF THE DRAWINGS

The actual construction of the streamer can be substantially varied but for a better understanding the invention will now be described with reference to preferred embodiments which will be described with reference to drawings in which:-

FIG. 1 is schematic cross-section of a first embodiment of this invention,

FIG. 2 is a plan view of the first embodiment with the layers successively stripped off,

FIG. 3 shows is a schematic cross-section of a second embodiment of the invention,

FIG. 4 is a plan view of the second embodiment with the layers successively stripped off,

FIG. 5 is a schematic plan view of the general layout of the third fourth and fifth embodiments of the invention, and

FIG. 6 shows a schematic cross section of the third embodiment in (a) the fourth embodiment in (b) and the fifth embodiment in (c).

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

Dimensions of certain of the parts as shown in the drawings may have been modified and/or exaggerated for the purposes of clarity of illustration.

The embodiments of the towed array streamer generally include a centrally located buoyant core 1 around which the rest of the streamer is built. The streamer is generally encapsulated by an outer jacket 2. Strength members 3 are arranged within the streamer to transmit tension along the length of the streamer. A data bearer layer is formed by data bearer wires 4 in some embodiments of the invention, but is not be present in all embodiments.

The buoyant core 1 is a lightweight component, and generally provides buoyancy. However for heavy tow section, the core can be made of a material with higher density. The material used to make this component can vary and might be a single polymer or a composite material can therefor vary in its modulus. Typical materials used are neoprene and thermoplastic rubber.

The strength members 3 can vary in their composition, and generally two types of strength members used in the illustrated embodiments. Non-compliant members are of a high tensile nature and can be made up of individual strands of a high tensile material such as materials known and sold under the Trade Marks KEVLAR, and VECTRAN. Such strength members have a few, for example three, strands twisted together, and then have several, for example sixteen, such twisted strands braided together to form a single strength member. Such non-compliant strength members might allow for a longitudinal elongation of, for example 4% of the length of the streamer, under conditions of high speed.

Compliant members can have a similar structure, but are made from a more compliant material such as nylon and can allow for much greater elongation for example greater than 10%, and obviously elongation of the strength member occur as a result of less tension than is required to elongate non-compliant member. The strength members being braided have interstices between individual strands, and these are impregnated with a gel. This gel filling prevents compression of the strength member.

The outer jacket 2 provides an abrasion resistant outer barrier which is also water impervious and prevents water from penetrating the cable. A suitable material for making the outer jacket is a thermoplastic polyurethane.

Referring specifically to the first embodiment, shown in FIG 1 and 2, strength members 3 are embedded within a first inner jacket 5, and a second inner jacket 6 surrounds first inner jacket. Data bearers 4 are embedded within the second inner jacket.

The strength members can take two forms, and in the first form high tensile strands are twisted and braided together to form a strength member as described above, however by using a larger number of twisted members, the high tensile strands form a generally cylindrical shape 7, the hollow of which is filled with cotton twine 8. Filling with a solid material like cotton twine prevents

the flattening of such a strength member on tension being applied, and thereby better maintains the relative position of the component layers of the streamer.

The strain members used in this first form are of a high tensile nature and if laid longitudinally provide a non-compliant transmission of tension along the streamer. The strain members in this embodiment however are braided, the braiding being such that on the application of strain the braid angle, relative to the longitudinal axis of the streamer, is decreased. The braided strength member therefore during initial elongation exhibits limited transmission of tension, and with increasing elongations, the strength members of the braid frictionally engage each other to an increasing extent and may compress against the core to an increasing extent. Thus the strength members are arranged to give variable compliance in response to the extent of elongation of the streamer. The characteristics of the extent of the variable compliance can be altered depending upon the braid angle and the number of strands in the braid.

The nature of the strands forming the strength member can also affect the tension transmission along the streamer. Thus in a second form of the first embodiment the more compliant nylon strands are used, and the overall compliance of the streamer is significantly increased.

The data bearers in this embodiment are also braided, and the angle and tightness of braiding is complementary to the braiding and compliance of the strength member braid in a way that provides that the data member braid is not put under strain on elongation of the streamer.

The method of making the first embodiment includes the forming of a core 1 of low density around which are overbraided strength members 3 filled with cotton twine. This is then gel-filled and has extruded over and around it a first inner jacket 5 of thermoplastic rubber. The data bearers 4 are braided around the first inner jacket and the second inner jacket 6 made of thermoplastics rubber is extruded over that assembly. The outer Thermoplastics Polyurethane jacket 2 is extruded over that assembly.

Referring now to the second illustrated embodiment as shown in FIG. 3 and 4, strength members 3 are embedded within a first inner jacket 5, and a second inner jacket 6 surrounds first inner jacket. There are no data bearers in this embodiment, and such an embodiment can be used for example in the tail

portion of the towed streamer.

The structure is thus quite similar to that of the first embodiment except that the braided strength members are not cotton fibre filled and are specifically based on nylon, as a material. The strength members like the strength members of the first embodiment are gel filled. This structure has similar compliance characteristics to the compliance characteristics of the second form of the first embodiment of the invention.

In this embodiment the streamer is made by extruding a thermoplastic rubber core 1 and overbraiding the core with Nylon braid cord 3. This is then gel-filled and then jacketed with the first inner jacket 5 by extrusion of the jacket and then the second inner jacket 6 with the outer Thermoplastics polyurethane jacket 2 being extruded over the second inner jacket.

The embodiments shown in FIGS. 5 and 6 have the cross sectional structure as one another except that the core structure varies. Generally, therefore a core 1 is surrounded by a braided data bearer 4 layer. The braided data bearer layer is gel filled to form a gel-filled layer. The gel filled layer is paper wrapped; having a strip of paper 9 wound helically over the gel filled layer. Compliant strain members 10 are positioned longitudinally along the streamer, and are positioned to transmit tension along the streamer, and a thermoplastics rubber inner jacket 11 is extruded over and around the compliant strength members. The whole streamer is encased by a thermoplastic polyurethane outer jacket 2, which jacket is extruded over the inner jacket.

In the third embodiment shown in FIG 6a, the core comprises a core tube 12 with a central hollow 13 which is gel filled. This core thus provides no non-compliant strength members, with tension being transmitted only by reason of the compliant strength members 10 within the inner jacket 11.

In the fourth embodiment shown in FIG 6b the core is again gel filled but having arranged therein a plurality of non-compliant strength members 14, laid longitudinally. In this embodiment then the non-compliant strength members are positioned so as to have some slack, so that on a predetermined elongation of the streamer, these non-compliant strength members become engaged. The gel filled core isolates the tension transferred along the strength members from the layers outside of the core 1.

Thus in the operational mode where the streamer is towed at relatively slow speed the non-compliant strength members are not engaged, and therefore vibrations associated with strength members are damped by reason of the compliance of the compliant strength member 10.

In the fifth embodiment shown in FIG 6c the core 1 includes a fluted central member 15 with non-compliant strength members 14 laid within grooves of the fluted member. Braided over the fluted member is a polyfill cord 16, and this is simply to maintain the strength members 14 within the grooves.

Various features of the invention have been particularly shown and described in connection with the illustrated embodiments of the invention, however, it must be understood that these particular arrangements merely illustrate and that the invention is to be given its fullest interpretation within the terms of the appended claims.

Claims

1. A towed streamer including an inner portion,
said inner portion including a central core (1), and strength members (3) positioned to transit tension along the streamer, arranged to render the streamer compliant for a predetermined elongation of the streamer,
said streamer including an outer jacket (2) encasing the inner portion

2. A towed streamer as in claim 1 wherein the strength members are longitudinally aligned compliant strength members (10).

3. A towed streamer as in claim 1 wherein the strength members (3) include both compliant strength members (10) and non-compliant strength members (14), the non-compliant strength members being engaged only after a predetermined elongation of the streamer.

4. A towed streamer as in claim 5 wherein and the central core (1) includes a core tube (12) being filled with gel, and the non compliant strength members (14) are aligned within the central core.

5. A towed streamer as in claim 3 wherein and the central includes a fluted central member (15) forming a plurality of longitudinal grooves, and the non compliant strength members are aligned within the grooves.

6. A towed streamer as in claim 1 wherein the module includes a data bearer layer, and the data bearer layer is formed of braided data wires (14).

7. A towed streamer as in claim 1 wherein the strength members (3) are braided around the central core (1).

8. A towed streamer as in claim 7 wherein the strength members (3) are non-compliant.

9. A towed streamer as in claim 7 wherein the strength members (3) are compliant.

10. A towed streamer adapted for use as a vibration isolation module as in claim 7 wherein a data bearer layer is formed outside of the strength members and takes the form of a braided data bearer wires (14).

AMENDED CLAIMS

[received by the International Bureau on 22 December 1992 (22.12.92);
original claims 2 and 8 deleted;
remaining claims amended and renumbered as claims 1-8 (2 pages)]

1. A towed streamer including an inner portion,
said inner portion including a central core (1), and strength members (3) positioned to transit tension along the streamer, arranged to render the streamer compliant for a predetermined elongation of the streamer, and when the streamer is elongated beyond the predetermined elongation the strength member acts to render the streamer non-compliant,
said streamer including an outer jacket (2) encasing the inner portion.

2. A towed streamer as in claim 1 wherein the strength members (3) include compliant strength members (10) and non-compliant strength members (14), the non-compliant strength members being engaged only after a predetermined elongation of the streamer.

3. A towed streamer as in claim 2 wherein and the central core (1) includes a core tube (12) being filled with gel, and the non-compliant strength members (14) are aligned within the central core.

4. A towed streamer as in claim 2 wherein the central core includes a fluted central member (15) forming a plurality of longitudinal grooves, and the non compliant strength members are aligned within the grooves.

5. A towed streamer as in claim 1 wherein the module includes a data bearer layer, and the data bearer layer is formed of braided data wires (14).

6. A towed streamer as in claim 1 wherein the strength members (3) are braided with respect to one another and around the central core (1) so that after a predetermined elongation said strength members frictionally engage with one another and with the central core to render the streamer non-compliant.

7. A towed streamer as in claim 6 wherein the strength members (3) are compliant.

8. A towed streamer adapted for use as a vibration isolation module as in claim 7 wherein a data bearer layer is formed outside of the strength members and takes the form of a braided data bearer wires (14).

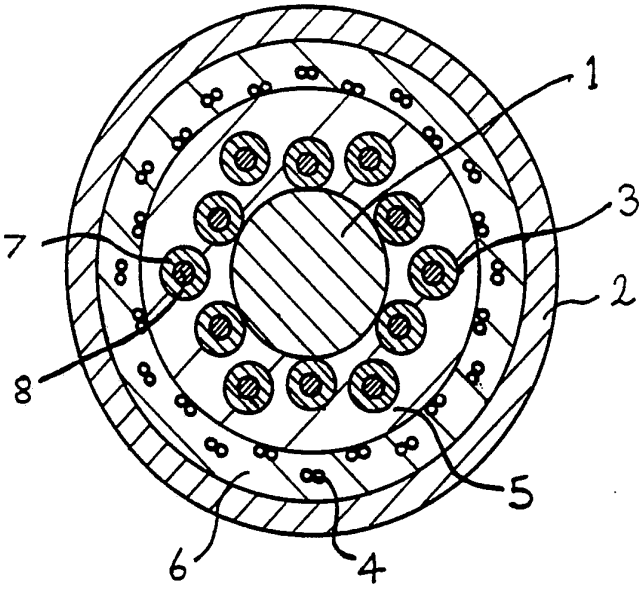

FIG 1

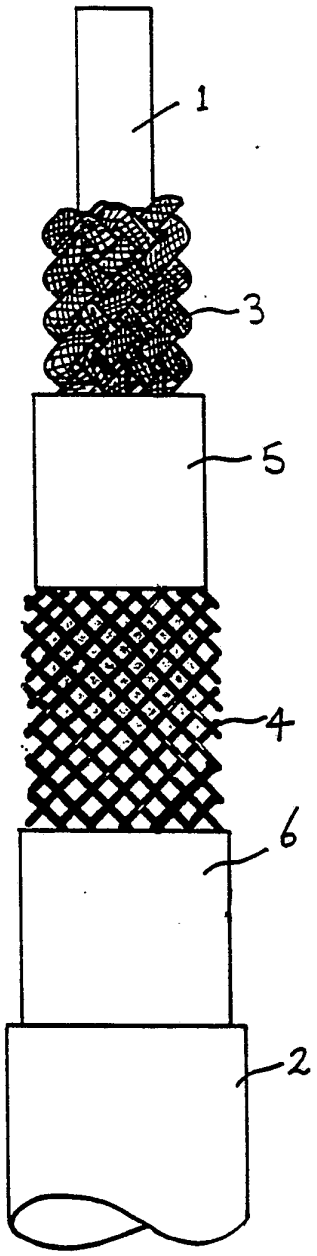

FIG 2

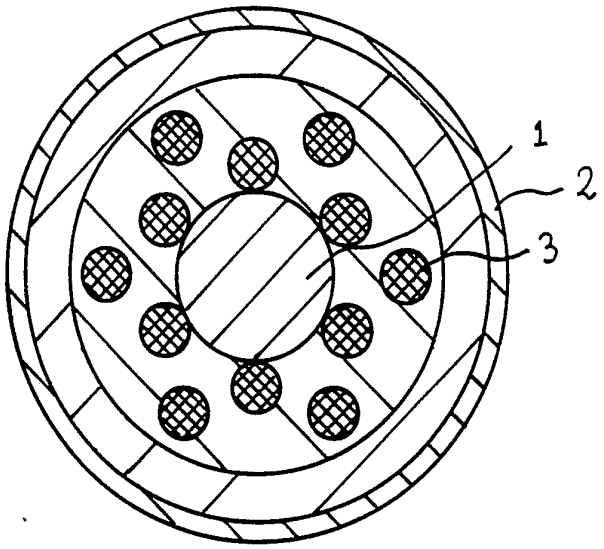

FIG 3

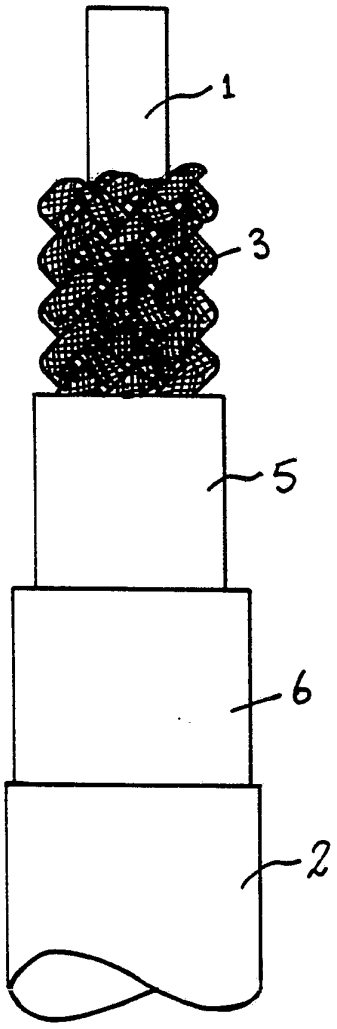

FIG 4

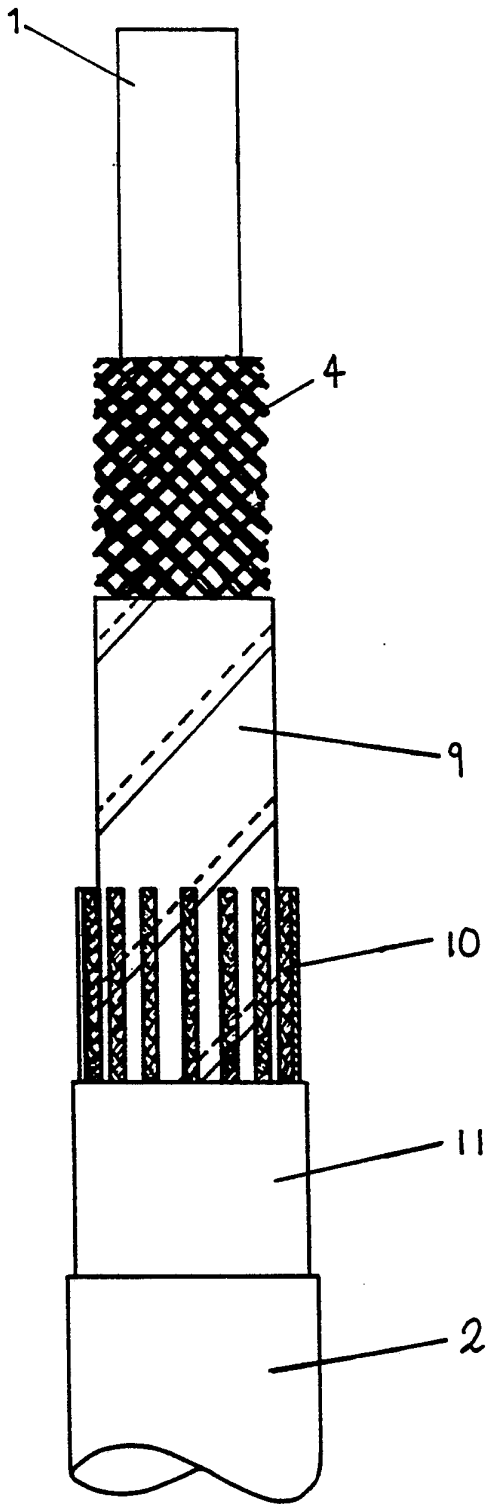

FIG. 5

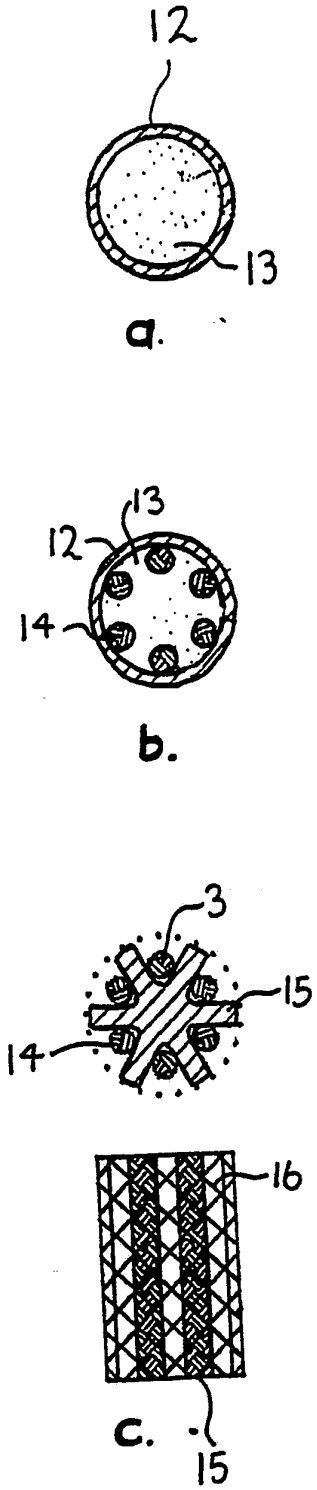

FIG. 6

INTERNATIONAL SEARCH REPORT

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

Int. Cl.[5] G01V 1/18, 1/38, H01B 13/32

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	G01V 1/18, 1/38, H01B 9/06, 13/32, H02G 15/20

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

AU : IPC as above, and H01B 7/12, 7/14, 7/16, 7/18, 13/22

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	AU,B, 87641/82 (554704) (COMMONWEALTH OF AUSTRALIA) 31 March 1983 (31.03.83) The whole document.	(1-10)
X Y	US,A, 4641288 (McGOWAN et al.) 3 February 1987 (03.02.87) Abstract; col.1 line 1-line 41, line 60 - col.2 line 37; col.3 line 43 - col.4 line 6; col.4 line 41-line 45, line 67 - col.5 line 16; claims; drawings.	(1-3,5) (10)
X Y	AU,B, 45319/89 (624447) (PLESSEY AUSTRALIA PTY LTD) 14 June 1990 (14.06.90) The whole document.	(1,2,6-9) (10)
X Y	US,A, 4510588 (KRUKA et al.) 9 April 1985 (09.04.85) Col.1 line 5-line 8, line 44-line 48; col.2 line 40-line 58; col.3 line 11-line 30; diagrams. (continued)	(1,2) (3,6-9)

* Special categories of cited documents : [10]

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

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"P" document published prior t 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

"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

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
12 June 1992 (12.06.92)	22 June 1992 (22.06.92)
International Searching Authority	Signature of Authorized Officer
AUSTRALIAN PATENT OFFICE	E.N. PERRIS

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

X Y	AU,B, 45321/89 (625782) (PLESSEY AUSTRALIA PTY LIMITED) 24 May 1990 (24.05.90) Page 1a line 9-line 12, line 24-line 30; page 2 - page 4 line 8; page 5 line 14-line 29; claims; drawings.	(1,2) (3-9)
Y	WO,A, 8703379 (RAYCHEM CORPORATION) 4 June 1987 (04.06.87) Abstract; pages 1-2; page 4 paragraphs 2,3; page 8 paragraph 2 - page 9 paragraph 1; page 11 line 6-line 15; examples; claims; figs 1-5.	(1-10)
X Y	US,A, 3766307 (ANDREWS) 16 October 1973 (16.10.73) Abstract; col.2 line 5 - col.6 line 15; col.8 line 25-line 46; claims; drawings.	(1,2) (3,6-9)
X Y	US,A, 4809243 (BLEDSOE et al.) 28 February 1989 (28.02.89) Col.2 line 5-line 35; col.3 line 9-line 44; claims; drawings.	(1,2) (3,7-9)

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim numbers ..., because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers ..., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers ..., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4a

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL APPLICATION NO. PCT/AU 92/00066

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member		
AU 87641/82	CA 1195396 US 4491939	DK 1614/83 WO 8300564	EP 85072 JP 58501289
AU 45319/89	CA 2003632	FR 2640290	GB 2226912
AU 45321/89	CA 2003279 US 5089668	FR 2639757	GB 2226690
WO 8703379	AT 60448 US 4685090	DE 3677212	EP 247187
US 4809243	US 4955012		

END OF ANNEX