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**F2G** G6A

(56) Documents Cited:
**EP 1388700 A**
**EP 0676840 A**
**DE 008517279 U**
**JP 110309578 A**
**US 5215338 A**

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INT CL[7] **E21B, F16C, F16L, G02B, H02G**
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(54) Abstract Title: **A bend restrictor**

(57) A bend restrictor comprises a plurality of housings (Fig. 1, 1), coupled to one another via universal joints, comprising a male head 14, defined by outwardly projecting ribs 32, to be received in a female socket 16, which may be defined by projecting shoulder 22, and preferably outwardly extending ribs 26, to define a continuous channel 35 able to receive an elongate member. The arrangement ensures that an elongate member disposed within the channel 35 is not bent beyond its maximum bending radius. The housings parts 2 are preferably of semi circular section, and may be joined together along a longitudinal axis by a band around neck 30, and pip and hole arrangement (Fig. 3, 10 and 12) to form a housing (Fig.1, 1). In a further embodiment, socket (Fig.3, 116) ribs (Fig3. 126) are preferably inwardly projecting forming a part-spherical locus, and the male head (Fig. 3, 114) ribs (Fig. 3, 132, 134) are internal and inwardly projecting.

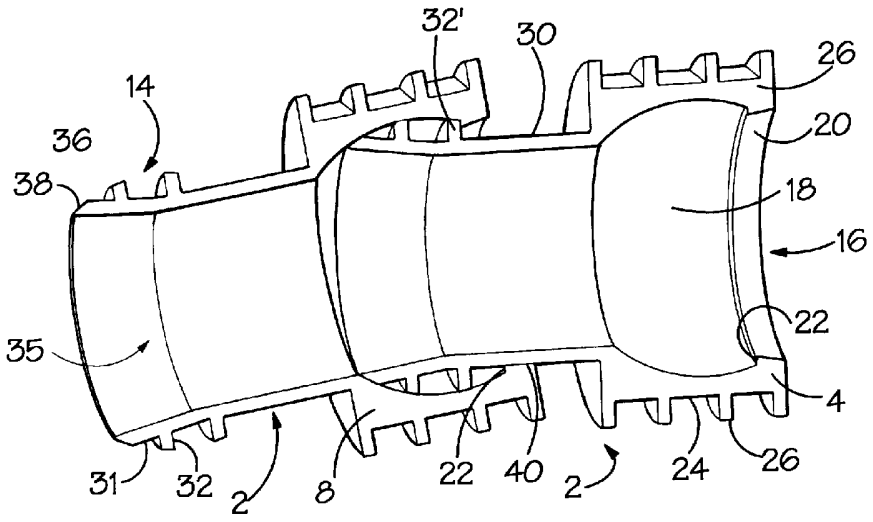


FIG.2.

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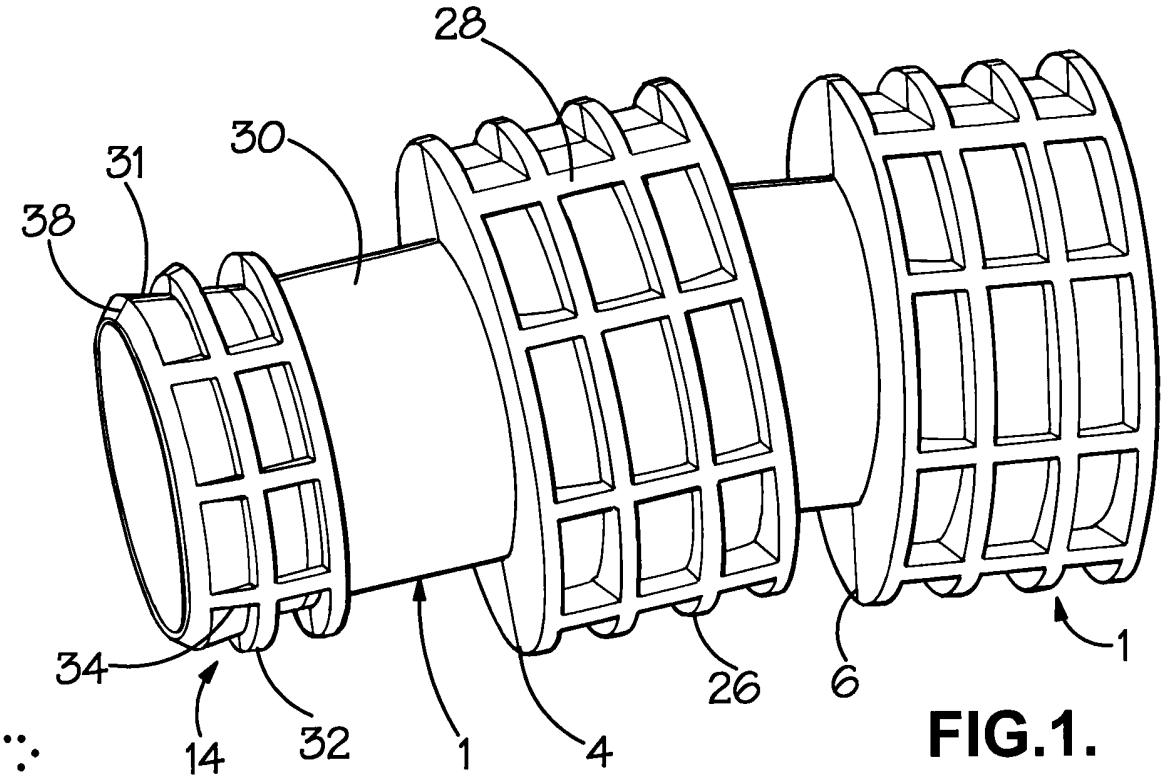
28
30
31
38
34
14
32
1
4
26
6
1

FIG.1.

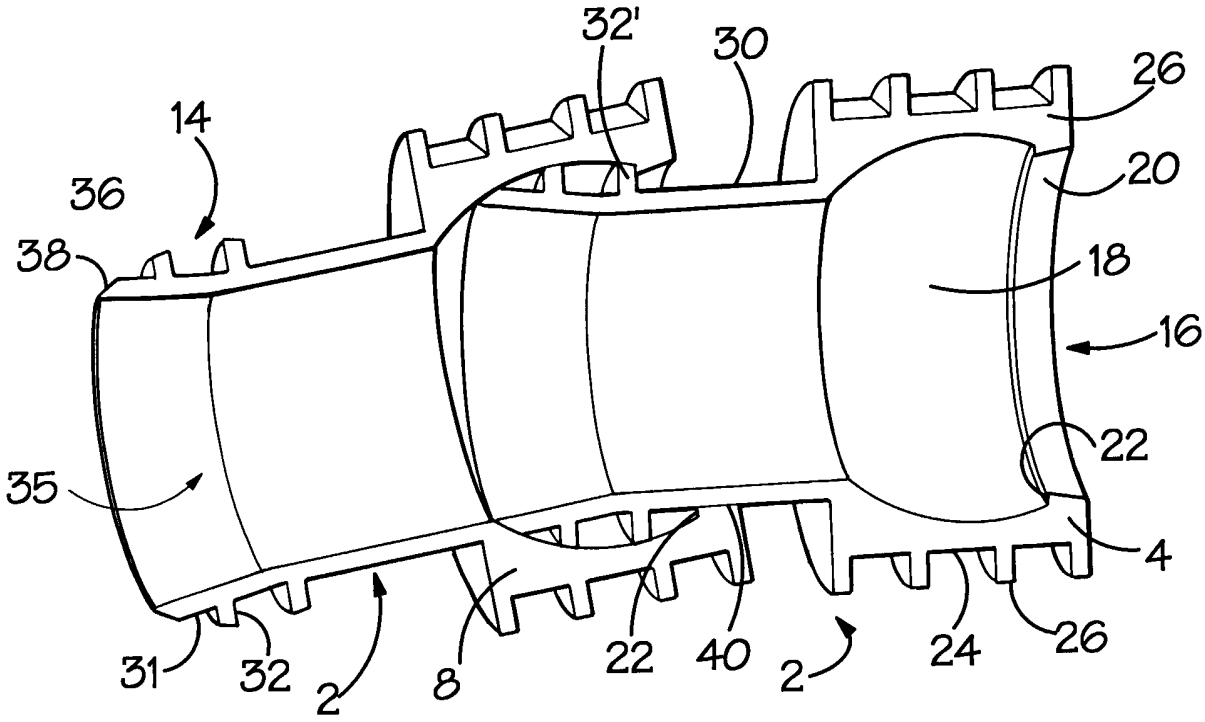
32'
30
26
14
36
20
38
18
16
22
35
4
31
32
2
8
22
40
2
24
26

FIG.2.

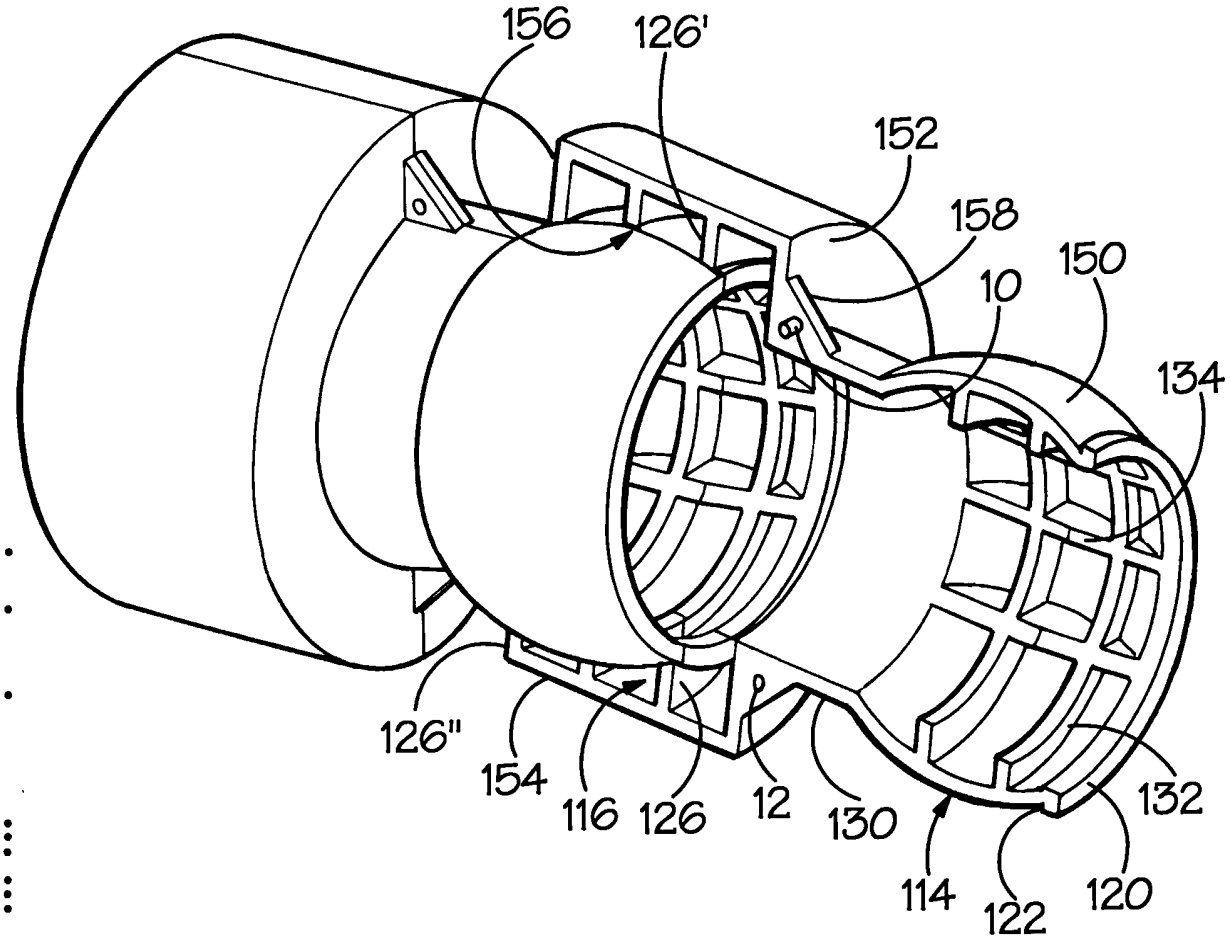


FIG.3.

# DESCRIPTION

## BEND RESTRICTOR

The present invention relates to bend restrictors for use with flexible elongate members.

A bend restrictor serves to receive some form of flexible elongate member, for example a cable, pipe, umbilical, marine riser etc., and to prevent it from adopting an excessively small radius of curvature. There are numerous applications for such devices. For example GB 2269274 describes a situation in which sub-sea cabling for telecommunications is deployed by passing it over a sheave. The cabling is subject to tension upon deployment and a segmented bend restrictor surrounding the cabling serves to prevent it from being excessively tightly bent in the process. The bend restrictor in question comprises a number of "housing members" each having a through-going bore to receive the cabling and being joined to identically formed neighboring housing members through universal joints of ball and socket type. Abutment of end faces of neighboring housing member limits the angular displacement of one relative to another, and in this way the overall minimum radii of curvature of the bend restrictor and the cabling within it are likewise limited.

It is necessary in some applications to provide for dissipation of heat from the elongate member, e.g. where it is formed by power cabling subject to ohmic heating. This can be problematic where the bed restrictor is formed by a material which is a poor heat conductor. Moulded plastics bend restrictors in particular

would be subject to this problem.

Forming the bend restrictor with sufficient stiffness for its purpose can also be problematic.

In accordance with the present invention, there is a bend restrictor comprising a plurality of housings coupled to one another through universal joints which permit relative angular movement of one housing relative to its neighbour, the universal joints each comprising a male head received in a female socket, the housings collectively defining a continuous channel for receiving an elongate member and the angular deflection of one housing relative to another being limited, thereby limiting the minimum radius of curvature to which the elongate member can be subject within the channel, wherein the male heads and/or the female sockets are defined by projecting ribs.

In the bend restrictor according to the invention the ribs can contribute to dissipation of heat. This is because, due to their surface area, they assist in exchange of heat with the bend restrictor's surroundings. The structure can also provide for circulation of the surrounding fluid (which may be air or water) within the bend restrictor, again improving heat dissipation.

In accordance with a second aspect of the present invention, there is a housing part for a bend restrictor, the housing part being semi-circular in transverse section and being shaped to enable it to be assembled with a similarly formed, laterally adjacent housing part to form a housing of circular transverse section having a male head, a female socket and a through-going channel, such

that a plurality of such housings can be coupled together to form a bend restrictor in which longitudinally adjacent housings are coupled by a universal joint formed by the receipt of the head of one in the socket of another in a manner which permits limited relative angular displacement, and the channels of adjacent housings communicating to form a continuous channel for receiving an elongate member, wherein the housing part comprises projecting ribs which define in the assembled housing at least one of the male head and the female socket.

Specific embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

Figure 1 is a perspective illustration of two housings forming part of a bend restrictor according to a first embodiment of the present invention;

Figure 2 is similar to Figure 1 except that respective semi-tubular components forming half of each housing are omitted; and

Figure 3 is a perspective illustration of two housings forming part of a bend restrictor according to a second embodiment of the present invention.

The illustrated bend restrictors are of moderately light duty construction and are intended for use with cabling whose diameter is up to roughly 125mm. The present invention could nonetheless be applied to larger bend restrictors. The illustrated restrictors are formed from plastics mouldings, and more specifically by injection mouldings. Nylon is a suitable material and may incorporate fibre reinforcement, e.g of glass fibres. In the illustrated example all of the components making up the housings are identical to one another. Each housing 1 is circular in

transverse section but is formed from two semi-circular housing parts 2. In Figure 1 the planes along which adjacent housing parts join are seen at 4 and 6. In Figure 2 planar faces 8 of the housing parts, which serve to abut corresponding faces of laterally adjacent parts, are exposed. Some registration feature is desirable to align the laterally adjacent housing parts 2 with each other. These features are omitted from Figures 1 and 2, but Figure 3 shows a suitable formation comprising a pip 10 which locates in a hole 12 of the adjacent part.

Longitudinally neighboring housings 1 are coupled together by a universal joint comprising a male head 14 received in a female socket 16 in the manner of a "ball and socket" joint. Each housing has a head 14 at one of its ends and a socket 16 at the other end. In the present embodiment the socket 16 has a part-spherical, continuous inner surface 18. At its longitudinal extremity the socket terminates in an open mouth surrounded by a circular collar 20 having a radially inwardly projecting shoulder 22. The socket 16 is defined by a wall 24 from whose outer surface project ribs or vanes 26, 28. These ribs project radially outwardly. Circumferential ribs 26 each form a complete ring around the socket 16 and are joined to each other by longitudinal ribs 28.

The wall 24 leads, at its end remote from the collar 20, to a cylindrical neck 30 which is in its turn leads to the head 14. In the present embodiment the head is formed upon a frustro-conical end section 31 of the neck 30 which again carries a square matrix of outwardly projecting ribs comprising circumferential ribs 32 and longitudinal ribs 34. Outer edges 36 of the ribs and also a chamfered

lip 38 at the frustro-conical end region 31 lie upon a notional sphere and in this way, despite not having a continuous spherical surface, the head 14 is adapted to serve in the manner of a ball in a ball and socket type joint, as Figure 2 makes clear.

Each housing 1 is hollow and it will be apparent from the drawings that together the housings form a continuous, through-going passage or channel 35 for receiving a flexible elongate member such as an electric cable. To assemble the bend restrictor laterally adjacent housing parts 2 are assembled with their socket 16 around the head 14 of a longitudinally adjacent housing. The laterally adjacent parts are secured to one another by a band passed around the neck 30 and joined to itself under tension. Suitable banding technology is well known in the art.

Relative angular displacement of longitudinally adjacent housing parts is limited by abutment of an inclined inner surface of the collar 20 against the neck 30, as seen at 40 in Figure 2. Any tendency for the head 14 to be drawn out of the socket 16 as a result is resisted by abutment of circumferential rib 32' against the shoulder 22.

The embodiment illustrated in Figure 3 differs from that of Figures 1 and 2 inter alia in the fact that its ribs or vanes project radially inwardly rather than outwardly. Correspondingly its head 114 has a continuous, part-spherical outer surface 150 which is received in socket 116 formed by ribs 126.

Looking at this construction in more detail, the part-spherical head 114 can be seen to terminate in an open mouth defined by a collar 120 forming a radially

projecting, circumferential shoulder 122. The head 114 is hollow but is internally reinforced by radially inwardly projecting circumferential ribs 132 and longitudinal ribs 134.

The head 114 leads to a cylindrical hollow neck 130 which in turn leads via a shoulder 152 to an enlarged diameter cylindrical wall 154 within which the socket is formed by a matrix of circumferential and longitudinal, radially inwardly projecting ribs 126. Inner edges 156 at the ribs 126 lie upon a notional sphere and so define the socket.

Angular movement of one housing relative to another is halted when rib 126" comes into abutment with shoulder 122, which happens concurrently with the inner edge of rib 126" coming into abutment with the neck 130.

The aforementioned pip 10 and hole 12 are formed in a web 158 at the junction of the neck 130 with the shoulder 152.

# CLAIMS

1. A bend restrictor comprising a plurality of housings coupled to one another through universal joints which permit relative angular movement of one housing relative to its neighbour, the universal joints each comprising a male head received in a female socket, the housings collectively defining a continuous channel for receiving an elongate member and the angular deflection of one housing relative to its neighbour being limited, thereby limiting the minimum radius of curvature to which the elongate member can be subject within the channel, wherein the male heads and/or the female sockets are defined by projecting ribs.

2. A bend restrictor as claimed in claim 1 wherein a housing comprises at least two parts separable along a longitudinal plane.

3. A bend restrictor as claimed in claim 1 or claim 2 wherein a housing comprises at least two parts of semi-or part-circular section.

4. A bend restrictor as claimed in any preceding claim wherein the housings each comprise at least two parts and all of the housing parts are the same.

5. A bend restrictor as claimed in any preceding claim wherein the socket is defined by radially inwardly projecting ribs forming a part-spherical locus.

6. A bend restrictor as claimed in any preceding claim wherein the head is defined by radially outwardly projecting ribs forming a part-spherical locus.

7. A bend restrictor as claimed in any preceding claims wherein the head

and the socket are both provided with projecting ribs.

8. A bend restrictor as claimed in any preceding claim wherein a circumferential lip on one of the head and the socket is able to abut against a circumferential shoulder on the other of the head and the socket to limit relative angular deflection of coupled housings.

9. A housing part for a bend restrictor, the housing part being semi-circular in transverse section and being shaped to enable it to be assembled with a similarly formed, laterally adjacent housing part to form a housing of circular transverse section having a male head, a female socket and a through-going channel, such that a plurality of such housings can be coupled together to form a bend restrictor, longitudinally adjacent housings being coupled by a universal joint formed by the receipt of the head of one in the socket of another in a manner which permits limited relative angular displacement, and the channels of adjacent housings communicating to form a continuous channel for receiving an elongate member, wherein the housing part comprises projecting ribs which define in the assembled housing at least one of the male head and the female socket.

10. A housing part as claimed in claim 9 wherein the socket is defined by radially inwardly projecting ribs forming a part-spherical locus.

11. A housing part as claimed in claim 9 or claim 10 wherein the head is defined by radially outwardly projecting ribs forming a part-spherical locus.

12. A housing part as claimed in any of claims 9 to 11 comprising a circumferential lip on one of the head and the socket for abutting against a

circumferential shoulder on the other of the head and the socket to limit relative angular deflection of coupled housings.

13. A housing part for a bend restrictor, substantially as herein described with reference to, and as illustrated in, accompanying Figures 1 and 2 or in accompanying Figure 3.

14. A bend restrictor, substantially as herein described with reference to, and as illustrated in, accompanying Figures 1 and 2 or in accompanying Figure 3.

**Application No:** GB0408186.5 **Examiner:** Ross Maclachlan

**Claims searched:** 1-14 **Date of search:** 22 July 2004

# Patents Act 1977: Search Report under Section 17

**Documents considered to be relevant:**

| Category | Relevant to claims | Identity of document and passage or figure of particular reference |
|---|---|---|
| X | 1-14 | EP 1388700 A (REIKU) See all figures, particularly 6 and 7 and WPI Abstract Accession no. 2004-171051 [17], noting bend limiting duct having housings with receiving socket end 5, and plug end 3, the socket and plug being formed by flanges/ribs 9 and 13. |
| X | 1-14 | EP 0676840 A (ELKUCH) See all figures, particularly 3-6 and WPI Abstract Accession no. 1995-346385 [45], noting (fig. 5) tube segments 2 of flexible cable shrouding, having a male heads and female sockets interlocking and formed from ribs. |
| X | 1-14 | US 5215338 A (TSUBAKIMOTO) See figure 20, noting flexible supporting sheath for cables having a series of universal joints formed from identical sections which are joined via a male head and female socket, the male part having annular ribs 73 and 74. |
| X | 1-14 | DE 8517279 U (VOGELSANG) See figures 1-3, noting flexible conduit sections having male heads and female sockets, formed by ribs, joining to form a length of conduit. |
| X | 1-14 | JP 11309578 A (KOMATSU) See page 6 of the 8 figure pages, and WPI Abstract Accession no. 2000-109166 [10], noting conduit made of identical sections where bending is limited by protrusions. |

Categories:

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|---|---|---|---|
| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
| Y | Document indicating lack of inventive step if combined with one or more other documents of same category. | P | Document published on or after the declared priority date but before the filing date of this invention |
| & | Member of the same patent family | E | Patent document published on or after, but with priority date |

earlier than, the filing date of this application

**Field of Search:**

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[W] :

E1F; E2F; F2G; H2C; H2E

Worldwide search of patent documents classified in the following areas of the IPC[07]

E21B; F16C; F16L; G02B; H02G

The following online and other databases have been used in the preparation of this search report

Online: OPTICS, EPODOC, WPI, PAJ