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TECHNICAL FIELD

The invention relates to the technical field of "rotating machinery" with flyer bow intended for assembly of cables and twisting of wires or strands, especially those
5 permitting the production of double or triple twists (so-called "braiding" operations).

It is recalled that this type of rotating machinery or flyer bow is well known to the person skilled in the art and is used in particular to twist individual wires to manufacture cables, especially cables intended to carry electricity, which require
10 physical properties (tension, torsion, symmetry, etc.) of very high perfection.

Throughout the present application, including the claims, the generic term "cable" will be used to designate the cable or wire or strand intended to run or "travel" as it is well known in or along the longitudinal surface of the flyer bow (all with appropriate "guide"
15 means, themselves also known as regards their principle), the rotating flyer bow functioning to impress a twist on this "cable", also in well known manner.

It is also known that the "cable" (or wire, etc.) arrives either from a winder (drum) or from another flyer bow combined with the first.
20

For a description of general aspects of flyer bows, the person skilled in the art will be able usefully to consult French Patent No. 9905435, non-limitatively.

A generic flyer bow is represented in the attached FIG. 1.
25

The present invention relates essentially to a means for guiding the "cable" (or wire, strand, etc., all referred to as "cable" for simplicity).

PRIOR ART
30

Devices exhibiting flyer bows made of composite fibers (mainly carbon and glass fiber), wood or steel are known.

In order to maintain the cable in position, the person skilled in the art has developed
35 cable guide elements (especially grommets, eyelets) capable of holding the said cable at a certain number of points along the flyer bow.

Problems have occurred as a result of the fact that, since the flyer bow rotates at very high speed and the cable is not fixed, the latter may collide with the grommet walls, thus causing fragility in the cable, even capable of breaking it.

- 5 It must be well understood, in fact, that the person skilled in the art is generally confronted with a double movement (in combination), the first being the rapid travel of the cable along the flyer bow and the second (simultaneous and in combination, which produces the sought mechanical effect on the cable) being the rapid rotation of the flyer bow around an axis of rotation. It is also well known that, in general, the cable (or
10 wire, strand, etc.) is led along the flyer bow at one end thereof, obviously in the direction of the said axis of rotation, and exits the flyer bow at the other end, also in the direction of the same axis of rotation of the flyer bow, for obvious reasons of kinematics.
- 15 In addition, the aerodynamics of the assembly comprising flyer bow, cable guide elements and cable is not absolutely optimum and, at the high speeds of rotation in question for the flyer bow, the resistance of the ambient air is very large, creating a strong drag that may be perturbed, with potentially very dangerous mechanical effects. This will also have the consequence that the motor of the flyer bow will consume more
20 energy.

Another disadvantage will be that the repeated impacts on the cables as well as the "uncovered" path of the cable in the air stream will generate vibrations that are dangerous in themselves and, in addition, because of a pressure effect, a noise level
25 that is too great for the operator.

The person skilled in the art has therefore searched for aerodynamic improvements of the shape of the flyer bow, especially to eliminate the grommets.

- 30 In this field there is known in particular U.S. Pat. No. 5,809,763 (Kamatics), which teaches a flyer bow having a cross section of improved aerodynamic shape, which in cross section will be referred to as a "drop" or "airfoil" shape, for better penetration through the air. The cable guide element is no longer external but is integrated in the flyer bow. For this purpose, the flyer bows are provided with a longitudinal orifice over
35 their entire length, thus permitting passage of the cable through and in the interior of the flyer bow.

Since the cable passes through the flyer bow, the air no longer causes friction and the aerodynamic shape of the flyer bow permits good penetration through the air and therefore a reduction of motor power.

- 5 Energy savings are therefore achieved with limitation of the air friction.

TECHNICAL PROBLEM POSED

- 10 Nevertheless, the creation of these aerodynamic flyer bows does not resolve one of the technical problems mentioned hereinabove: the fact that the cable may suffer wear and even break when the flyer bow is rotating at high speed.

- In fact, even if the grommets were replaced by a longitudinal orifice integrated in the flyer bow, the cable remains "free" in this orifice and, when the flyer bow is set in
15 rotation at high speed, the said cable will always collide (violently) with the walls of the "channel" made in the flyer bow, with the same consequences of wear, since the repeated impacts will cause deterioration of the cable.

- The prior art includes an old USP patent 3, 570, 234 which concerns a flexible flyer
20 bow made of a spring and which contains at least one, preferably two, springs. These elements are all flexible and aim - at the time - to ensure a precise entry and exit point for the cable.

- We also know the Kamatics WO 2006 / 09 40 99 PCT US / 2006 / 007369 patent,
25 which describes a cable guide integrated in an "aircraft wing" profiled structure, designed to evacuate wear debris through an orifice 91 provided in the guide and which is maintained in coincidence with the debris outlet orifice 82 of the flyer bow by the fact that the guide is not circular on its external surface and therefore, once correctly installed, cannot rotate in the flyer bow.

30

Another disadvantage is that the worn cable creates debris (cable fragments dust), which will obstruct the orifice. Consequently, it is necessary to dismantle the flyer bow in order that this debris can be removed. Some prior art documents provide aeration systems, but these may prove ineffective and therefore useless.

35

In this field there is known U.S. Pat. No. 6,223,513 of Kamatics, which describes, in

the context of such an aerodynamic flyer bow, a cable guide element 112 combined with air-pressure relief orifices 108. Cable guide 112 is expressly designed to comprise large spaces between the turns, so that the debris just mentioned is able to be easily dislodged therefrom. This is indicated as imperative in column 3 lines 5 to 7 "provided
5 that "openings" (apertures, spaces) are made in the cable guide in order to permit the debris to leave ("exit") cable channel 106". It is noted that in this document there are provided orifices 108, 110 through which the air can escape by compression effect, thus creating a "fluid flow" in cable channel 106 "from a high-pressure zone toward the orifices", "without which the debris would accumulate in channel 106" (approximate
10 summary of the bottom of column 2).

This document therefore teaches forcing the debris to be ejected from the cable channel by the combination of broad spaces (see FIG. 3 in particular and the description such as "open wound spring" or spring with open turns in column 3 line
15 36), which leaves the debris more or less free by virtue of these deliberate and large spaces between the turns, with a differential flow of air that benefits from this degree of freedom of the debris between the turns in order to expel it, and also in combination with a high-pressure zone on "the intrados" 104 of the "airfoil" cross section (profile shaped like an airplane wing), creating a pressure differential by virtue of the low-
20 pressure zone on "the extrados" 102, creating violent aspiration/ejection via the orifices 108, 110.

The guide 112 is described as a worn guide spring ("worn wire guide spring" 112 column 3 line 25) that may be easily removed from the longitudinal orifice and
25 replaced by another, because naturally it is subjected to considerable wear.

This document does not absolutely prevent the formation of debris and therefore wear of the cable; its objective is solely to expel this debris more or less continuously.

30 A real need therefore exists to create a device of flyer bow type with which absence of wear of the cable can be guaranteed to the maximum.

GENERAL DESCRIPTION OF THE INVENTION

35 The present invention relates to a device of flyer bow type of profiled shape with aerodynamic, preferably ovoid cross section, having:

- an internal orifice or tube or "channel" created all along the longitudinal axis of the said flyer bow, in the mass of the said flyer bow,
- an internal guide element disposed in this "internal tube" over the entire length of the flyer bow, adapted so that the cable runs in at one end and runs out at the other.

In a first step, a longitudinal recess is created in the cross section of the flyer bow (obviously the diameter of this recess is naturally larger than that of the cable), over the entire length thereof ("internal tube").

The guide element according to the invention, which is adapted to be inserted easily in this recess or "internal tube", is then inserted.

In order to maintain this guide element in position, it is fixed at the ends by any known means, especially by a screw-type fastening element.

The inside diameter of the internal tube, the outside diameter of the guide element and the outside diameter of the "cable" will obviously be optimized so that the guide element is held lightly in position in the internal tube and so that the "cable" has only a minimum vibration space.

These concepts of simple geometry will be obvious to the person skilled in the art.

The invention therefore relates to a flyer bow of the type described hereinabove, the essential characteristic of which lies in a guide element that is a preferably metallic element of the type spring with "closed" turns, in other words without spaces between them. The turns are therefore adjacent. This is exactly the inverse of the solution with "open" turns of U.S. Pat. No. '513 of Kamatics.

In addition, the present invention does not necessarily employ orifices 108/110 or pressure differential 102/104, contrary to the aforesaid Kamatics patent.

The present invention has therefore overcome the prejudices of the prior art.

The cable will be inserted at one end of the flyer bow and will pass through the center of the turns in the guide element.

This guide element will be made removable by sliding out of the tunnel in order to facilitate its replacement or simply to clean out the debris and other dust.

5 The Applicant noted that, in entirely surprising manner, the cable guide element greatly reduced the wear of the cable (despite the increase of surface area in contact with the turns compared with that of U.S. Pat. '513, which is surprising), because the adjacent turns form a succession of "small bulges" and "small hollows" which, unexpectedly and according to the non-limitative theory of the Applicant, reduce the rebound effect of the cable against the walls of traditional
10 guide elements while generating contacts of the cable here and there rather than continuous friction, with the consequence of much less wear and therefore much less debris.

This is all the more important because of the fact that the device of flyer bow type
15 rotates at very high speed and that the cable itself also travels at great speed.

By "adjacent" turns "almost zero spacing" the spirit of the invention is therefore a "zero" spacing that is capable of tolerating minimum manufacturing imperfections, for example of accidental type.

20

By rejecting the teaching of U.S. Pat. No. '513, the present invention reduces not only wear of the cable but also its freedom to "flap" in the guide, therefore greatly reducing vibrations, impacts and production of debris. Each aspect taken separately is surprising, and the combination of these advantages is even more so.

25

Of course, it will be noted that the invention is based on "cable" guide (or referred to globally as a "guide element"), the internal surface of which is formed by "micro bulges" alternating with "micro hollows". A spring with closed or "adjacent" turns has been described hereinabove as being the best embodiment at present, but any
30 internal guide tube, not necessarily a spring, may be envisioned, provided that its internal surface is formed by micro bulges alternating with adjacent micro hollows.

DETAILED DESCRIPTION OF THE INVENTION

35 The invention therefore relates to a flyer bow according to claim 1.

Preferably the guide element (EG) completely surrounds the "cable".

Such micro bulges (MB) and alternating "adjacent" micro hollows (MC) are represented on the attached FIG. 9.

5

The order of magnitude (in height) of the micro hollows and bulges ranges from 0.1 to 1 mm, preferably between 0.1 to 0.3 mm.

10 Said "element" is actually of the type of a spring with "closed" turns, meaning without space between them, the turns therefore being "adjacent".

In the usual case in which the "cable" is of copper, micro deposits (MD) of copper debris may accumulate in the micro hollows (MC). Surprisingly, these micro deposits, undoubtedly by virtue of their miniscule volume, do not in any way detract
15 from the advantages mentioned hereinabove; it has also been noted that they were dislodged by the travel of the cable and that their very low mass ensured that even their evacuation did not perturb the system.

20 According to one possible theory, these micro deposits even have a "smoothing" effect on the internal surface (SI) of the guide, thus limiting even more the rebounds of the cable.

According to a preferred but non-limitative embodiment, the flyer bow will be made of carbon/epoxy fiber.

25

The guide element will preferably be of steel.

The Applicant has noted a very distinct reduction, as large as 35%, of electrical consumption of the flyer bow motor, associated directly with the reduction of the
30 aerodynamic drag.

The Kamatics profile of U.S. Pat. No. '513 ("airfoil" or airplane wing) would be even more favorable.

35 However, the ovoid and symmetric profiles according to the invention have the very useful feature in practice of permitting the use of the machine in clockwise or

counter-clockwise mode without having to dismantle it.

A reduction of noise due to the said reduction of drag may attain -2.5 dB at high speed (see Table 1).

5

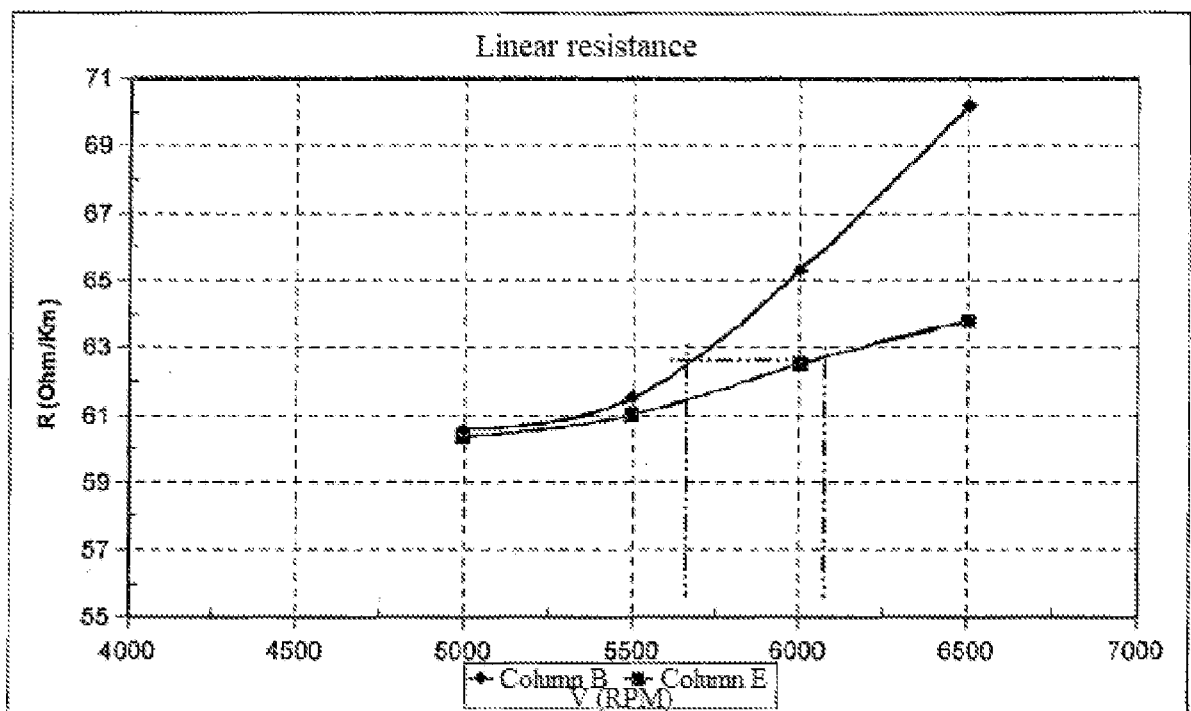
Flyer bow speed %	80%	100%
Flyer bow according to the present invention	75,8	81,3
Standard flyer bow	77,7	83,8

Table 1

- 10 An improvement of the resistance per unit length of the cables (in other words a reduction of the losses of diameters) is also observed.

Linear resistance measurement (see details in Table 2)

15



Analysis:

The measurements are similar at 5000 rpm, but above there is a distinct advantage in favor of the flyer bow according to the present invention: micro-bulge effect of the spring when the wire is centrifuged. For example, production at 5700 rpm with the standard flyer bow may be achieved at 6100 rpm with the same final product quality (i.e. a 7% productivity gain).

Column E represents the flyer bow according to the present invention.

10 Column B represents a standard flyer bow.

Linear resistance

Speed:	Eyelet		Flyer Bow according to the present invention		Delta%	Delta
	R (Ω/Km)	Temperature	R (Ω/Km)	Temperature		
5000	60,66	17,5	60,35	17,5	-0,33	-0,19999999999999999
5500	61,5	17,5	61	17,5	-0,81	-0,5
6000	65,3	17,5	62,5	17,5	-4,29	-2,8
6500	70,2	17,5	63,8	17,5	-9,12	-6,400000000000001

15

It is also possible to envision placing a reinforcing and protective element (EP) in the internal tube or orifice (O) (in other words, the tubular conduit made in the thickness of the flyer bow), between the said internal tube and the cable guide element (RS). This reinforcing element will have the function of protecting the guide element and

20 cushioning the impacts to which it is subjected.

The said protective element (EP) is preferably a carbon tube installed during production of the flyer bow.

25 DRAWING and NON-LIMITATIVE EXEMPLARY EMBODIMENTS

These characteristics, and elements employed, will be better understood by reading the attached FIGS. 1 to 9.

30 FIG. 1 represents in known manner a rotating flyer bow 1 with an entry and an exit for the cable, wire or strand.

FIGS. 2 and 2a as well as 3 and 3a respectively represent the detailed arrangements of the cable entry and exit zones, as well as (FIGS. 2a and 3a) the respective cross sections through CC and DD respectively of these mechanical arrangements well known in themselves.

5

FIGS. 4, 5 and 6 represent cross sections through three non-limitative embodiments of a flyer bow according to the invention. These figures show a flyer bow cross section of the shape referred to here as symmetric "ovoid", which is the preferred shape. It is seen that it is symmetric and not in the shape of an "airfoil" or airplane wing, and therefore it permits a change in the direction of rotation of the flyer bow.

10

These figures are three sections through GG of FIG. 1.

As already indicated, any globally ovoid and symmetric shape is suitable and is

15

preferred, although in certain cases it is possible to accept a cross section of "airfoil" or airplane wing shape, or any other shape that favors entry into the flyer bow in the air at high speed of rotation.

FIG. 4 distinctly shows two lateral and obviously symmetric recesses (a) and (b); the recess itself is visibly the tubular center (3) that will pass all along the flyer bow. An optional protective element (2) may be adjoined thereto. The objective is to make the flyer bow as lightweight as possible, naturally depending on the inside diameter (Di), which is the diameter of the cable. FIG. 4 is appropriate especially for a Di of 4.7 mm.

20

Also on FIG. 4 there has been shown the preferred embodiment of the invention, where the guide for the cable (or wire, strand, etc.), in this case the preferred embodiment, which is a spring with adjacent turns (RS), is disposed adjacent to a protective tube (EP), itself accommodated in precise manner during mounting in the tubular orifice (O) made in the entire length of the flyer bow.

25

30

It has been seen that this protective element (EP) was optional but very clearly preferred for the technical reasons indicated.

The grouping obviously leaves the channel for the cable or wire or strand, etc. (PF) free, the "cable" not being represented so as to avoid overloading the figures.

35

PF is naturally determined by D_i , which itself is adapted as a function of the outside diameter of the "cable", which is very slightly smaller than D_i , in the manner known for reduction of friction between the "cable" and (RS) and also to permit only very slight flapping of the "cable".

5

The "gap" between the outside diameter of the cable and D_i will be at least 0.6 mm-0.8 mm and depends on the cable. It will be easy for the person skilled in the art to define the optimum value. A maximum value will be from 3-3.5 mm, preferably 0.8-1.5 mm, depending on the actual cables.

10

FIG. 5 is totally comparable with FIG. 4 except that it is provided with 4 lateral recesses (a, b and c, d). Such an arrangement is suitable, for example, for a cable diameter D_i of 8 mm.

15 FIG. 6 is also comparable with FIGS. 4 and 5, except that it is not provided with lateral recesses of type (a, b, etc.); as indicated, these recesses are not obligatory, because their purpose is to lighten the mass of the rotating flyer bow and therefore to decrease both the centrifugal force of the flyer bow and the necessary motor power.

20 FIG. 7 represents the "cable" guide system and shows the adjacent turns (S) separated by a zero interval or spacing.

FIG. 8 is composed of FIG. 8a, which is the cross section through BB of FIG. 7, and of FIG. 8b, which is (circle and arrow) an enlarged view of the position of the "point"

25 created when the spring is cut, which point must be positioned (during mounting) so that the wire is not able to flap above it during its travel. In other words, this "point" is "polished" manually to reduce its sharpness as much as possible.

The same references represent the same elements or measures as in the preceding

30 figures, and L is the length of the cable guide element.

FIG. 9 represents a longitudinal section of the cable guide (RS) in the form of a spring with "adjacent" turns (S) having zero interval or spacing (ES). This figure is intended to show the micro bulges (MB), while the micro hollows MC are situated at the inside
35 diameter (D_i) of the guide RS, naturally with the axis of symmetry of the guide RS in rotation, denoted by ASG.

The micro deposits (MD) from the very small quantity of debris produced by the cable during its travel in the channel for the cable or wire or strand, etc. (PF) also is noted.

5 The person skilled in the art naturally will know how to calculate and apply all of the tolerances between the parts, for example the compromise between friction and flapping, as well as the tolerances on the tube and spring diameters, so as to achieve the best compromise between interchangeability and maintenance of position.

10 The invention also covers all the embodiments and all the applications that will be directly accessible to the person skilled in the art upon reading the present application and from his own know-how.

PATENTKRAV

1. Svingbøjle til sammenføjning/snoning/fletning af kabler, hvilken svingbøjle omfatter:

- 5 - et legeme (C) med en langsgående åbning (O) dannet i massen af legemet (C) og over hele længden af svingbøjlen, og
 - et kabelføringselement (EG) indeholdt i åbningen (O) til at føre den langsgående gennemløbning af kablet, hvilket kabelføringselement (EG) har en indvendig overflade (SI), som afgrænser kabelpassagen (PF),

10

kendetegnet ved, at den indvendige overflade (SI) er dannet af en fjeder (RS) med indbyrdes tilstødende viklinger, hvilke viklinger af fjederen (RS) danner mikro-buler (MB) og mikro-fordybninger (MC), hvis højdeamplitude er imellem 0,1 og 1 mm.

- 15 2. Svingbøjle ifølge krav 1, **kendetegnet ved, at** den omfatter et rørformet beskyttelseselement (EP) placeret imellem en indvendig væg i den aflange åbning (O) og en udvendig overflade på fjederen (RS).

- 20 3. Svingbøjle ifølge krav 2, **kendetegnet ved, at** det rørformede beskyttelseselement (EP) er fremstillet af carbon.

- 25 4. Svingbøjle ifølge ethvert af kravene 1 til 3, **kendetegnet ved, at** de nævnte mikro-buler (MB) og mikro-fordybninger (MC) har en højdeamplitude på imellem 0,1 og 0,3 mm.

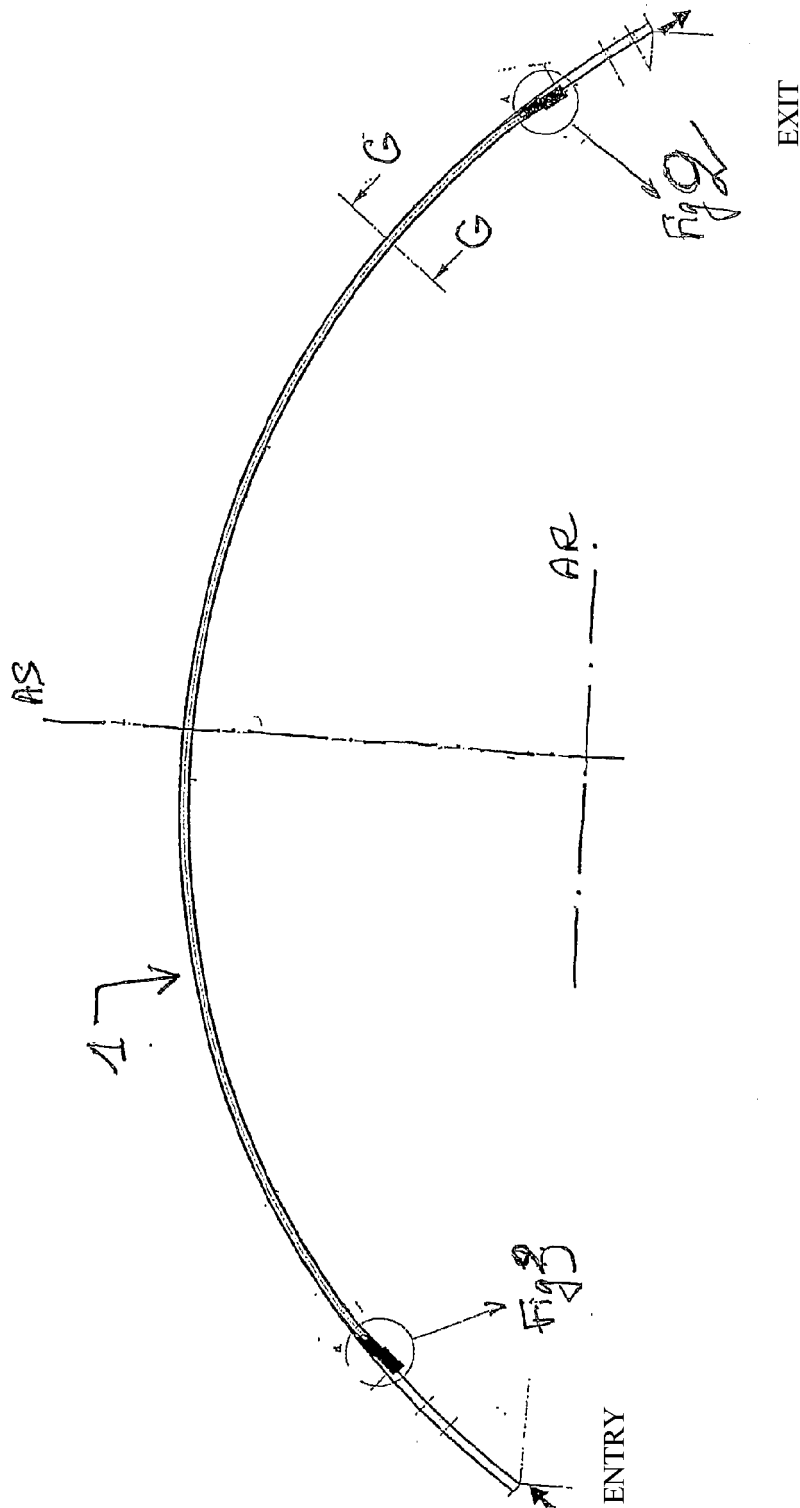
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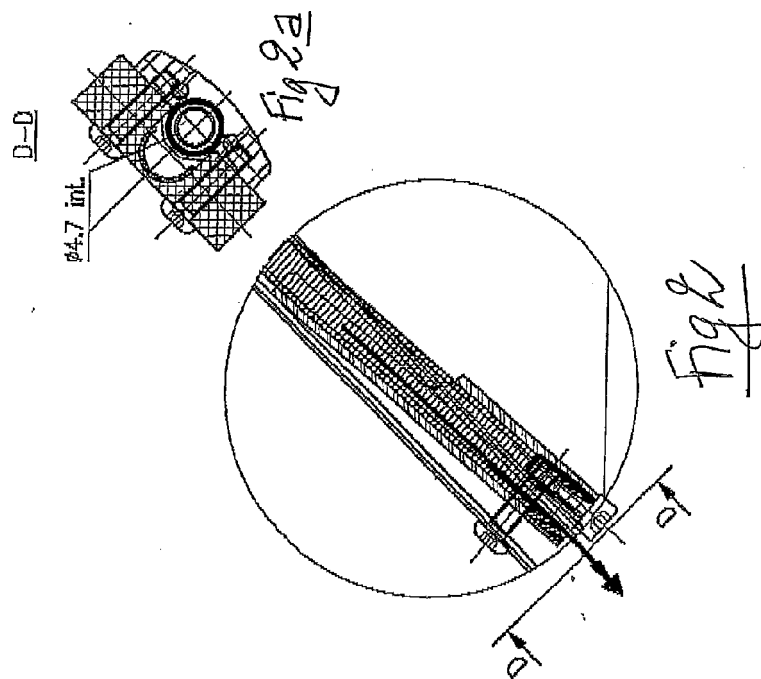
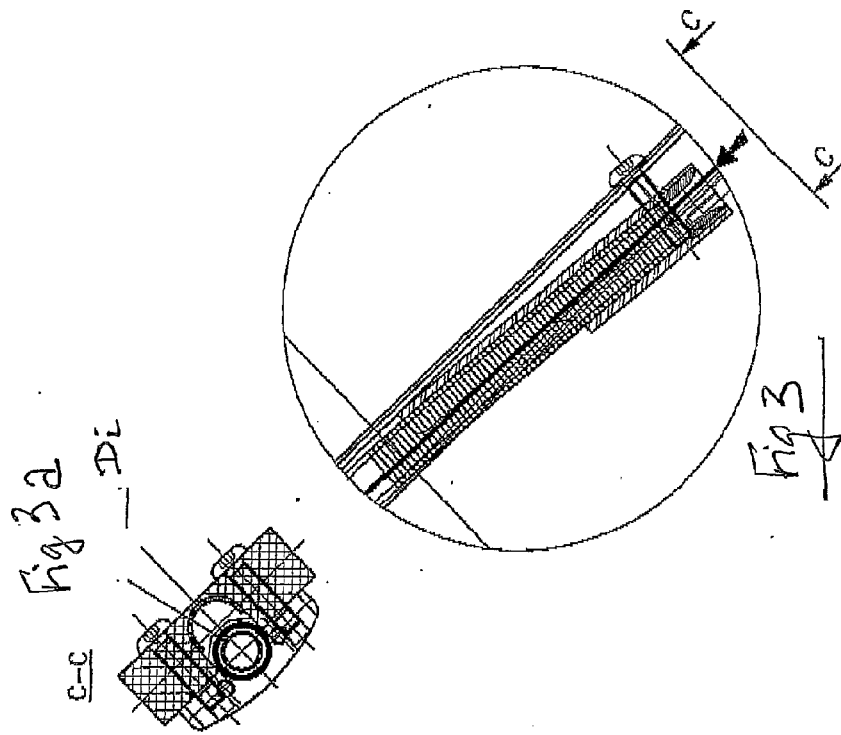
5. Svingbøjle ifølge ethvert af kravene 1 til 4, **kendetegnet ved, at** den er fremstillet af carbon-/epoxy-fibre.

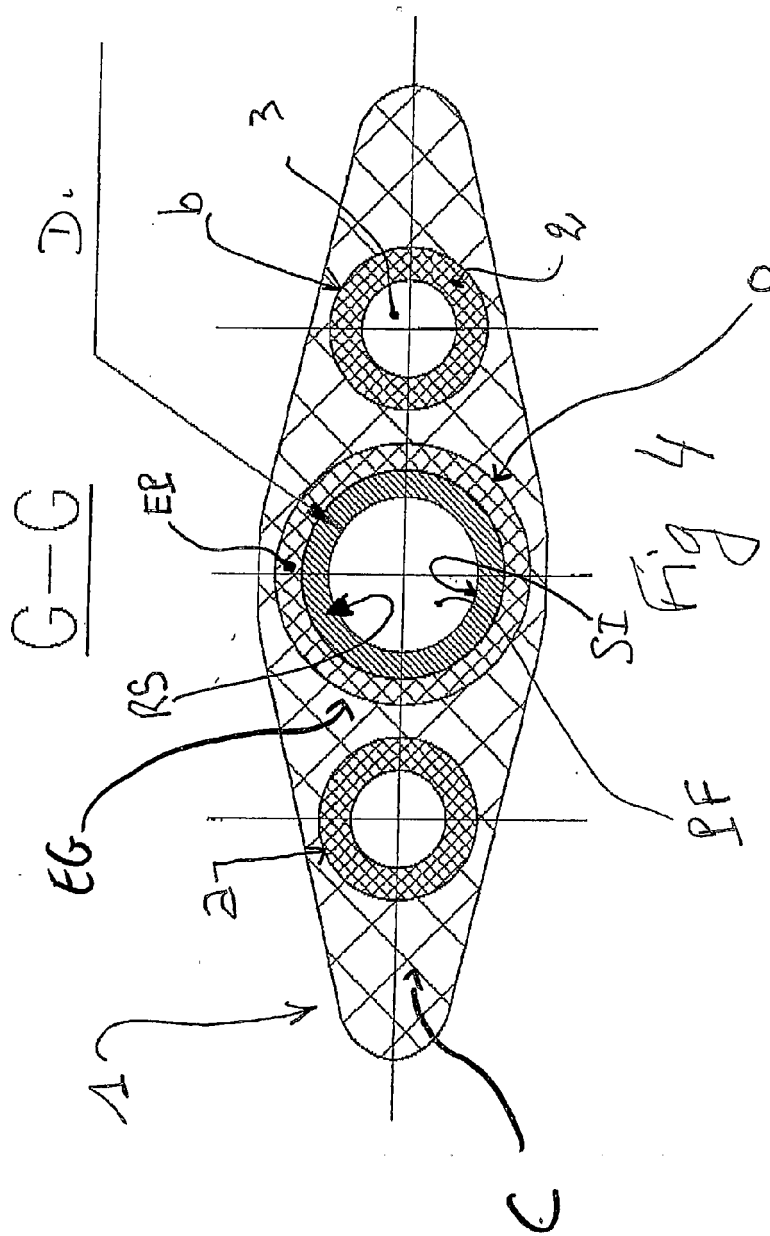
- 30 6. Svingbøjle ifølge ethvert af kravene 1 til 5, **kendetegnet ved, at** den har et symmetrisk ovalt tværsnitsprofil.

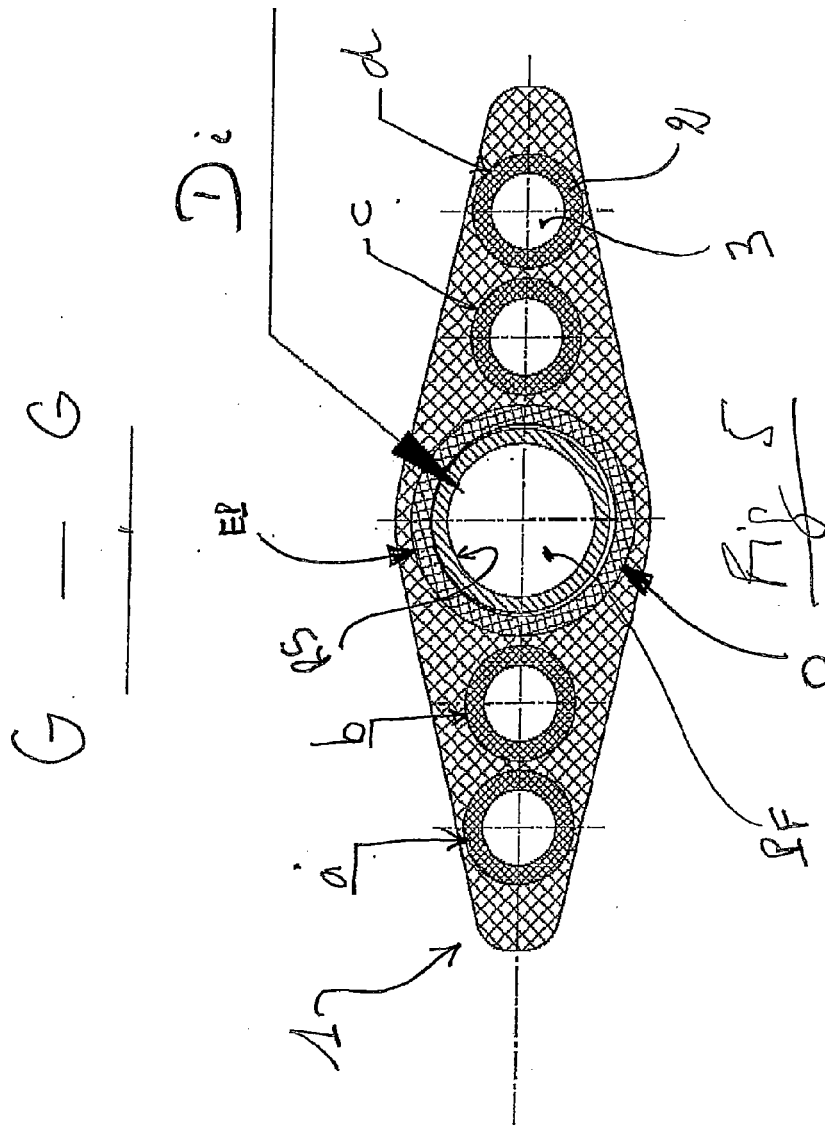
7. Svingbøjle ifølge ethvert af kravene 1 til 6, **kendetegnet ved, at** den har 2 til 4 symmetriske sideværts udsparringer (a, b, c, d).

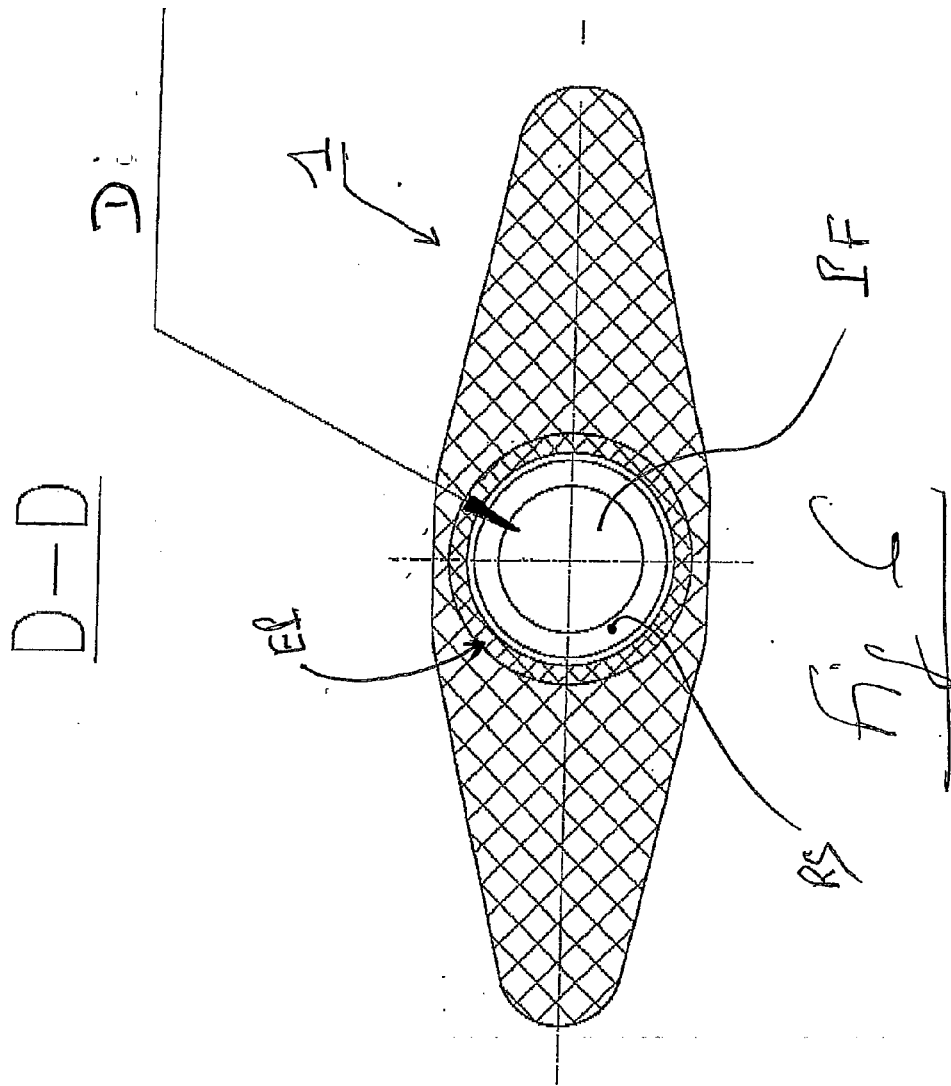
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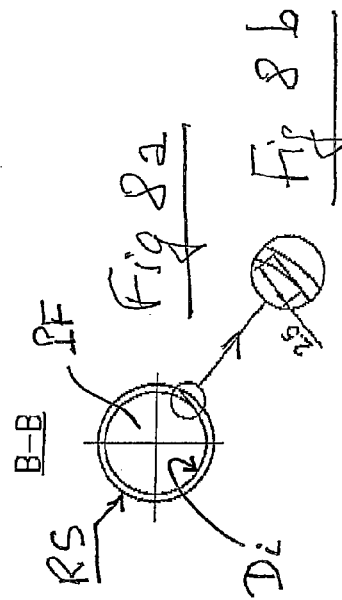
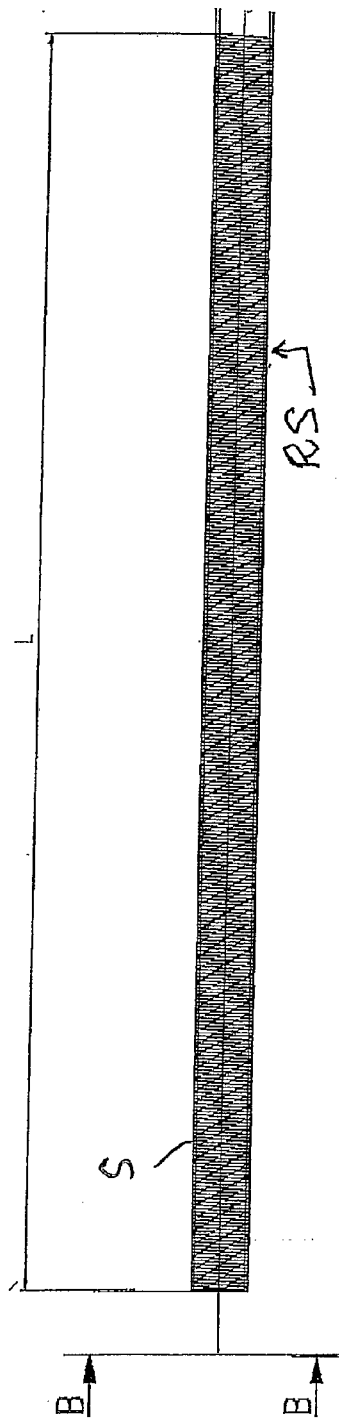












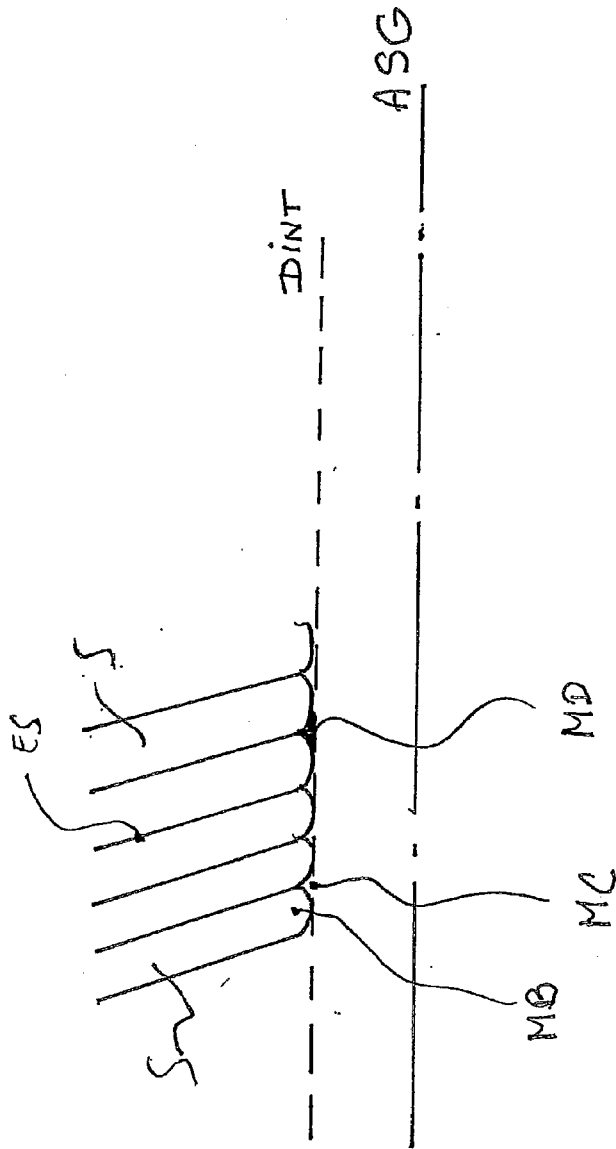


Fig 9