United States Patent

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[33] **Great Britain**
[31] **55708/68**

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[54] **LOW-DRAG FAIRING CONFIGURATION FOR FLEXIBLE TOWING CABLES**
7 Claims, 5 Drawing Figs.

[52] U.S. Cl. ..... **114/235 F**
[51] **Int. Cl.** **B63b 21/00**
[50] **Field of Search** ..... 114/235, 235.2 F

[56] **References Cited**

UNITED STATES PATENTS

2,397,957	4/1946	Freeman	114/235.2 F
3,086,491	4/1963	Rather et al.	114/235.2 F
3,194,204	7/1965	Nichols et al.	114/235.2 F
3,443,020	5/1969	Loshigian	114/235.2 FX

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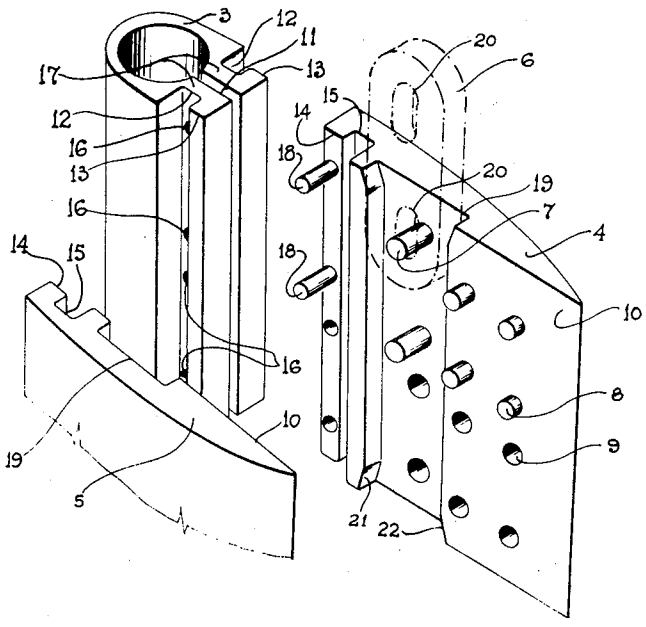
Attorney—Douglas S. Johnson

ABSTRACT: A cable fairing has a flexible hollow nose and a rigid tail; the fairing is in short sections with each adjacent pair connected by flexible pivotal links.



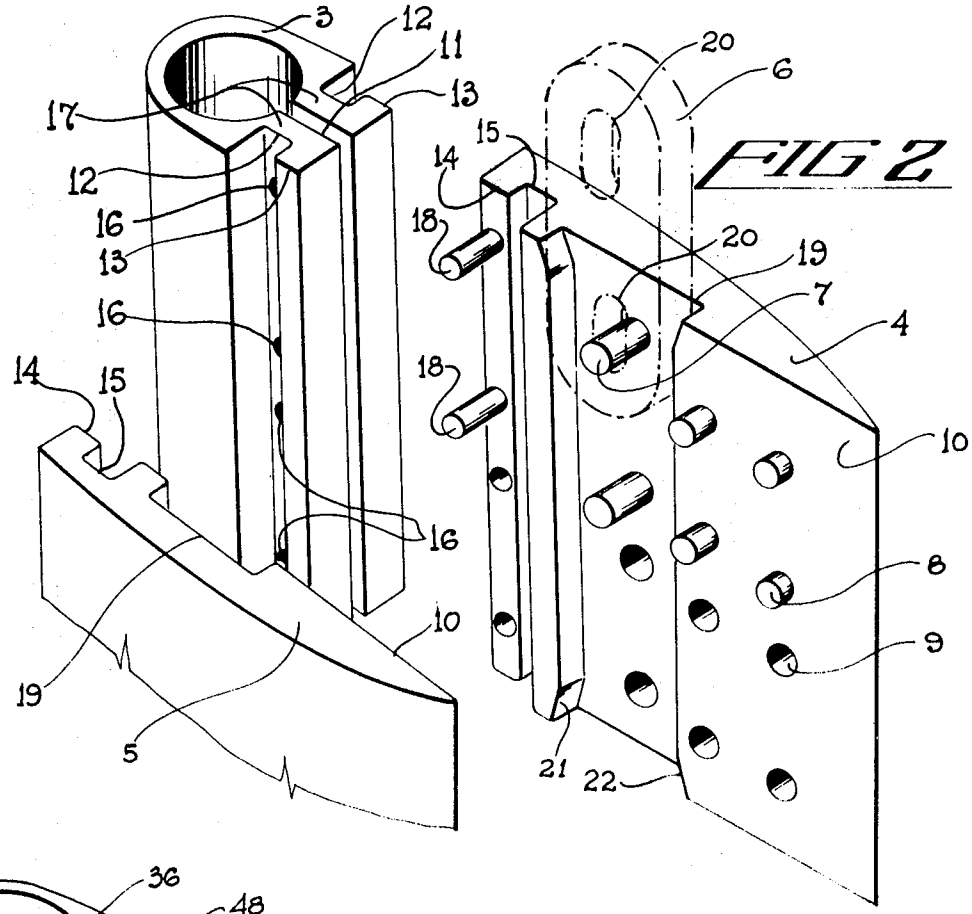


FIG 2

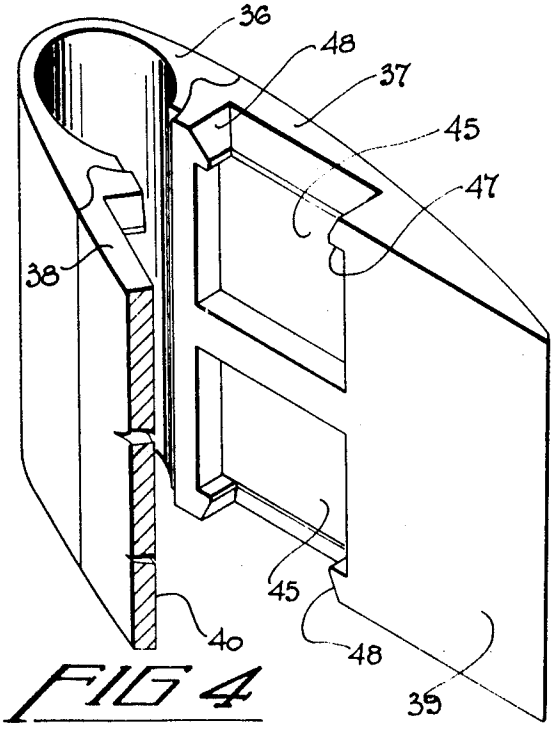


FIG 4

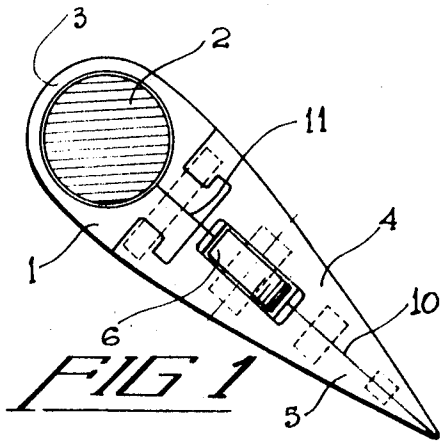


FIG 1

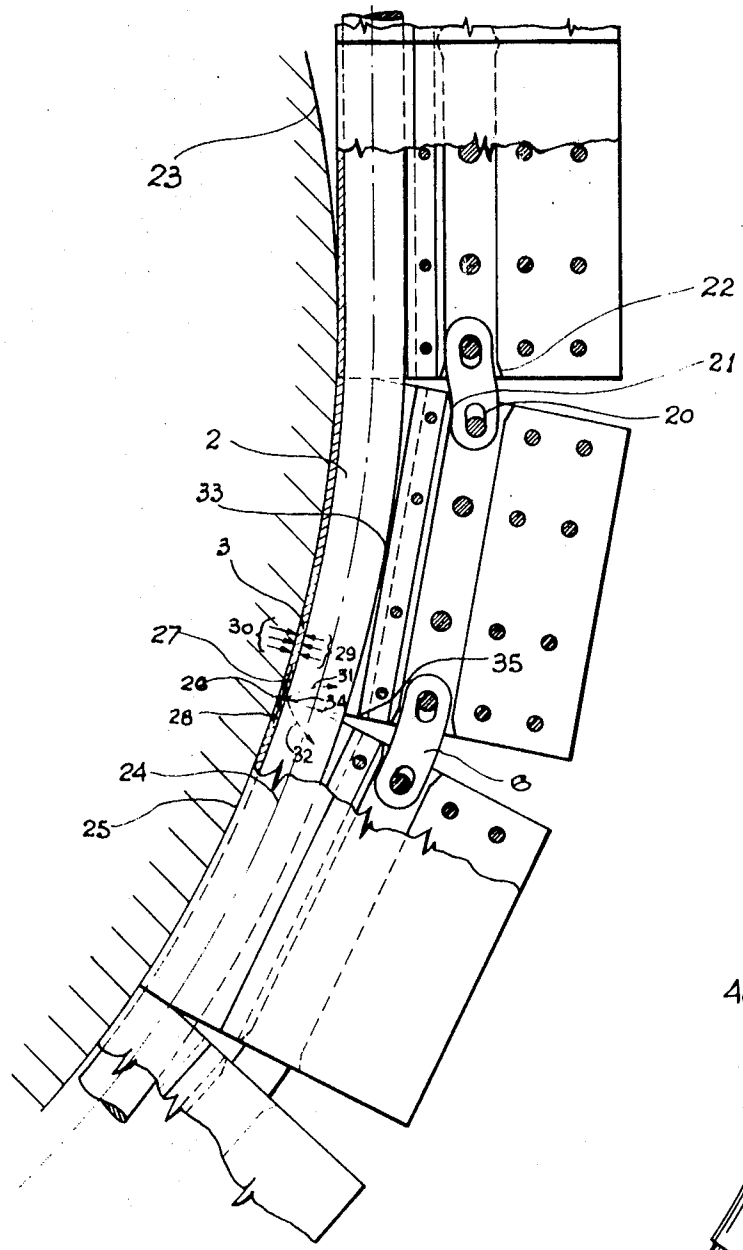

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FIG 3

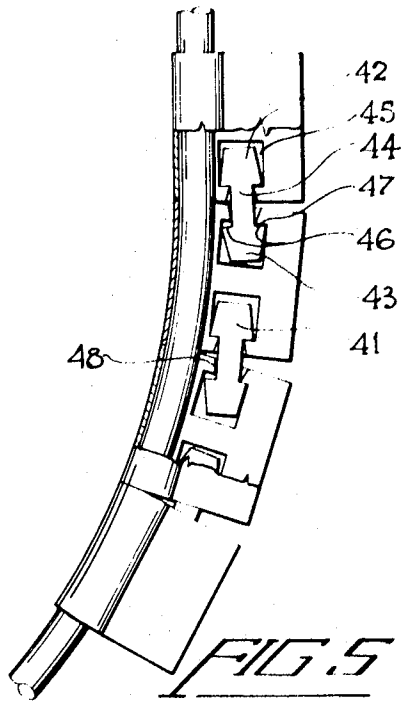
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FIG. 5

LOW-DRAG FAIRING CONFIGURATION FOR FLEXIBLE TOWING CABLES

FIELD OF THE INVENTION

The invention relates to cable fairings.

DESCRIPTION OF PRIOR ART

In the application of cables for underwater towing such as variable depth sonar, water sampling, hydrographic surveys and related oceanographic fields, fairings of aerofoil configuration are attached to said cable in order to reduce hydrodynamic drag and vibration.

In theory, a continuous fairing moulded to the cable is ideal. In practice, however, it is found that as the cable takes on a characteristic catenary curvature due to hydrodynamic drag acting thereon, the trailing edge of the fairing is thrown into tension and the leading edge is thrown into compression. In consequence, the fairing tries to equalize these stresses by 'ruddering' to one side or the other. The result is the development of instability in the cable system.

A solution to this problem now widely used is a sectionalized fairing which comprises a trailing plastic member joined to a metallic nose piece which surrounds the cable. Such a fairing has, dependent upon shape, a theoretical drag coefficient of about 0.06 as compared to a bare cable drag coefficient of 1.2. In practice, however, it is found that the actual drag is much higher than this.

It has been established by carefully controlled hydrodynamic tests that the majority of the excess drag comes about by the necessity of a 'V' notch which is formed between the butting adjacent nose sections. This 'V' notch has to exist with rigid nose fairings to allow the fairing to follow the curvature of the cable without interference. The notch has to be quite liberal in order for the cable to be wound on a storage drum and to pass over towing sheaves.

Somewhat lesser contributors to drag occur due to discontinuities across the flow lines at the nose-tail interface and at rivets that join the components together.

The development of an improved fairing, therefore, is not so much a question of selecting a more perfect sectional profile but rather the evolution of a design that eliminates the causes of departure from theoretical results.

The principal object of our invention therefore is to provide a fairing that is flexible in the nose section thereof in order that it may temporarily yield in compression at the abutment with its adjacent section as the cable bends and regains its original dimensions when the cable is straight, thus eliminating the 'V' notch discontinuity.

A second important object is to provide a fairing that combines axial rigidity in the tail portion of the fairing with the flexible nose portion in order that hydrodynamic forces acting parallel to the axis of the cable, particularly in high-speed applications, do not distort the fairing.

A third object is to provide a fairing design and manufacturing technique that inherently assures perfect symmetry of each fairing section.

A fourth important objective is to simplify the means of assembly of the fairing on the cable and to reduce the number of loose components to a minimum in the assembly operation.

BRIEF DESCRIPTION OF THE DRAWINGS

We will describe our invention making reference to the following figures in which:

FIG. 1 is a plan view of our fairing assembly.

FIG. 2 is an exploded perspective view of our fairing.

FIG. 3 is a sectionalized view of a group of fairings shown in relationship to a sheave.

FIG. 4 is a fragmented perspective view of an alternate type of fairing.

FIG. 5 is a sectionalized view of a group of alternate fairings situated on a flexed cable.

Identical numerals on the several figures indicate similar parts.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a cable fairing 1 attached to a tow cable 2. The fairing comprises a nose piece 3 interlocked with a pair of identical tail members 4 and 5. A link 6 which connects adjacent sections of fairing as shown in FIG. 3 is retained between tail members 4 and 5 by means of projecting pin 7 best shown in FIG. 2.

Tail members 4 and 5 are identical injection mouldings, preferably of light weight plastic, with register pins 8 and register holes 9 so arranged that when the interfaces 10 of the two tail members 4 and 5 come together, pins 8 register and insert into holes 9. A permanent connection between members 4 and 5 may be achieved in the assembly process by a snap-fit between pins 8 and holes 9 or by a solvent bonding or ultrasonic welding process.

Nose member 3 is injection moulded in a durable and flexible material such as polyurethane. A split line 11 permits the nose member to be flexed open for the purpose of wrapping it around the cable 2. Recess 12 and projection 13 in nose piece 3 register with 4 and 5. Holes 16 which pass through the necks 17 formed between split line 11 and the base of recess 12 register with pins 18, said pins being integrally moulded with members 4 and 5. This provides axial alignment between nose member 3 and tail members 4 and 5 when the three components are brought into final register.

Channel recess 19 in tail members 4 and 5 provides accommodation for link 6.

Link 6 comprises a strip of durable and flexible material such as polyurethane with two slotted holes 20, said holes being so placed and dimensioned that link 6 is not substantially thrown into tension when the cable is flexed to its minimum bend radius nor thrown into compression when the cable is straight (see FIG. 3). Flexibility of said link will however permit it to yield laterally to momentary misalignment of adjacent fairing sections as said fairings pass on and off sheaves and the winch drum as indicated in FIG. 3. Chamfered entries 21 and 22 to channel recess 19 provide clearance for lateral flexing of link 6.

OPERATIONAL CONSIDERATIONS

Control of Compression Forces

When a submerged body is towed from a surface vessel by a tow cable at any significant speed, the hydrodynamic drag acting on the cable causes the cable to form a catenary curvature which has its greatest displacement from the vertical at the water surface. The drag acting on the cable and fairing is a force that can be considered in two components, one acting at right angles to the cable and one acting axially down the cable.

The force that acts down the cable is a cumulative one which causes the fairing sections to crowd towards the lowest point. For this reason, the fairing sections must be designed to withstand this cumulative force without undue distortion, and because of this fact, tail members 4 and 5 are manufactured in a hard material to withstand this force without deformation.

Function of the Interconnecting Links

When the cable is submerged and towing at any significant speed, the faired sections become automatically aligned by the water flow. However, as the cable is withdrawn from the water, usually passing over a towing sheave located above the water surface, it is important that the fairing sections do not respond to wind since this may cause them to pivot around the cable at random and enter the sheave or winch drum back to front and thus become crushed and destroyed. Quite obviously, this situation is prevented by links 6. It may be noted that links 6 have slotted holes 20 thus allowing the fairings to move apart during cable flexure without imposing a tensile load thereon. This is best shown in FIG. 3.

Flexibility of Fairing Nose

The primary feature of our invention is that there is always a closed butt joint at the leading edge of the interface between adjacent fairings regardless whether the cable is straight or when the cable is curved.

When the cable is straight the fairing nose 3 is in a substantially relaxed state. When the cable flexes over a sheave 23 (FIG. 3) its length remains constant along its neutral axis 24 and some foreshortening takes place on its concave side 25. In consequence compression takes place at interface 26 as indicated by arrows 27 and 28 and the nose material, being flexible, will yield to these forces.

There is, however, also a compression force acting upon nose 3 where it is sandwiched between the cable 2 and the sheave 23, as illustrated by arrows 29 and 30. Thus the displaced material at interface 26 will flow or squeeze into the area around the nose at the sides of the cable, as illustrated by arrows 31 and 32.

Due to the cable curvature also, the convex side of the cable will bear on the compression portion of the fairing at 33 and will cause an elongation of the nose wrap between locations 34 and 35. Thus between these said locations the nose 3 will be thrown into tension and will naturally be stretched to the required dimension. A fortuitous feature of this fairing is that the compressed material at 26 will flow into the tensioned area at 35, thus tending to reduce both the tensile and compression stresses somewhat. Quite obviously the stresses will be at a maximum at the upper and lower edges of the fairing and they will, with the exception of stresses illustrated by arrows 29 and 30, reduce to zero at the center of the fairing.

An alternative design of flexible nose fairing is shown in FIGS. 4 and 5. Operationally this fairing is identical to the fairing depicted in FIG. 1. The structural differences are described below.

The fairing as shown in FIG. 4 comprises a flexible nose piece 36, preferably of a polyurethane material, and a pair of tail members 37 and 38, preferably moulded in a rigid light weight plastic material.

In the manufacturing process an integral bond is made between nose piece 36 and tail members 37 and 38.

The completed fairing may be flexed open in order to wrap it around the cable then closed and colvent bonded or ultrasonically welded at the interface of surfaces 39 and 40.

A link 41 comprises a pair of equilateral trapezoids 42 and 43 joined by a rectangular neck 44 in the form of a planar stamping from flexible material such as rubber or polyurethane (FIG. 5). One trapezoidal end of each link is retained loosely in a rectangular recess 45 which is formed in the inner surface of parts 37 and 38 such that the shoulders 46 of the link 41 may bear against overhanging portion 47 of the recess 45 to prevent escapement of said link from said recess.

A chamfered entry 48 to said recess 45 permits said link to articulate during bending of the cable as shown in FIG. 5.

The dimensions of link 41 and recess 45 are arranged such that the link will remain substantially relaxed when the cable is straight and also when it is bent to its minimum radius of curvature.

The invention discussed herein has been described substantially in terms of the components used. We do not, however, wish the said invention to be restricted to the precise arrangement of parts described since this disclosure is intended to explain a workable construction illustrating a concept, and is not for the purpose of limiting the invention to any subsequent embodiment or details thereof.

We claim:

1. An assembly of a cable and a plurality of cable fairings, each fairing having a flexible hollow nose with said cable accommodated therein, and a comparatively rigid tail; said flexible nose of each said fairings having flexibility in the longitudinal direction thereof, and each said fairing having end surfaces from front to back thereof which are each substantially planar; each adjacent pair of fairings being connected by a flexible link member; the leading edge of said faired cable being substantially smooth and formed by the closely butted front edges of each adjacent pair of fairings.

2. An assembly according to claim 1 wherein each said link member is flexible.

3. An assembly according to claim 1 wherein each end of each link member is pivotable in the fairing, to which that end is connected.

4. An assembly according to claim 1 wherein each end of each link member is located in the tail of the fairing, to which that end is connected.

5. An assembly according to claim 1 wherein the length of cable covered by the nose of each fairing is substantially the same as the axial length of said nose and said tail of said fairing.

6. A cable fairing comprising a flexible hollow nose and a comparatively rigid tail, said nose and said tail being made of dissimilar materials, and integrally bonded together; said cable fairing having end surfaces from front to back thereof said end surfaces each being substantially planar; each of said nose and said tail portions being noncoextensive with the other over the entire front to back extent of the other of said portions; said flexible nose having flexibility in the longitudinal direction thereof and being flexible in a forward direction away from the tail portion of said fairing; whereby, when the cable fairing is associated with a cable, the cable may be reeled so that it is curved in a forward direction away from the tail of the fairing.

7. A cable fairing comprising a flexible hollow nose and a comparatively rigid tail; said flexible nose having flexibility in the longitudinal direction thereof; said cable fairing having end surfaces from front to back thereof, said end surfaces each being substantially planar; said tail being made of separable portions, and said nose being split at the back side thereof and adapted to be joined on each side of said split to one of said separable portions of said tail, so as to permit entry of a cable into said nose.