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ABSTRACT OF THE DISCLOSURE

A towline and a plurality of fairings are guided through a shееve arrangement into a converging, engaging relationship to automatically clip the fairings to the towline as it is being strung out below a towing vessel. The towline and fairings are automatically separated for winding on separate drums as the towline is pulled in.

BACKGROUND OF THE INVENTION

In many marine operations, a subsurface vessel is towed behind or below a surface vessel, as by a cable or other similar means. It is generally desirable that the subsurface vessel be maintained at a constant or predetermined depth, especially when this vessel contains instruments such as in offshore geophysical operations. When a towline that extends downward into a body of water is moved forward through the body of water, the resistance of the water creates lift or drag which tends to set up vibration in the towline as well as to raise it toward the surface of the body of water. This lift or drag makes it difficult to maintain a towed vehicle or other object at a predetermined depth as it is being towed through the body of water. It has been found that a great deal of the lift or drag on a towline may be eliminated by the use of fairings which are attached to the towline and trailed backward therefrom and reduce or break up low pressure areas that exist behind the towline. The storage of a towline when it is pulled in, as, for example, by winding on a drum, is difficult and burdensome with the presence of fairings thereon. It is therefore desirable that such fairings be readily removable from the towline as it is drawn in to be stored on a drum. Prior known fairings are generally attached to the cable or towline by hand as the cable is being let out and removed therefrom by hand as the cable or towline is being pulled in for storage on a drum. Such methods of attaching and detaching the fairings from the towline are time consuming and generally consume a great deal of labor.

It is therefore a primary object of the present invention to provide an improved fairing that is rapidly and easily attachable and detachable from a marine towline as it is being let out or pulled in.

It is another object of the present invention to provide approved apparatus for the automatic attachment and detachment of fairings to a marine towline as it is being respectively played out and pulled in.

In accordance with the invention, improved clip-on fairings are provided which are guided into engagement with the towline as it is being let out and automatically separated therefrom as the towline is being pulled in.

BRIEF DESCRIPTION OF THE DRAWING

A greater understanding of the present invention may be obtained from the following description when read in conjunction with the drawings, in which:

FIGURE 1 is a side elevational view of a preferred embodiment of the present invention with portions broken away to reveal underlying structure;

FIGURE 2 is a side view of a portion of the fairing assembly of the present invention;

FIGURE 3 is a sectional view taken along lines 3—3 of FIGURE 2;

FIGURE 4 is a partial section taken along lines 4—4 of FIGURE 2;

FIGURE 5 is a side view of a portion of a modified fairing assembly of the present invention;

FIGURE 6 is a partial section taken along lines 6—6 of FIGURE 5;

FIGURE 7 is a side view of an element of the assembly of FIGURE 5;

FIGURE 8 is a schematic diagram of a string of fairings in a stream of water;

FIGURE 9 is a view similar to a portion of FIGURE 1 with certain parts broken away to reveal underlying structure;

FIGURE 10 is an elevational view in section showing a form of the sheave of FIGURE 1;

FIGURE 11 is an elevational view partially in section of a modified form of structure for the apparatus of FIGURE 1; and

FIGURE 12 is a top view of a portion of the guide assembly of FIGURE 1.

DESCRIPTION OF PREFERRED EMBODIMENTS

As illustrated in FIGURE 1, a preferred embodiment of the present invention comprises a base member 11 having a pair of vertically extending support members connected thereto in any suitable manner and extending vertically therefrom. A pair of shafts 13 and 14 and rotatable journeled in spaced relationship in vertical support members 12. A first storage drum 15 is mounted on shaft 13 for rotation therewith. A second storage drum 16 is fixedly mounted on shaft 14 for rotation therewith. A first driving sprocket 17 is mounted on shaft 13 and drivingly coupled thereto by means of a slip coupling 18 which is retained on the shaft 13 by means such as a nut 19. A second driving sprocket 20 is drivingly mounted in a suitable manner on drive shaft 14. A drive chain 21 drivingly couples sprockets 17 and 20 together.

A string of fairings 22 which is made up in any suitable manner of a plurality of individual fairings 23 are stored in a conventional manner on first storage drum 15. The string of fairings may be made up in a number of ways, as will be discussed later. A towline 24 is stored in the conventional manner on storage reel or drum 16. The string of fairings 22 and the towline 24 extend through guide means into converging relationship such that the string or strand of fairings engage the towline and become resiliently connected to the towline as the line assembly is extended or let out. In a similar manner, a string of fairings are guided in a diverging manner and become disconnected from the towline assembly as the assembly is being retracted. The guide means is supported by support members 25 and 26 which is connected in any suitable manner such as by bolting 27 to base member 11 and extends upward at an angle therefrom. A suitable guide assembly comprises a composite sheave 28 (FIGURES 1, 6, and 7) which is rotatably supported on shaft 29 which is attached by means such as nuts 30 between support members 25 and 26. This guide assembly comprises a composite sheave made up of first guide means 73, 74, 77 and second guide means in the form of a split sheave 83, 84. The first guide means 73, 77 engages and guides the towline 24 into proper position for attachment or detachment of the fairings 23. The second guide means 83, 84 engages and maintains the fairing 23 in proper orientation to engage and attach to the towline 24. Third or further guide means in the form of a stationary cam or guide members 31 and 33 are attached in a suitable manner to support members 25 and 26 and extends along
adjacent the path of the string of fairings as it extends between drum 15 and guide means 28. The brace member 32 is attached to support member 25 and extends upward and is connected to cam member 31 to give additional stability thereto. A subsurface vehicle 37, generally illustrated as a fish, is attached by means of a clevis 38 to the outer or trailing end of the towline 24. A fin 39 is attached to and extends outward from the cylindrical body of the fish to improve stability when moving through a body of water.

The fairings of the present invention, which are more clearly illustrated in FIGURES 2 through 4, are preferably constructed to be clipped to the towline. In general, the fairings may be constructed of substantially any material that resists corrosion by sea water, but they are preferably constructed of a resilient material such as rubber or a suitable plastic. When the flexible strand of the fairings is vertical, each fairing should have a height that is generally less than one foot and is preferably from about 4 to 8 inches. Each of the fairings should have a length of from about 5 to 7 times its width and the width of each fairing should be at least about equal to the outer diameter of the largest portion of the line assembly which the fairings are intended to reduce. One form of line assembly to which the fairings are attached is shown in FIGURE 2. This form of line assembly includes a stress member or cable and comprises a stress cable 24 which may contain electrical conduits and a flexible conduit member 40 which may be a hose of flexible material such as nylon or other suitable material. With this arrangement, each fairing 23 is provided with a central opening or bore 41 through which the hose or conduit member 40 is inserted. A second opening 42 which is semicylindrical in configuration is formed at the leading edge of the fairings. A slit 43 extends through the body portion of the fairings between openings 41 and 42. A pair of spring clips 43 and 44 are formed on the leading edge of each fairing 23. Each of the clips comprises a pair of spring members 45 and 46; each spring member 45 and 46 has an end portion 47 and 48, respectively, which extends into slit 43 between openings 41 and 42. Each end portion 47 and 48 has a hole 49 and 50, respectively, therethrough which align with hole 53 in fairing member 23. A bolt 54 extends through the aligned holes 49, 50, and 53 and is secured in place by means of a nut 55.

Another arrangement for the line assembly of the present invention is shown in FIGURES 5 and 6. This arrangement is useful where only a single conduit is needed, which conduit is capable of serving as a stress member. For example, an electrical conduit is generally capable of serving as the stress member. In such an arrangement, the hose receptive openings through the fairings are omitted, as shown in FIGURES 5 and 6. As illustrated in FIGURE 5, the line assembly comprises a stress line or towline 56 to which is clipped a plurality of fairings 57. The plurality of fairings may be up in a strand or string and connected together by any suitable means such as by a link member 58. The link member 58 may be made of any suitable material, such as a metal or plastic. The link member 58 comprises an elongated strip of material having holes 59 and 60 in the ends thereof. Each of the fairings 57 has a pair of clips 63 and 64 which are adjacent and connected by a stress member 56. Each of the clips is constructed substantially as those illustrated in the previous embodiment. As illustrated in FIGURE 6, the clip comprises a plurality of spring members 65 and 66 received in a semi-cylindrical opening on the forward end 67 of the fairing 57. Each of the spring members 65 and 66 includes an end portion which extends backward through a slot in the body member of fairing 57 and is retained in place by means of bolt and nut assembly 68. This assembly, thus, forming a frictional clip fairing assembly whereby the substantially C-shaped clip means is adapted to surround a portion of a towline and fric-tionally retain a fairing thereon under predetermined stress conditions. A pair of adjacent fairings are connected together by means of link member 58 which extends into a slot 67a in each adjacent fairing and retained in place by means of bolt and nut assembly 68.

This size and the resilience of each of the clip members or connectors on the fairings is adjusted so that the dimensions of the stress member to which they are clamped. Where desired, one or more of the resilient connectors or clip members may be mounted on each fairing. It is not essential that each fairing have a clip or plurality of clips formed therein. For example, fairings which do not have clips may be interpersed between and connected to fairings containing connectors or clips so long as sufficient points of attachment are provided to keep the strand of fairings closely paralleling the stress member within the water. For operations in rough seas, or at relatively high tide, additional clip members or connectors may be manually or automatically attached at selected intervals along the stress member to which the fairings are connected. In the strand or string of fairings, each individual fairing should be free to rotate relative to its neighbor by an angle of from about 10 to 30°. As illustrated in FIGURE 8. When the fairings of such a strand are clippings around a continuous member such as a fluid conduit or electrical conduit, the fairings are preferably free to rotate about the continuous member.

It has been found that when a string of fairings is towed through a body of water each fairing will tend to assume its own orientation with respect to the direction of the strand or string of fairings through the body of water. This orientation is assumed to be that of least resistance and in many cases has been found to be as much as 30° from that of an adjacent fairing (FIGURE 8).

The guide assembly of the present invention is more fully illustrated in FIGURES 9 through 12 and will now be described in detail. The guide assembly comprises first guide means formed of a sheave assembly 28 and second guide means in the form of a pair of elongated flanges 31 and 33 which extend along the portion of the path of the string of fairings. The sheave assembly comprises a first or inner sheave 73 which has a central hub member 74 and is rotatably journaled by means of bearings 75 and 76 on shaft member 29. The sheave member 73 has an outward rim comprising a circumferential, semicircular groove 77 in which a tension member such as 24 is received. The sheave member 73 also includes a pair of abutting, sloping faces 78 and 79 which are adapted to engage sloping surfaces 45 and 46 on a fairing such as 23 forcing the spring clips open to release the tension of towline 24. The sheave assembly also comprises a pair of outer annular flange members 83 and 84 which are rotatably mounted such as by bearing means 85 and 86 on a hub member 74 of central sheave member 73. The outer annular guide flange 83 comprises a downwardly, inwardly sloping guide surface 87 which is adapted to engage one side of fairing member 23. Outer annular guide member 84 comprises a like surface 88 which slopes inwardly and downwardly and adapted to engage the opposite side portion of bearing 23. The downwardly sloping guide surfaces 87 and 88 on members 83 and 84 aid in guiding a plurality of fairings such as a strand into a converging relationship with a stress member thereto. The fairing member and attachment thereto. Also, the surfaces 88 and 87 aid in orienting the fairing member 23 or a plurality of fairing members into proper orientation for engagement of the clip means thereon into engagement with the stress member or towline. A pair of annular retainer plates 89 and 90 retain the fairings 23 and 24 in place in the hub of the sheave assembly. A plurality of screws hold the retainer plates 89 and 90 in place in the ends of hub 74 of sheave member 73. The guide flange is more clearly detailed in FIGURE 12.
and extends partially along the line of movement of the fairing assembly as they move in the direction of the storage drum 15 for winding thereon. Elongated flange or cam member 33 extends partially along the path of a strand of fairings with a camming portion thereof 33a engaging each individual fairing and diverts them from their substantially horizontal position into a substantial vertical position so as to extend in substantially the same plane as towline 24 as they move toward the sheave assembly 28 for attachment to towline 24 as they move thereover.

OPERATION

In operating the apparatus of the present invention, the flexible stress member 22, which is normally stored on a drum or reel 15 on the deck of a vessel, is extended over a sheave assembly 28 and is connected to a weight or a preferably buoyant fish 37 which is to be towed through the water. The flexible strand of fairings 22 is stored on a separate drum or reel 15 and is extended over the same sheave assembly 28 and connected along the portion of the stress member that enters the water. The lower end of the strand of fairings 22 is preferably connected to the weight of fish to which the stress member is connected. The positions of the drums 15 and 16 relative to the sheave assembly 28 are arranged so that a strand of fairings extends above the stress member 24 to facilitate guiding engagement therewith. The guide flanges 31 and 32 extend along the fairing assembly 22 to direct the fairings 23 into their upright position for a proper engagement with the flanges 87 and 88 which direct the leading edge of the fairing down into contact with the stress member 24. The operation of the drum 15 for storing the strand of fairings is synchronized with the stress member spool or drum 16 to the extent required to maintain only a moderate tension on the portion of the strand of fairings between the storage drum and the sheave assembly 28. As illustrated in FIGURE 1, this is accomplished by interconnecting the drums by means of chains and sprockets and clip coupling 18.

We claim as our invention:
1. An apparatus for attaching a plurality of frictional clip fairings to a marine towline comprising:
   first guide means for guiding engagement with said towline;
   second guide means for guiding engagement with a plurality of clip fairings each of said frictional clip fairings having at least one forwardly directed C-shaped frictional clip formed in the leading edge thereof;
   at least one of said guide means comprising a pair of guide surfaces engaging opposite sides of said fairing and directing the leading edge thereof toward said towline; and
   said second guide means mounted adjacent one another and cooperating to guide said towline and said string of fairings into engaging relationship, whereby said fairings engage and clip to said towline.

2. The apparatus of claim 1 wherein:
   said first guide means comprises a sheave;
   said second guide means comprises a sheave concentrically mounted with respect to said first guide means; and
   said second guide means includes guide surfaces spaced radially outward of and to either side of said first guide means.

3. The apparatus of claim 1 including:
   storage means for said fairings; and
   storage means for said marine towline.

4. The apparatus of claim 1 wherein:
   said first guide means comprises a sheave; and
   said second guide means comprises a split sheave.

5. An apparatus for attaching a plurality of friction clip fairings to a marine towline, said apparatus comprising:
   a base member;
   support means extending from said base member;
   first and second guide means rotatably mounted on said support means;
   said first guide means adapted to support and guide a marine towline;
   each frictional clip fairings having at least one forwardly directed C-shaped frictional clip formed in the leading edge thereof;
   said second guide means adapted to guide the leading edge of a plurality of said frictional clip fairings into attaching engagement with said towline.

6. The apparatus of claim 5 wherein:
   said plurality of fairings are connected together to form a strand.

7. The apparatus of claim 6 wherein said fairings are connected together by link means extending between adjacent ones of said fairings; and
   said link means is operatively connected to said fairings to permit relative movement between adjacent ones of said fairings.

8. The apparatus of claim 1 including:
   third guide means for orienting said fairings to extend in a radially outwardly direction from said first guide means and in substantially the same plane thereof.

9. A frictional clip fairing assembly for a marine towline, said assembly comprising:
   a fin member having a substantially symmetrical hydrofoil cross-sectional configuration;
   an accurate opening formed in the leading edge of said fairing member; and
   frictional clip means comprising flexible means surrounding said opening and biased toward the center thereof for gripping engagement with a towline.

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