United States Patent [19]

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[54] **BUOYANT ELECTRICAL CABLE**

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[52] **U.S. Cl.** ..... **174/101.5**, 340/7 PC, 114/235 B

[51] **Int. Cl.** **H01b 7/12**

[58] **Field of Search** ..... 174/101.5; 340/7 PC; 114/235 B

[56] **References Cited**

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[57] **ABSTRACT**

An improved electrical conductor of the buoyant type is herein disclosed. An electrical conductor, or a plurality thereof, is supported in a flat casing co-extensive therewith by a shaped loom. A plurality of inflatable buoyancy devices are supported along one surface of said casing to support said casing on the surface of a body of water. Means are disclosed for inflation of said buoyant means individually as well as collectively.

8 Claims, 5 Drawing Figures

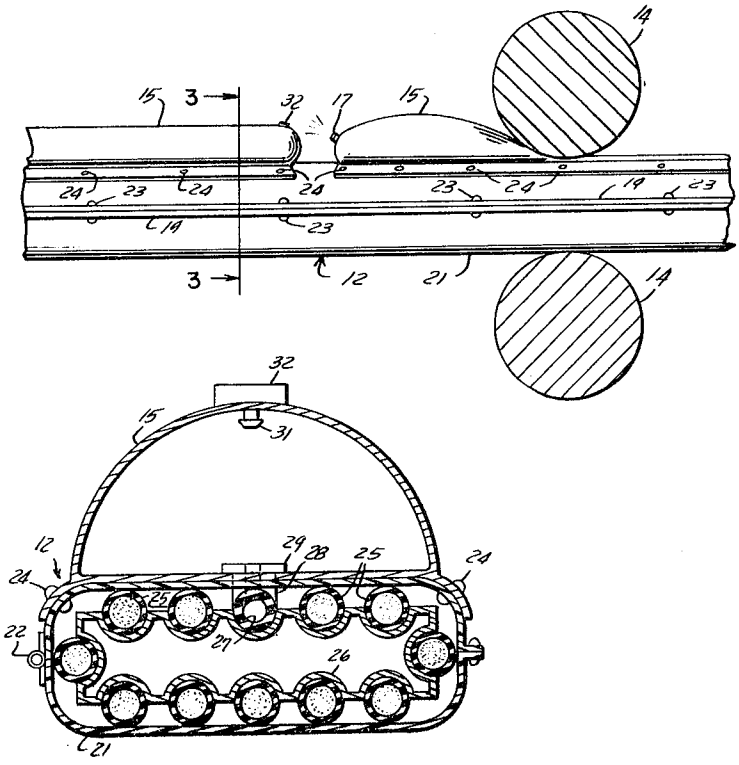


FIG. 1

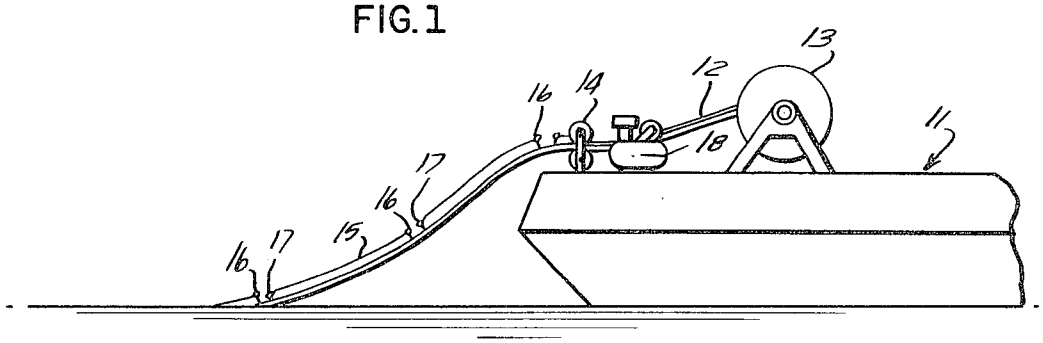


FIG. 2

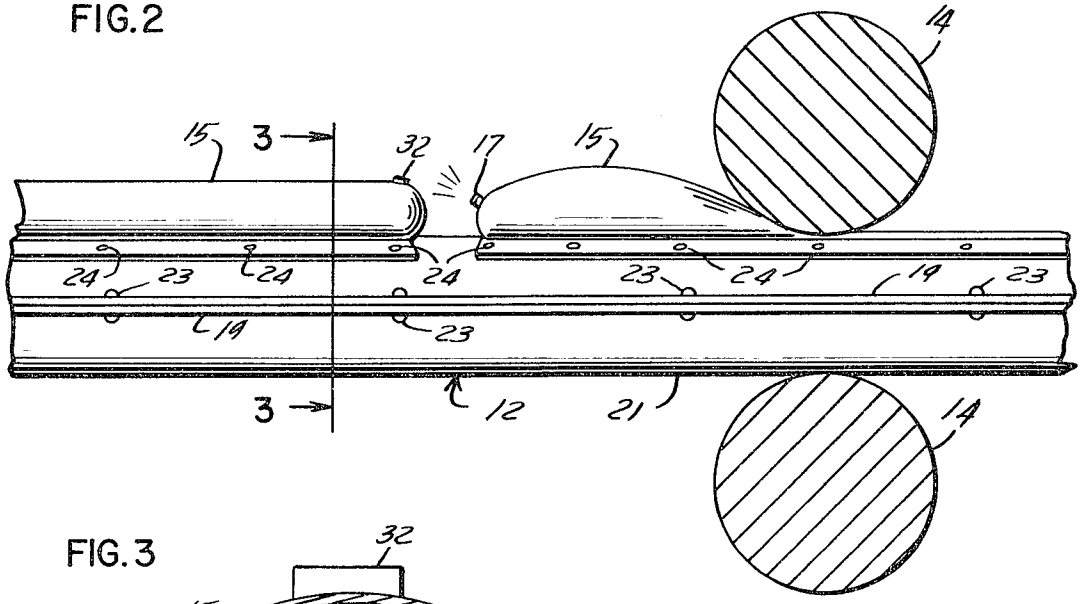
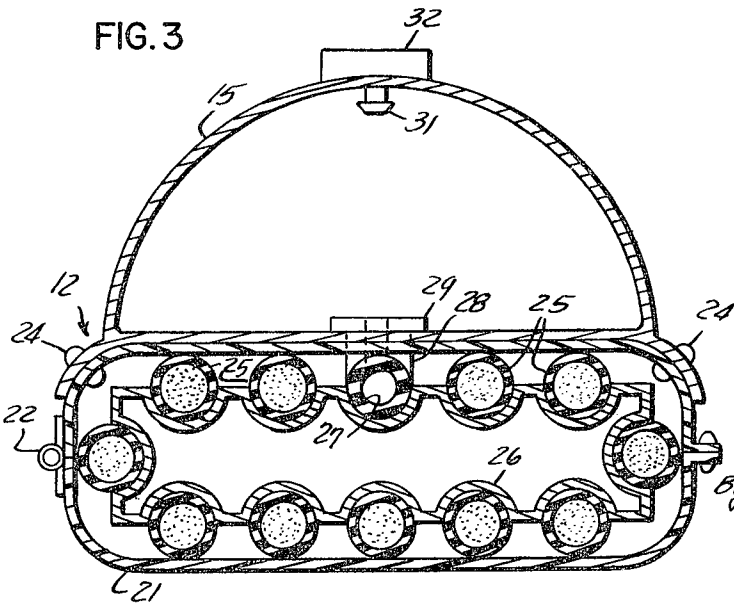


FIG. 3



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FIG. 4

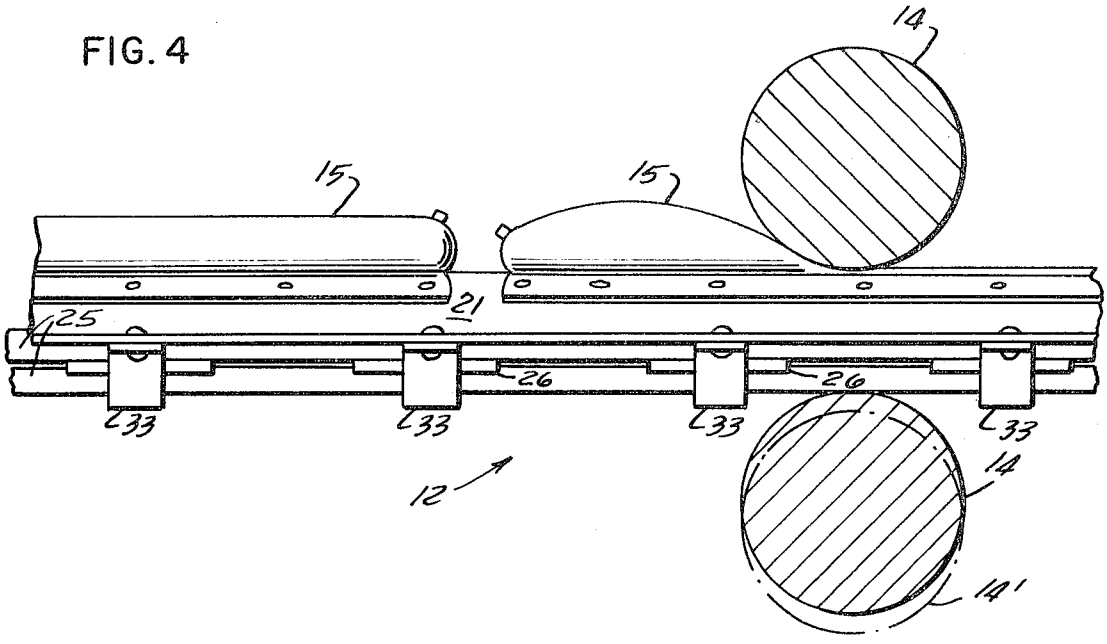
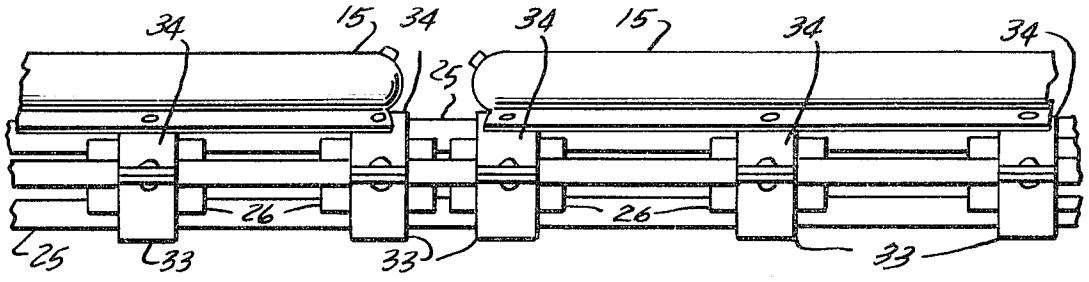


FIG. 5



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BUOYANT ELECTRICAL CABLE

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

This invention relates to an improved electrical cable of the buoyant type. More specifically, but not by way of limitation, the invention relates to buoyant cables designed to conduct large amperage electrical currents for minesweeping and oceanographic applications. Prior art devices of this type may, for purposes of discussion, be classified into categories depending on the type of buoyancy structure employed.

One type, exemplified by U. S. Pat. No. 2,422,727 issued June 24, 1947, to F. H. Gooding for Buoyant Electrode, has a layer of conductors laid up on a hollow or cellular body forming the core of the cable. This type of cable requires that the insulating sheath encompass the entire cable including the buoyant core. Since the resulting cable is of a large diameter, this precludes a simple extruded insulating sheath being used as the exterior insulation. Generally this results in the outer insulating layer being laid up in strips and vulcanized together. Aside from being time consuming and expensive to fabricate, the resulting cable is relatively weak, easily ruptured, and susceptible to water penetration.

A second type of prior art construction is exemplified by U. S. Pat. No. 2,419,053 granted on Apr. 15, 1947, to C. E. Bennett for Buoyant Electrical Cable. In this type construction external cylindrical buoyant floats are placed on the exterior of a more-or-less conventional conductor which may incorporate extruded insulation. These cables have inherent heat dissipation problems in high amperage applications. Further, the individual cylindrical floats cause localized abrasion on the outer insulation of the cable. Such abrasive ruptures are difficult to locate since the floats cover the entire length of the cable. Repairs are also made difficult since the float must be removed, usually by sawing it off, to gain access to the cable.

A third method of construction in which an outer cellular rubber or plastic sheath is extruded about a centeral conductor is seldom used in high amperage applications. The thermal insulation properties inherent in the buoyant cellular sheathing makes the cooling of the conductor difficult.

All of the above construction techniques result in a bulky cable having high hydrodynamic drag. Further, the constructions of the prior art result in a cable which requires a great deal of storage space and large bulky reels with comparable elephantine driving mechanisms. Those familiar with shipboard space limitations on oceanographic and mine sweeping vessels recognize what a limitation this is. In fact, the storage and handling considerations have placed design limitations on the electrical systems carried by such vessels. A high amperage low bulk system has been a long awaited improvement.

SUMMARY OF THE INVENTION

Applicant's invention makes possible a high amperage cable having low cost, ease of service, good thermal properties, and very low bulk. These highly desirable features are made possible by a flat, ribbon-like conductor assembly which is buoyed on the surface by a collapsible chamber carried thereby. Details of construction and other desirable features will be made more clear upon consideration of the preferred embodiments disclosed herein, and the appended claims.

It is, accordingly, an object of this invention to provide an improved buoyant electrical conductor.

A further object of the invention is to provide a high amperage buoyant cable with low hydrodynamic drag.

A further object of this invention is the provision of a high amperage buoyant electrical cable having improved cooling.

A further object of this invention is to provide a buoyant cable for high amperage applications which may be conveniently reeled and stored.

Another object of this invention is to provide a buoyant electrical cable which may be easily repaired.

A still further object of this invention is the provision of a buoyant electrical cable with collapsible buoyant chambers.

Another object of this invention is to provide a buoyant electrical conductor with inflatable chambers.

A still further object of this invention is the provision of an electrical cable containing conduit means for inflation of buoyant chambers attached thereto.

Yet another object of this invention is to provide for automatic filling of collapsed buoyant chambers attached to an electrical conductor as said conductor is paid out from a tractor vehicle.

Other objects and many of the attendant advantages will be readily appreciated as the subject invention becomes better understood by reference to the following detailed description, when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevation of the device of the invention in use;

FIG. 2 is an elevation view of a section of the buoyant cable of the invention, as it is being reeled in to the tractor vehicle;

FIG. 3 is a sectional view of a preferred cable construction taken along line 3—3 of FIG. 2;

FIG. 4 is an elevational view of another construction of the cable according to the invention; and

FIG. 5 is an elevational view of a further constructional variation of the cable of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a surface vessel 11 is shown paying out a buoyant cable 12 from a deck mounted reel 13. Although the tractor vehicle depicted is a surface vessel, other vehicle types, such as rotary wing aircraft, may be used, if desired. Cable 12 passes between rollers 14 prior to entering the water. As cable 12 is paid out, rollers 14 serve primarily as guides. During recovery, the rollers serve to evacuate flotation units 15, which are serially attached to cable 12, as will be presently made clear. Each flotation unit 15 has an inlet valve 16 at the bitter end thereof and an exhaust valve 17 at the distal end thereof. Inlet valve 16 may be of

the quick connect variety. Exhaust valve 17 is preferably of the pressure release variety.

An air compressor 18, shown mounted on the deck of vessel 11 for illustration purposes only, is connected so as to inflate flotation units 15 when desired. The particular operational details of air compressor 18, as applies to the invention, will be considered in greater detail presently.

By referring to FIGS. 2 and 3, the constructional details characterizing one embodiment of the cable of the invention will be more clearly understood. Casing 21 is formed from upper and lower halves hingedly connected by hinges 22 along one edge and fasteners 23 through flanges 19 extending along the other edge. Fasteners 23 may be of a quick disconnect variety, if desired, or they may be easily severable rivets.

On the upper half of casing 21, a plurality of flotation units 15 are secured by suitable fasteners 24, which may be identical to fasteners 23, if desired. Flotation units 15 are arranged serially along the length of casing 21, so as to provide buoyant support along the entire length thereof. Flotation units 15 may be constructed of any suitable waterproof flexible material. For developmental studies, fabric impregnated with synthetic rubber has proven satisfactory. Flotation units 15 are of a suitable length, 15 meters, for example, so as to permit convenient individual replacement. Further, should one flotation unit 15 become faulty in operation, the overall performance of buoyant cable 12 is not compromised.

Pressure relief exhaust valve 17 provides an escape for the gas in flotation units 15 as they pass between rollers 14 upon recovery of cable 12. This forced evacuation of the inflating gas causes flotation units 15 to flatten against casing 21 so as to permit compact coiling on reel 13, FIG. 1. Flotation units 15 may be constructed to fold flat by precreasing the sides thereof in a similar fashion to that employed in the construction of life jackets and similar inflatable articles made of impregnated fabric. Further, the volume of flotation units 15 may be determined in advance to support the particular weight to be supported thereby. Thus, a variety of sizes of units may be made available to be used in accordance with the particular application for which the cable is to be used. Likewise the spacing along the cable may be altered to obtain a desired degree of buoyancy.

A plurality, up to eleven in the illustrated configuration, of insulated conductors 25 are carried within casing 21 supported on loom 26, so as to be clamped in mechanical and thermal contact with casing 21. Loom 26 may be coextensive with casing 21, or, alternatively, may comprise short sections spaced along the length of casing 21. The individual conductors 25 are low cost, conventional, high-amperage, insulated conductors. Such conductor stock is readily available, thereby facilitating repairs of buoyant cable 12, when necessary. Casing 21 and loom 26 are free flooding to permit water to cool the conductors as cable 12 is towed therethrough.

Casing 21 and loom 26 may be made of a variety of materials. Several modern plastics have the strength and abrasion resistance to perform satisfactorily and are preferred. However, in certain instances, a rubber and fabric arrangement similar to that used in pneumatic tires may be used. Also, certain select metallic materials may be used if it does not interfere with the operation of the electrode and if the cable, so constructed is sufficiently flexible to permit coiling on reel 13. Casing 21 may have apertures, not shown, to facilitate flooding and drainage as cable 12 is payed out and recovered.

An air line 27 is carried along the upper half of casing 21. At spaced intervals along the length of air line 27, hose fittings 28 are located. Fittings 28 extend through casing 21 to receive valve seat 29 therein. Valve seat 29 is bonded to the lower wall of flotation unit 15 at the bitter end thereof, so as to effectively become integral therewith. A plug 31 is carried by the upper wall of flotation unit 15 and is positioned to be inserted in valve seat 29 when flotation unit 15 in its collapsed condition and thereby provide an effective air tight seal therefor. A float 32 is attached to plug 31 and the upper wall of flotation unit 15. Float 32 withdraws plug 31 from valve seat 29 when cable 12 is placed in the water, so as to submerge float 32.

Float 32, plug 31, and valve seat 29 together comprise a float actuated valve to permit filling of flotation unit 15, via air line 27, upon entrance of cable 12 into the water. The fit of plug 31 in valve seat 29 is such that the pressure within air line 27 is insufficient, by itself, to unseat the plug, but the combined lift of float 32 and pressure within line 27 causes plug 31 to be lifted from its seat.

Other float actuated valve arrangements are, of course, available and may be used, if desired, to provide automatic inflation of flotation units 15. The only design consideration worthy of particular note concerns the size and strength of the proposed substitute. That is, it should be capable of withstanding the pressure of outer layers of cable 12 when stored on reel 13, and be of a small size so as not to interfere with the winding and reeling of the assembled cable.

The assembled cable 12 presents the smooth surface of the bottom half of casing 21 to the water. This, together with the overall uniformity cross sectional area, provides a low drag force to be encountered when cable is streamed. Such an improved drag figure results in faster tow speeds, or more cable streaming capacity for a given size tractor vessel.

The flat, ribbon-like cross section of casing 21 and the free flooding thereof permit cooler conductor temperatures to be maintained when cable 12 is in use. This results in improved electrical efficiency and more effective utilization of the cable. Further, the shape with flotation units 15 collapsed facilitates the storage of more cable in a given volume, i.e., reel size. This, in turn, permits older vessels with accommodations for limited reel sizes to be utilized without modification for high amperage applications requiring greater cable capacity. This later consideration is of considerable economic value.

In warmer seas or in very high amperage applications, additional cooling may be required. Referring now to FIG. 4, a slightly different construction of the buoyant cable according to the invention which will provide the necessary additional cooling will be described. The lower half of casing 21 has been replaced by a series of straps 33. Straps 33 cooperate with the upper half of casing 21 to secure insulated conductors 25 together with looms 26 thereto. In this construction, rollers 14 function as before, but have limited movement as indicated by the position shown by broken lines 14', so as to clear straps 33 as cable 12 is recov-

ered from the water so as to be reeled aboard vessel **11.**

The construction of FIG. **4** permits more water contact with insulated conductors **25** and, consequently, greater cooling thereof. Therefore, higher amperages may be used with the construction of FIG. **4** than that of FIG. **2.** Furthermore, the construction of FIG. **4** permits easier service of conductors **25** and a considerable saving of weight.

Further saving of weight and increase of cooling may be effected by the use of the construction of FIG. **5.** In this embodiment the upper half of casing **21** is dispensed with, so that a continuous envelope structure no longer exists. In place of the upper half of casing **21,** straps **34** cooperate with straps **33** to comprise spaced cable ties to unit insulated conductors **25,** loom **26,** and flotation units **15.** The spaced ties comprising straps **33** and **34** may be regarded as a discontinuous casing means. This arrangement is the lightest weight and lowest bulk of the several constructions shown.

It should also be noted that further weight reduction may be effected by making the flotation units of light weight, close weave, synthetic fabric, such as nylon, for example, rather than the heavier impregnated fabric. Since the flotation units remain in communication with air line **27,** the leakages through the pores of the material of which flotation units are constructed will be supplied by air compressor **18.** This arrangement is particularly useful in the open type casing of FIG. **5** since the roller **14** evacuation of flotation units **15** may not be completely effective. The lightness and compactness of this cable is remarkable in comparison with cables of the prior art of similar amperage rating.

MODE OF OPERATION

The operation of the device of the invention is, of course, ultimately dependent on the use to which buoyant cable **12** is to be put. That is, power transfer to a towed load will require one cable configuration while the use as a magnetic field producing electrode will require another configuration. Nonetheless, the proximate operational aspects of streaming and recovery of the various constructions are the same regardless of the use to which cable **12** is put.

If quick disconnect inlet valves **16** are used, cable **12** is stopped each fifty feet of length as it is paid out from reel **13.** As each flotation unit **15** emerges from between rollers **14,** air compressor **18** is connected to valve **16** thereby inflating flotation unit **15,** so as to buoyantly support cable **12** on the surface of the water. In this type of filling technique cable **12** may be caused to assume different degrees of buoyancy, and hence different angles with respect to the surface, along its length by selective filling of serial flotation units **15.**

If the float valve arrangement of FIGS. **2** and **3** is used, air compressor **18** is connected to air line **27,** via fittings on reel **13,** not shown. Cable **12** is paid out continuously and each flotation unit **15** is inflated as the bitter end thereof is emersed in the water. Such emersion causes float **32** to withdraw plug **31** from valve seat **29** thereby inflating flotation unit **15.** If other state-of-the-art float actuated valves are used, the operation is essentially the same.

As previously explained, the electrical operation of the cable remains the same as in prior art applications. One such possible utilization system is shown in U. S. Pat. No. 2,937,611 granted on May 24, 1960, to W. Schaelchlin et al. for Control Systems, and other applications as now practiced in the oceanographic, minesweeping, and similar related arts will suggest themselves to proficient artisans in these fields of endeavor.

The recovery operation of cable **12** is the same for both types of flotation units. Reel **13** is driven so as to wind cable **12** back aboard vessel **11.** As cable **12** passes between rollers **14,** the air contained in flotation units **15** is expressed therefrom, venting through exhaust valve **17.** In the arrangement of FIGS. **2** and **3,** rollers **14** also insert plug **31** in valve seat **29,** although, if desired, plug **31** may be inserted manually.

The foregoing description taken together with the appended claims constitute a disclosure such as to enable a person who is skilled in the oceanographic instrumentation and marine engineering arts and having the benefit of the teachings contained therein to make and use the invention. Further, the structure herein described meets the objects of invention, and generally constitutes a meritorious advance in the art unobvious to such a skilled worker not having the benefit of the teachings contained herein.

Obviously, other embodiments and modifications of the subject invention will readily come to the mind of one skilled in the art having the benefit of the teachings presented in the foregoing description and the drawings. It is, therefore, to be understood that this invention is not to be limited thereto and that said modifications and embodiments are intended to be included within the scope of the appended claims.

What is claimed is:

1. An improved high amperage buoyant cable comprising in combination:

casing means for providing a wear resistant structure having an enclosed passageway therein;

electrical conductor means located within said enclosed passageway and coextensive therewith for conducting electrical currents therein;

loom means having a hollow preform with a plurality of arcuate indentations therein for supporting said electrical conductor means in contact with said casing means;

conduit means located within the aforesaid casing means and supported by one of the arcuate indentations in said loom means for supplying gas under pressure to the enclosed passageway within said casing means;

fitting means attached to said conduit means and extending through said casing means for providing a passage for said gas to the exterior of said casing means; and

a plurality of inflatable flotation means attached to said casing means in such a manner as to serially extend therealong for buoyantly supporting said casing means and the electrical conductor and loom means encased thereby.

2. A buoyant cable according to claim **1** in which said casing means further includes:

upper casing means for enclosing said conductors and supporting said flotation means;

lower casing means shaped to fittingly cooperate with said upper casing means, so as to support and enclose the aforesaid conductor means; and

hinge means attached to one side of said upper and lower casing means, so as to hold them in hingedly cooperating relationship for providing readily ob-

tainable access to the interior of said casing means and the conductors and looms carried thereby.

3. A buoyant cable according to claim 2 additionally comprising fastener means attached to said upper and lower casing means for securing said hingedly joined upper and lower casing means together to provide enclosing support for said electrical conductor means.

4. A buoyant cable according to claim 1 wherein the aforesaid flotation means further comprises:

pressure relief exhaust valve means at one end of each aforesaid flotation unit for exhausting the inflating gas therefrom; and

inlet valve means at the opposite end of each aforesaid flotation unit from said exhaust valve means for admitting inflation gas therethrough.

5. A buoyant cable according to claim 4 wherein said inlet valve means is attached to the aforesaid fitting means for admitting gas from said conduit means.

6. A buoyant cable according to claim 5 in which said inlet valve means is a submergence actuated valve for admitting gas therethrough when said flotation unit is submerged in a liquid.

7. A buoyant cable according to claim 6 in which said submergence actuated valve comprises:

valve seat means located on the lower wall of said flotation unit so as to extend therethrough, and attached to aforesaid fitting means for conducting gas therethrough to inflate said flotation unit;

plug means attached to said upper wall of said flotation unit and positioned for fitting within said valve seat when said flotation unit is deflated for stopping the flow of gas therethrough; and

float means attached to said upper wall of said flotation unit, so as to be effectively attached to said plug means for lifting said plug means from said valve seat means when said flotation means is submerged in a liquid.

8. A buoyant cable for conducting high amperage electrical currents therethrough while floating on the surface of a liquid comprising in combination:

upper casing means comprising a broad, flat, inverted U-shaped member and having outwardly extending flange means along one edge thereof for providing enclosure and structural support of said cable;

lower casing means comprising a broad, flat, U-shaped member complementarily shaped to said upper casing means and having an outwardly extending flange means on one edge thereof in mating relation with said flange on said upper casing means for cooperating with said upper casing means in providing enclosure and structural support for said cable;

fastener means passing through said flange means for securing said upper and lower casing means together;

hinge means connected to said upper and lower casing means on the edges thereof opposite said flanges for hingedly joining said casing means, so as to permit hinged relative movement therebetween when said fastener means are removed;

insulated electrical means within said upper and lower casing means for conducting electrical currents therethrough;

loom means within said casing means formed to receive said insulated electrical conductor means and for supporting said insulated electrical conductor means in a predetermined relationship in contact with said casing means;

conduit means enclosed within said upper and lower casing means and supported by said loom means for supplying gas therethrough;

a plurality of fitting means spaced along said upper casing means and extending therethrough and communicating with said conduit means for providing spaced passageways for gas flow from said conduit means through said casing means;

a plurality of serially spaced inflatable flotation units attached to said upper spacing means for buoyant support thereof;

inlet valve means disposed in the bitter end of said inflatable flotation units and connected to said fitting means for inflation of said flotation units, said valve means being submergence actuated to cause inflation of said flotation units upon submergence thereof within a liquid; and

pressure release exhaust valve means in the distal ends of each flotation unit for exhausting the inflating gas therein when said buoyant cable is retrieved.

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