Dec. 30, 1952 J. N. BEEBE 2,623,932

MAGNETIC COUPLER

Filed March 5, 1948 2 SHEETS—SHEET 1

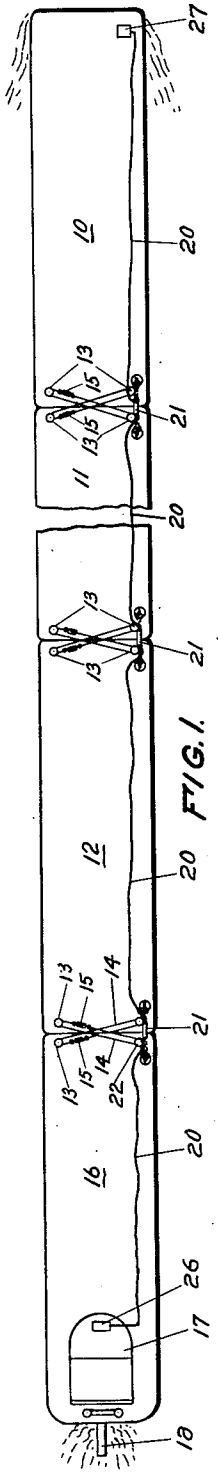

FIG. 1.

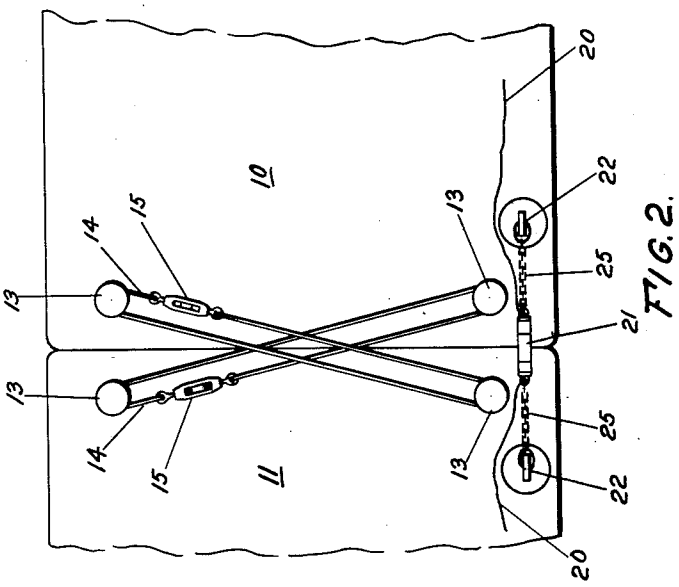

FIG. 2.

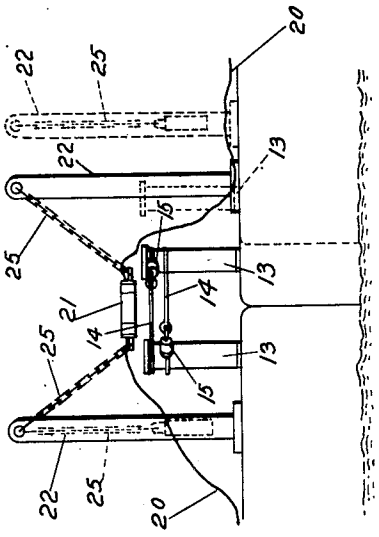

FIG. 3.

INVENTOR
JOHN N. BEEBE
BY Elmer J. Gow
ATTORNEY

Dec. 30, 1952 J. N. BEEBE 2,623,932

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Filed March 5, 1948 2 SHEETS—SHEET 2

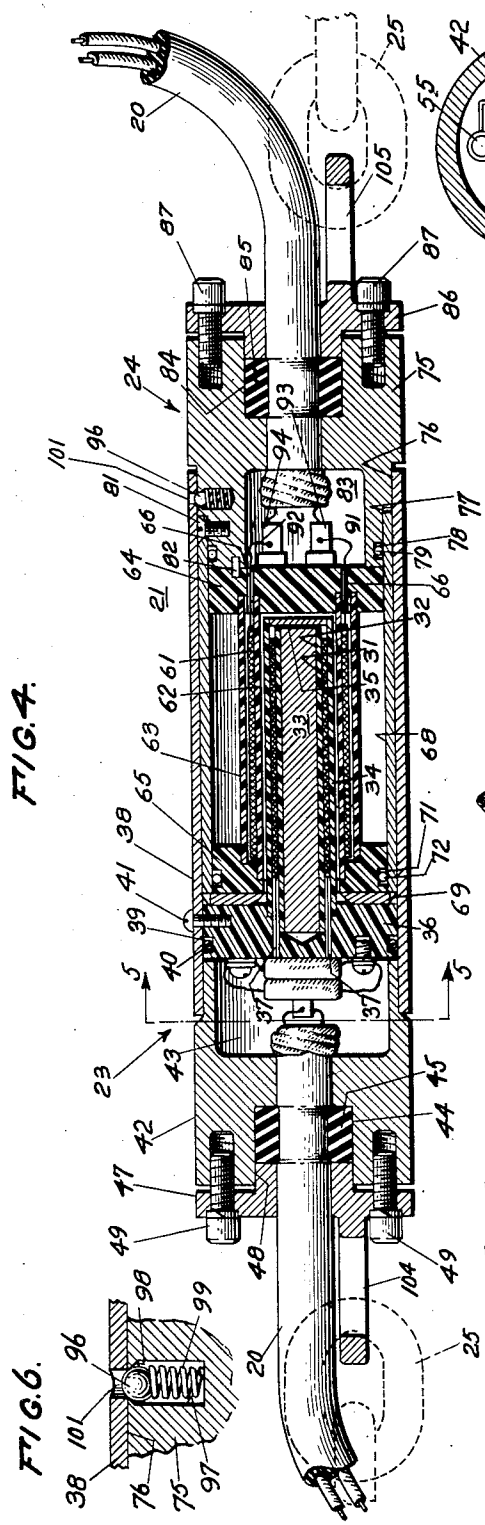

FIG. 4.

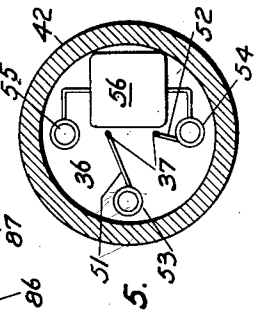

FIG. 5.

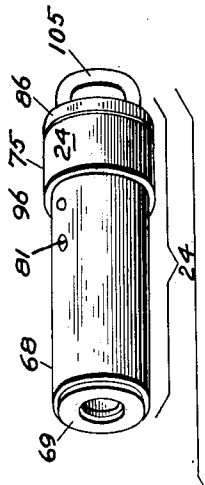

FIG. 8.

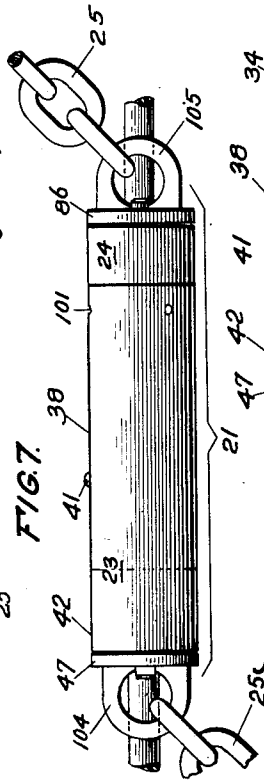

FIG. 7.

FIG. 6.

INVENTOR
JOHN N. BEEBE
BY Elmer J. Fox
ATTORNEY

Patented Dec. 30, 1952

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MAGNETIC COUPLER

John N. Beebe, Newton, Mass., assignor to Raytheon Manufacturing Company, a corporation of Delaware

Application March 5, 1948, Serial No. 13,312

3 Claims. (Cl. 175—356)

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This invention relates in general to cable connectors for alternating electric power cables and more particularly to a novel magnetic coupler for connecting together portions of such a cable in readily disconnectible fashion.

It is the principal object of this invention to provide a readily disconnectible cable connector for alternating electric power cables which is completely suitable in all respects for use aboard barges and the like which carry inflammable products, such as petroleum products.

It is accordingly an object of the invention to provide a readily disconnectible cable connector for alternating electric power cables wherein there is no sparking when connection is made or broken.

It is another object to provide such a connector that provides inductive or magnetic coupling to a uniform degree without critical manufacturing tolerances.

It is another object to provide such a connector wherein the electrical function is completely unaffected by immersion in water.

It is a further object to provide such a connector wherein all electrical connections to power cables are fully shielded from water.

It is a still further object to provide such a connector that is rigidly sheathed and protected from harm due to shocks, banging, dropping, or compression under heavy weights, and in which each separable part thereof is individually so protected.

It is another object to provide such a connector that remains coupled together when so placed, and does not come apart when kicked, stepped on, or otherwise treated in the course of its normal useage, but which readily becomes disconnected when a force of greater than a predetermined amount is applied to separate its parts.

Other and further objects and features of the invention will become apparent from the description of a particular embodiment thereof that follows. The description refers to the accompanying drawings, wherein

Fig. 1 shows a barge tow employing the invention;

Fig. 2 is an enlarged view of the abutting ends of two of the barges shown in Fig. 1;

Fig. 3 is a side elevation of Fig. 2;

Fig. 4 is a longitudinal sectional view of a connector in accordance with the invention;

Fig. 5 is a section along line 5—5 in Fig. 4;

Fig. 6 is an enlarged view of the retaining arrangement employed in the connector of Fig. 4;

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Fig. 7 shows the connector when the two parts thereof are connected together; and

Fig. 8 shows the connector with the two parts thereof separated.

Referring now to Figs. 1, 2 and 3, Fig. 1 shows an arrangement known as a "barge tow." A plurality of freight barges 10, 11, 12, etc., are firmly fastened together as shown most clearly in Fig. 3 by means of stanchions 13 mounted one at each corner of each barge, and lines 14 looped over the stanchions to tie the barges together. The lines are crossed diagonally and are provided with turnbuckles 15 for tightening. The barges thus form a rigid unitary vessel about 800 or 1000 feet long. This vessel is pushed by a powered craft 16, which is fastened firmly to one of the end barges, here, barge 12. The powered craft 16 is provided with a pilot house 17 and a rudder 18. Screws are, of course, also provided, but are not illustrated.

For various purposes, it is desired to convey electric signals and power between the pilot house and the forward barges, and to this end a power cable 20 is laid on the decks of the barges, from one barge to the next. Because various ones of the barges are separated from the tow and other barges may be added at various docking points, in the same manner as freight cars are attached to and taken from freight trains, this cable 20 is provided with connectors 21 at each junction between barges, whereby the cable may be readily broken and made up.

Additional stanchions 22 are provided on each barge at the corners on one side only thereof. Each cable connector 21 is made of two separable parts 23 and 24 as shown more clearly in Figs. 7 and 8, and each part is connected by way of a chain 25, for example, to one of the additional stanchions 22. As will be described in detail below, the power cable 20 is brought into and out of the connector parts 23 and 24, and the connector remains assembled until pulled apart intentionally or because of a break in the tow. The chains 25 are long enough to permit a small degree of play and sideway in the position of the connector 21, but are sufficiently short so that, when the connector is parted, neither part 23 nor 24 can fall over the side of the barge, where it might be crushed between barges, or between the barge and a dock. In addition, the cable 20 is left sufficiently loose at the connector so that, if two barges part, the chains 25 will become tight before the cable does, and part the connector 21 before the cable pulls out of either part 23 or 24 thereof.

Because the barges very often carry inflammable products, the connector is spark free, and, because it is roughly handled, there is a rigid sheath provided and the parts are individually waterproofed, all as will be described below.

The stanchions 22 that support the connectors 21 are sufficiently high, and the chains 25 sufficiently long, so that there can be some play or freedom of motion before the connector is pulled apart, but, when it is pulled apart, as illustrated by dotted lines in Fig. 3, neither part of it will fall over the side of the barge. In this way the crushing of the part between barges or barge and dock is avoided, while the connector is in a convenient position for handling.

The cable 20 carries power from a control station 26 in the pilot house 17 to a forward station 27. The two stations 26 and 27 may, for example, be telephone stations, or they may be, respectively, the locations of a depth-finder indicator and an electroacoustic transducer, in which case a signal having a frequency of 40 to 50 kc./sec. may be transmitted through the cable 20. In any case, the cable 20 will carry alternating current, as will appear from the discussion to follow.

Referring now to Figs. 4 to 8, inclusive, it will be seen that the connector 21 comprises essentially a magnetic coupler in two separable parts, each of which is provided with a rigid protecting sheath and has its electrical parts all protected from water, and that the magnetic coupler portions and the sheaths all interfit telescopically when the connector is assembled. Thus the first part 23 of the connector is provided with a first coil 31 which is wound on a coil form 32. Contained within the coil form 32 is a magnetizable core 33, which, for high frequencies of the order of 40 to 50 kilocycles per second, is preferably of powdered iron. Surrounding the first coil 31 is a waterproof covering or tube 34, which may, for example, be coil form material coated with beeswax or a waterproof varnish. The end of this tube 34 is closed with a waterproof closure in the form of a disc 35. The coil form 32 and the tube 34 are both made of insulating material, and are mounted on an insulating base 36, being cemented into grooves cut therein. The outer covering tube 34 at least must be sealed to the base 36 in watertight fashion. Two holes 37 are provided across the base 36, starting from points between the grooves for the coil form 32 and tube 34, for the passage of wires from the coil 31 through the base.

The base 36 is mounted in a rigid sheath 38, which may be a piece of metal tube or pipe for strength, and is preferably of brass to avoid the striking of sparks between the connector and steel parts of the barges. The base is provided with a peripheral groove 39 wherein is fitted a rubber or similar ring 40 to provide a water seal between the base and the sheath 38. The base is firmly held in place in the sheath by means of screws 41, placed on the side of the groove 39 that is toward the free end of the coil assembly.

The sheath 38 is closed at the end holding the base 36 by a rigid end cap 42 which has a cavity opening toward the base 36 and forming with the base a chamber 43 for wire connections and certain electrical components to be described later. The closure between the shield 38 and the end cap 42 is made rigid and watertight, as by brazing, when brass is used, or another suitable process. The far end of the end cap is provided with an opening 44 for the passage of the cable 20, and a soft gasket 45 of rubber or the like is placed around the cable in the opening. A pressure cap 47 fits around the cable and has a boss 48 extending and fitting into the opening 44. The pressure cap is attached to the end cap by a plurality of bolts 49, which, when tightened, cause the boss 48 to apply axial pressure to the gasket 45 so that it is enlarged in radial directions and is squeezed tightly into the opening 44 and against the cable 20. The cable is thereby compressed and firmly held in the opening 44, and the passage is made watertight.

The gasket 45 and the ring 40 thus cooperate to maintain the chamber 43 watertight, so that the electrical connections therein are always dry. The connections that are made in this chamber are shown in Fig. 5. Wires 51 and 52, which are the leads from the coil 31, emerge from the holes 37 in the base 36. Three binding posts 53, 54 and 55 and a capacitor 56 are mounted on the base 36 on the side facing into the chamber 43. The capacitor 56 is connected across two binding posts 54 and 55, and one coil lead 52 is connected to one of these, here 54. The other coil lead 51 is connected to the third binding post 53. The cable 20 may then be connected to binding posts 53 and 55, in which case the capacitor 56 is in series with the coil 31. The connection may be made otherwise if desired.

The second part 24 of the connector is provided with a second coil 61 which is wound on a coil form 62 having an inner diameter slightly larger than the outer diameter of the outer watertight tube 34 that protects the first coil 31, so that the two coils may be telescopically fitted together. Surrounding the second coil 61 is a second tube 63, of waterproof material like tube 34. The second coil form 62 and water-protective tube 63 are both supported in a waterproof and non-conductive base 64 in concentric grooves cut therein and cemented in firmly and with a watertight seal, as is done in the first part 23 of the connector. A front block 65, of annular form and having about the same outside diameter as the base 64, is similarly fastened to the other end of the second coil form and protective tube assembly. Lead wire holes 66 are provided in the base 64 between the two tubes as in the base 36 of the first part.

The second coil assembly fits snugly into and is protected by a rigid protective sheath 68, like the first part sheath 38 but of smaller diameter so that it can be telescopically fitted thereinto. This sheath 68 has a rigid annular front end piece 69, attached thereto as, for example, by brazing, and the second coil assembly is fitted into its sheath with the front block 65 close to or in contact with this end piece. In this manner the second coil assembly is adequately protected from shock and concussion at the front and sides. The front block 65 is provided with a circumferential groove 71 and a ring gasket 72 therein like the ring 40, which provides a watertight seal at this end of the assembly. The second coil assembly with the protective sheath 68 thus fits over the first part coil assembly including the watertight tube 34 and into the first part protective sheath 38.

The second part 24 is provided with an end cap 75 which is recessed in one end and has portions of successively reduced outer diameter 76 and 77, respectively, toward the recessed end. The portion 77 of smallest outer diameter fits into the back end of the sheath 68. This portion is provided exteriorly with an annular groove 78 and a ring gasket 79 therein like rings 40 and 72, to provide a watertight seal between the end cap 75 and the sheath 68. Screws 81 hold the sheath

68 and the end cap 75 firmly together. The periphery of the open end of the end cap abuts the end block 64, being properly positioned with respect thereto by means of a locating pin 82, and a chamber 83 is thus provided with the end block 64 as one wall thereof. This chamber has in the opposite wall an opening 84 with an annular gasket 85 therein, through which the other part of the cable 20 passes. A pressure cap 86 and bolts 87 are employed to hold the cable firmly in place and effect a watertight seal, all in the same manner as is done in the first part 23 of the connector. In fact, the pressure caps 36 and 47 are identical.

Inside the chamber 83, the lead wires 91 and 92 from the second coil 61 are brought to lugs 93 and 94, respectively, mounted on the base 64, and the cable 20 is connected to these lugs.

In each chamber the cable may be taped at the end to assist in preventing play and pulling out.

The end cap 75 has in its intermediate portion of reduced diameter 76 a series of ball-retainers 96 for holding the two parts 23 and 24 of the connector together in a readily releasable fashion. One of these is shown enlarged in Fig. 6. Each retainer includes a metal sphere 96 which is held in place in a hole 97 in the end cap 75, by means of a flange 98. A spring 99 urges the sphere 96 outward. A cooperating hole or detent 101 in the first part sheath 38 admits a portion of the sphere 96 when the two parts of the connector are assembled, and the sphere then serves to hold the two parts in assembled relation. A pull of predetermined force, suitably about 25 pounds, is sufficient to pull the two parts 23 and 24 apart against the retaining action of the spheres 96 in holes 101. The retainers are made by first drilling the hole 97 of larger diameter than the sphere 96, inserting first the spring 99 and then the sphere 96, and hammering out the flange 98 over the sphere, as with a sharp tool.

Each of the pressure caps 47 and 86 is provided with a tie ring 104, 105, respectively, by which the two parts of the connector are tied or linked to the chains 25. As stated above, the pressure caps are identical, and the tie rings are cast or formed integral therewith.

The construction that has just been described is designed not only to provide rigidity, waterproofness, spark-free operation, general ruggedness, and other advantages thus far apparent, but also to make possible inexpensive and easy assembly. Considering the first part 23, this part is assembled as follows. The sheath 38 and end cap 42 are first assembled. These parts may be fabricated in one piece if desired, but it will be less expensive to fabricate them as described herein. The coil assembly, including the base 36 with its water-seal ring 40 and the capacitor 56 and binding posts or lugs 53, 54 and 55, is made up as a separate unit. The pressure cap 47 and gasket 45 are then put loosely in place on the cable 20, which is then inserted through the hole 44 and drawn out the open end of the sheath 38, where connection to the lugs 53 and 55 is made. The coil assembly is then inserted in the sheath 38, the cable 20 being suitably withdrawn through the hole 44 until the base 36 is in the proper position and the screws 41 can be put in place. The gasket 45 is then seated in the opening 44 and the pressure cap 47 is put in place and the bolts 49 are tightened evenly all around.

The assembly of the second part 24 is equally simple. The second coil assembly, including the base 64 with lugs 93 and 94 thereon and the front block 65 with the water-seal ring 72 in place thereon, is assembled as a saparate unit. The sheath 68 and front end piece 69 are assembled as a unit, which may be stamped or otherwise formed, or assembled from two separate pieces as described herein. The coil assembly is then inserted in the sheath with the front block 65 flush with or very close to the front end piece 69. The pressure cap 86, gasket 85, and end cap 75 are then loosely fitted over the cable 20, which is then connected to the lugs 93 and 94. The end cap 75 has on it the water-seal ring 79 and carries the retainer spheres 96. The end cap is then inserted in the sheath 68, the joint being made watertight by the ring 79, and the screws 81 are driven in. The gasket and pressure cap 86 are then assembled and the bolts 87 are tightened in place. The connector is now ready for use. The two parts appear as shown in Fig. 8 and the assembled connector appears as shown in Fig. 7.

When the connector is assembled, the two coils 31 and 61 and the core 33 function as an open-core transformer. This transformer has a certain amount of leakage reactance, which is tuned out at the operating frequency with the capacitor 56. Where the cable 20 is carrying a band of frequencies, for example, from 40 kc. to 50 kc., the capacitor 56 is chosen to tune out the leakage reactance at 45 kc. With a low Q, this provides a sufficiently broad band for frequencies in this entire range. Because of the elongated construction of the transformer, the exact degree of telescopic interfitting is not critical so far as variations in leakage reactance and magnetic coupling is concerned. That is, there are no highly precise tolerances to be met in the positioning of the retainer spheres 96, the holes 101, or any of the other sizes. Ordinary tolerances are satisfactory. Also, because of the radial symmetry of the two parts, there is no critical assembly consideration. The two parts are merely interfitted as described herein and snapped together. The entire device is foolproof and simple.

Since many changes in particular details of the embodiment of the invention shown and described herein may be made without departing from the spirit of the invention, it is intended that the appended claims shall not be limited to particular details shown and described, but shall be limited only by the prior art.

Having now described my invention, I claim:

1. A spark-free and watertight disconnectible cable connector for alternating electric power cables comprising two separate parts adapted to be fitted telescopically together, each part comprising a substantially rigid sheath open at one end and having a watertight chamber at the other end, said sheaths being adapted to fit one telescopically over the other when brought together with their open ends confronting, a pair of elongated transformer windings mounted axially one within each of said sheaths and adapted to fit telescopically one within the other and both within both of said sheaths when said sheaths are fitted together, means within the watertight chambers of each of said parts for making electrical connections to the coil mounted in said part, a first wire passage through the closed end of each part, a clamp member fastened to each closed end, said clamp member having a second wire passage in register with the first wire passage, and a flexible compression ring between each closed end and its clamp member, said ring

adapted when under compression frictionally to engage a wire in said passages.

2. A spark-free and watertight disconnectible cable connector for alternating electric power cables comprising two separate parts adapted to be fitted telescopically together, each part comprising a substantially rigid sheath open at one end, said sheaths being adapted to fit one telescopically over the other when brought together with their open ends confronting, a pair of elongated transformer windings mounted axially one within each of said sheaths and adapted to fit telescopically one within the other and both within both of said sheaths when said sheaths are fitted together, a first wire passage through the closed end of each part, a clamp member fastened to each closed end, said clamp member having a second wire passage in register with the first wire passage, and a flexible compression ring between each closed end and its clamp member, said ring adapted when under compression frictionally to engage a wire in said passages.

3. A spark-free and watertight disconnectible cable connector for alternating electric power cables comprising two separate parts adapted to be fitted telescopically together, each part comprising a substantially rigid sheath open at one end, said sheaths being adapted to fit one telescopically over the other when brought together with their open ends confronting, a pair of elongated transformer windings mounted axially one within each of said sheaths and adapted to fit

telescopically one within the other and both within both of said sheaths when said sheaths are fitted together, means for yieldably holding said connector in its assembled relation when the parts are so interfitted, a first wire passage through the closed end of each part, a clamp member fastened to each closed end, said clamp member having a second wire passage in register with the first wire passage, and a flexible compression ring between each closed end and its clamp member, said ring adapted when under compression frictionally to engage a wire in said passages.

JOHN N. BEEBE.

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