United States Patent [19]

Donecker et al.

[11] **3,772,454**

[45] **Nov. 13, 1973**

[54] **TORQUE BALANCED CABLE**

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[73] Assignee: **United States Steel Corporation,** Pittsburgh, Pa.

[22] Filed: **Nov. 22, 1972**

[21] Appl. No.: **308,925**

[52] **U.S. Cl.** .... **174/113 R,** 174/102, 174/103, 174/115, 174/128

[51] **Int. Cl.** **H01b 7/00**

[58] **Field of Search** .... 174/113 R, 128, 115, 174/102, 103; 57/148

[56] **References Cited**

UNITED STATES PATENTS

2,167,098 7/1939 Wells 174/103

3,482,034 12/1969 Rhoades 174/128

Primary Examiner—E. A. Goldberg

Attorney—Rea C. Helm

[57] **ABSTRACT**

A torque balanced conductor cable includes between three and six strands spiraled together with the torque exerted by the cable being approximately equal to the torque exerted by the strands. Each strand includes an insulated conductor as a core with steel wires stranded therearound and the insulation extending into the interstices of the strands. Another species includes insulated conductors positioned in the outer valleys of the cable and a sheath extruded over the entire assembly. This second species may be used with the first species or with cables in which the strands have a steel wire core member.

5 Claims, 5 Drawing Figures

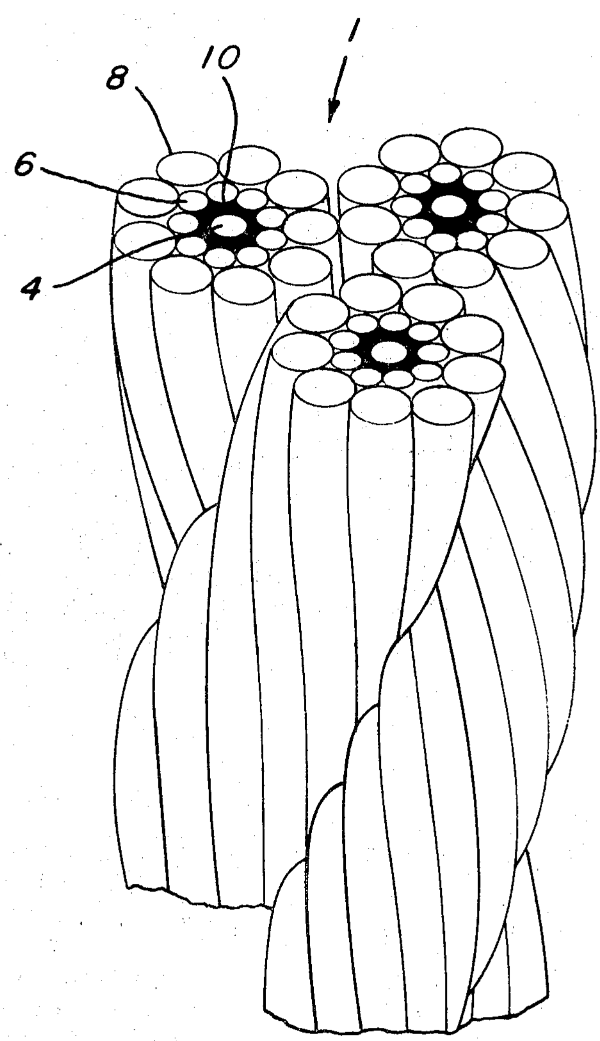

FIG. 2.

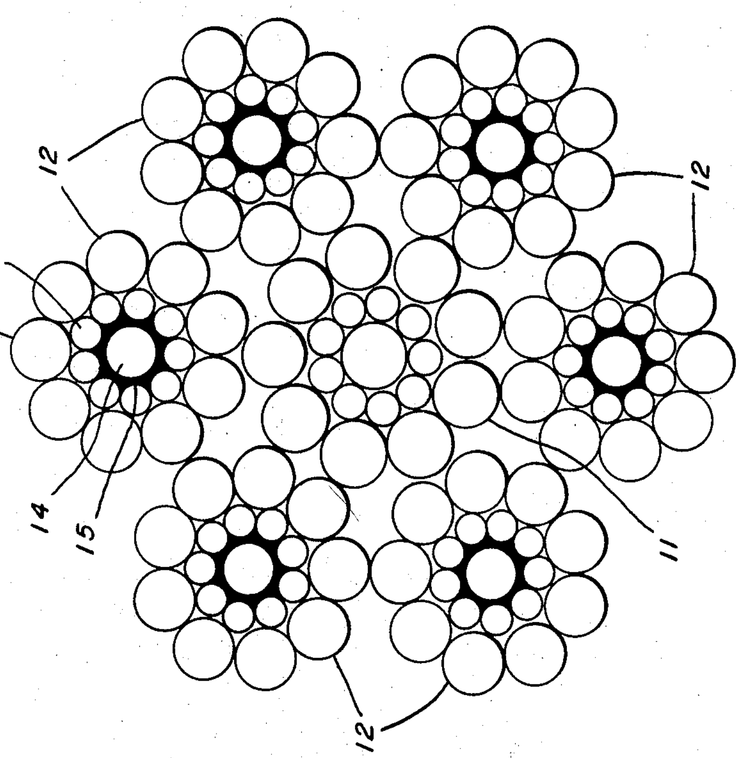

FIG. 1.

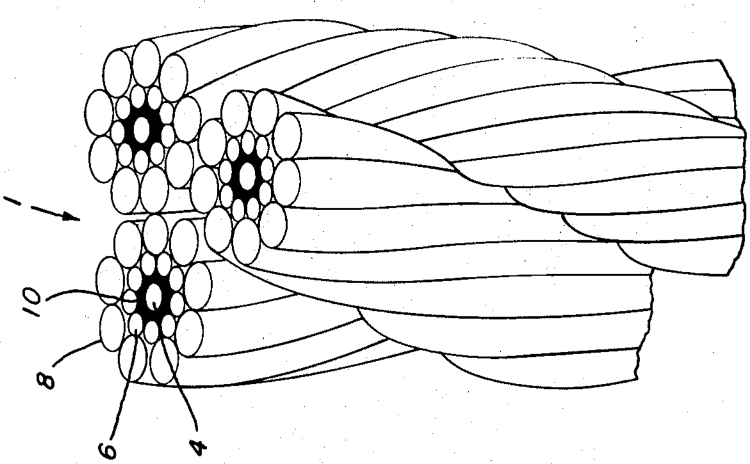

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FIG. 4.

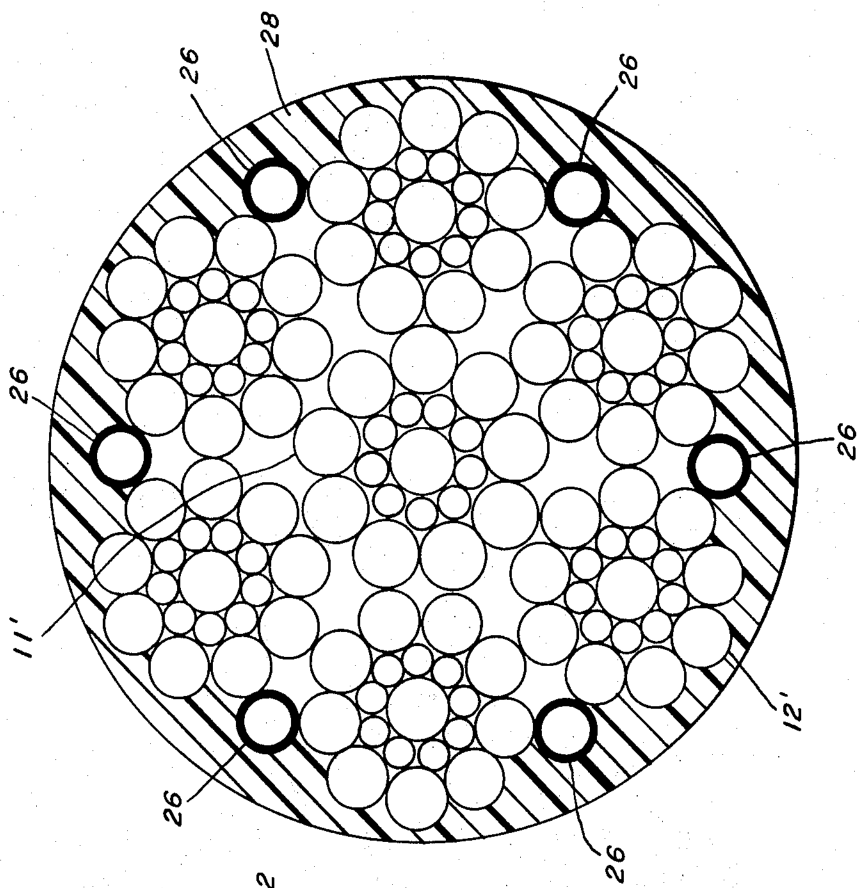


FIG. 3.

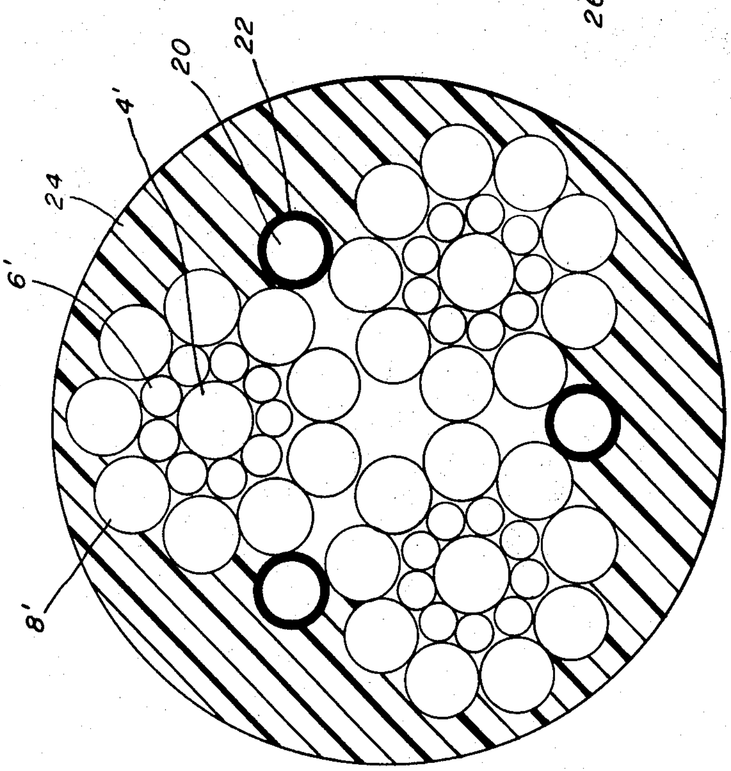
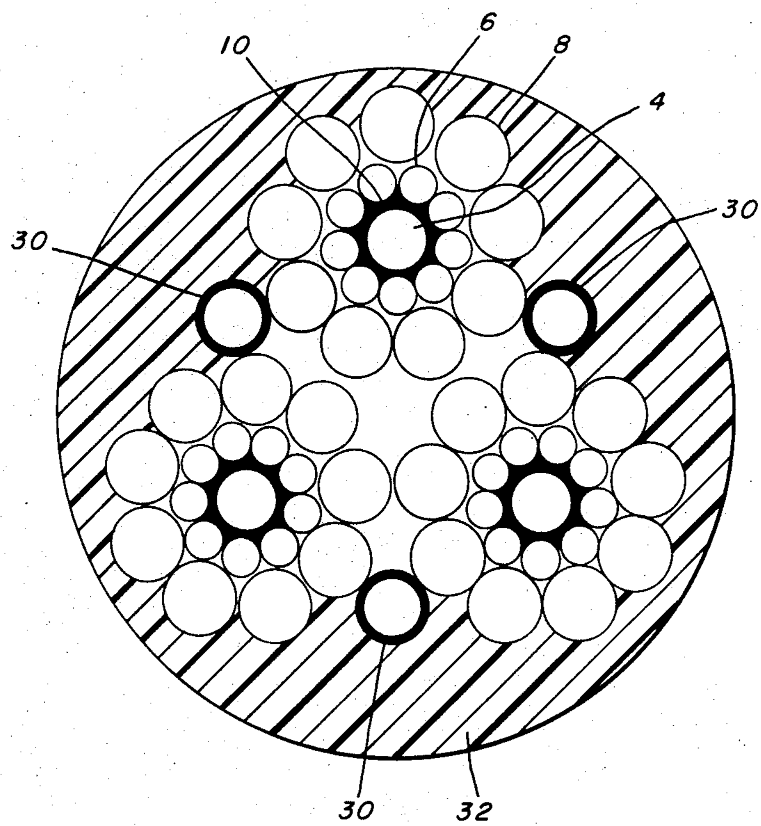


FIG. 5.



TORQUE BALANCED CABLE

This invention relates to a torque balanced conductor cable and more particularly to such a cable which is an improvement over the wire rope shown in Adams and Lucht U.S. Pat. No. 3,374,619 dated Mar. 26, 1968.

In many marine applications, oceanographers use a conductive cable that is payed out by means of winches to great depths. The conventional cable consists of electrical conductors in the core, surrounded by insulation, and lastly covered with one or more layers of steel wire. Wire rope terminology would name this a strand construction as opposed to a wire rope construction. A wire rope construction consists of two or more strands twisted together. At greater depths damage to the electrical wires due to pinching and crossover winding on the drum occurs.

I have found that by replacing the center steel wire of each strand by an insulated electrical conductor, such as copper or aluminum, and shortening the lay of the rope from that disclosed in the Adams et al. patent, the rope will not unwind more than 1° per foot under a free hanging load at 75 percent of the rope breaking strength. The conductor may be a single solid wire or a multiple wire strand.

I have also found that a suitable conductor cable can be made by placing insulated conductors in each valley of the rope disclosed in the Adams et al. patent and covering the entire assembly with a plastic sheath.

It is therefore an object of my invention to provide a torque balanced conductor cable which will lay dead when cut.

Another object is to provide such a cable which has longer life than previous cables.

These and other objects will become more apparent after referring to the following specification and drawings in which:

FIG. 1 is a perspective view of a 3 × 18 seale regular lay cable of my invention;

FIG. 2 is an end view of a 6 × 18 seale regular lay cable of my invention;

FIG. 3 is an end view of a 3 × 19 seale regular lay cable showing another species of my invention;

FIG. 4 is a view, similar to FIG. 2, showing another species of my invention; and

FIG. 5 is a view, similar to FIG. 3, showing still another embodiment of my invention.

Referring more particularly to FIG. 1 of the drawings, reference numeral **1** indicates a conductor cable consisting of three strands, each having an insulated center core wire **4** surrounded by nine intermediate wires **6** and nine outer wires **8**. Each center core wire **4** includes a core made of a non ferrous metal, such as copper or aluminum, having greater electrical conductivity than steel. Insulation **10** surrounds the center core wire **4** and extends into the interstices of the surrounding wires. The insulation is made of a material which will retain some plasticity when the cable is subjected to the stress relieving temperature. After being heated, the insulation must have a dielectric strength capable of withstanding 30 volts d.c. per mil of wall thickness for 5 minutes at room temperature. It should also have good abrasion resistance and be resistant to natural environments, such as salt water. A satisfactory material is radiation cross linked polyolefin. This material has no melting point but is very soft. Other suitable materials are Tetra Fluoro Ethylene, Fluorinated Ethylene Propylene, Cross LInked Poly Vinylidene Fluoride, and other Cross Linked Polyolefins. In making the strand, a core wire is selected whose diameter including the insulation is greater than the cavity which was normally occupied by a steel wire. The wires **6** and **8** are then stranded around the core wire **4** in the usual manner with a portion of the insulation being forced into the interstices of the strand. The strands are then formed, roll straightened, and stranded together in a strand machine. The strands are partially preformed as in the above-mentioned Adams et al. patent. The completed cable is stress relieved at a temperature between 600° and 1,150° F as in the Adams et al. patent. The angle of lay of the strands in the cable is greater than the seven degrees which is used in the above-mentioned patent. The angle of layer of the outer wires in each strand is at least 1 ¾ times that of the angle of lay of the strands in the cable. The heat treating is accomplished very rapidly by passing the cable continuously through an inductor coil while the cable is in tension. The result of the heat, tension, and oversized insulation results in a star-shaped appearance in the conductor and locks the conductor wire to the steel wires. This construction enables the conductor wire to last as long as the steel wires. Table I shows the results of a test made on a 5/16'' 3 × 18 cable constructed as shown in FIG. 1 in accordance with the present invention.

TABLE I

5/16'' 3 × 18 Cable with Electrical Cord

Test No.	Load as % of Rope Strength	Sheave Size	No. of Cycles To Rope Failure	No. of Cycles Last Satisfactory Electrical Check
1	20	24''	40,000	32,000
2	50	24''	4,094	4,000
3	30	10''	2,670	2,500
4	50	10''	1,782	1,500
5	50	10''	677	625

NOTE: The electrical wires retained conductivity without shorts to ground until the rope failed.

After immersion in salt water for one-half hour, the insulation resistance at 5,000 volts d.c. was 350,000 megohms for 200 feet.

Table II shows the results obtained by a rotation test of a 5/16'' 3 × 18 Monitor AA cable constructed as shown in FIG. 1 in accordance with the present invention. The catalog breaking strength of this cable is 9,270 pounds.

TABLE II

5/16'' 3 × 18 Monitor AA with Raychem Insulated Conductors

Load	Degrees Rotation Per Foot
1000	0
2000	0
3000	0
4000	0
5000	0
6000	0
7000	0
8000	0
9000	0
9200	Less than 1°

Table III shows similar test results on a ⅝'' 3 × 18 Monitor AA cable made according to the invention and having a catalog breaking strength of 36,270 pounds.

TABLE III

5/8" 3 × 18 Monitor AA with Raychem Insulated Conductors

Load	Degrees Rotation Per Foot
1000	⅔
2000	1
5000	1
10000	1
15000	1
20000	1
25000	1
30000	1

One particular cable manufactured according to my invention was a ⅝" 3 × 18 Seale Right Regular Lay made with Monitor AA steel wires with the angle of lay of the outer wires in each strand being 21.8° and the angle of lay of the strands in the cable being 11.3°. A ⅝" 3 × 18 Right Regular Lay cable constructed of wire made from Monitor AA strand had the same lays as the above ⅝" cable.

The rope of FIG. **2** includes a stranded core member **11** surrounded by six strands **12,** each having an insulated center conductor wire **14** surrounded by insulation **15,** nine intermediate wires **16,** and nine outer wires **18.** The insulation is the same as in the first embodiment and the strands are formed in the same manner as in the first embodiment. The strands are roll straightened and stranded together in a stranding machine, after which the cable is stress relieved as in the first embodiment. The relationship between the angle of lay of the outer wire in each strand and angle of lay of strands in the rope is greater than in the three-strand rope. In the six-strand rope shown, the angle of lay of the strands in the rope is greater than 7°. It will be understood that other types of strands may be used in the construction of the cable.

FIG. **3** shows another embodiment of my invention in which a three-strand cable is made in the same manner as in the above-mentioned Adams et al. patent and the various parts are indicated by priming the reference numbers of FIG. **1.** According to my invention, one or more insulated electrical conductors **20** are then laid in each valley of the cable. The center is made of the same material as the conductor of the first two embodiments but any common insulation material **22** may be used since the steel wires of the cable are stress relieved prior to placing the insulated conductors in the valleys. An outer sheath **24** is then extruded over the assembled strands and conductors. The melting point of the insulation should be greater than the melting point of the jacket material to prevent it from melting during the extruding operation. Polyethylene may be used as the outer sheath with the conductor insulation being Polypropylene. It is also necessary that the two materials not bond together as the unwinding of the cable will usually induce a tensile load on the conductors and stretch them beyond their elastic limit.

FIG. **4** shows another embodiment of my invention which includes a cable constructed as shown in FIG. **2** of the Adams et al. patent but having a stranded core member **11.** One or moe insulated conductors **26** are positioned in each of the valleys and an outer sheath **28** is extruded around the assembled strands and conductors **26.** The insulated conductors **26** and outer sheath **28** are made of the same materials as the insulated conductor **22** and outer sheath **24.** It will be understood that this type of cnstruction may also be used with any of the cables constructed as shown in the Adams et al patent.

The embodiment of FIG. **5** combines the features of FIGS. **1** and **3.** In othe words, a three-strand cable is constructed in the same manner as in FIG. **1** and the same reference numerals are used for these parts. One or more insulated electrical conductors **30** are then laid in each valley of the cable and an outer sheath **32** is then extruded over the entire assembly as in the embodiment of FIG. **3.** This construction may also be used with any of the cable constructions utilizing strands having a insulated core conductor.

While several embodiments of my invention have been shown and described, it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. A torque balanced regular lay conductor cable comprising between three and six strands spiraled together, each of said strands including a center core made of a non-ferrous metal having greater electrical conductivity than steel, steel wires spiraled around said center core, and electrical insulation surrounding said center core and extending into the interstices of the surrounding wires, the angle of lay of the outer wires in each strand being at least 1¾ times that of the angle of lay of the strands in the cable, the angle of lay of the strands in the cable being greater than 7°, the torque exerted by the rope being approximately equal to the torque inserted by the strands, said cable being stress relieved at a temperature of between 600° and 1,150°F, said insulation being made of a material which will retain some plasticity when subjected to the stress relieving temperature.

2. A torque balanced cable according to claim **1** in which three strands are spiraled together, and the angle of lay of the strands in the cable is greater than 10°.

3. A torque balanced regular lay conductor cable comprising between three and six strands spiraled together with outer valleys between the strands, each of said strands including a plurality of steel wires stranded together, the angle of lay of the outer wires in each strand being at least 1¾ times that of the angle of lay of the strands in the rope, the torque exerted by the cable being approximately equal to the torque exerted by the strands, said cable being stress relieved at a temperature of between 600° and 1,150°F., an insulated electrical conductor in each of said valleys, said conductor being made of a non-ferrous metal having greater electrical conductivity than steel, and a plastic sheath surrounding said assembled strands and conductors, said plastic sheath being made of a material which will not bond to said sheath.

4. A torque balanced cable according to claim **3** in which each strand includes a center core made of a non-ferrous metal having greater electrical conductivity than steel, and electrical insulation surrounding said center core and extending into the interstices of the surrounding wires, the angle of lay of the strands in the cable being greater than 7°.

5. A torque balanced cable according to claim **4** in which three strands are spiraled together, and the angle of lay of the strands in the cable is greater than 10°.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,772,454 Dated November 13, 1973

Inventor(s) Frederick W. Donecker et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 10, "strand" should read -- stranding --;

line 16, "layer" should read -- lay --.

Column 3, line 60, "moe" should read -- more --.

Signed and sealed this 21st day of May 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

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★ U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.

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