

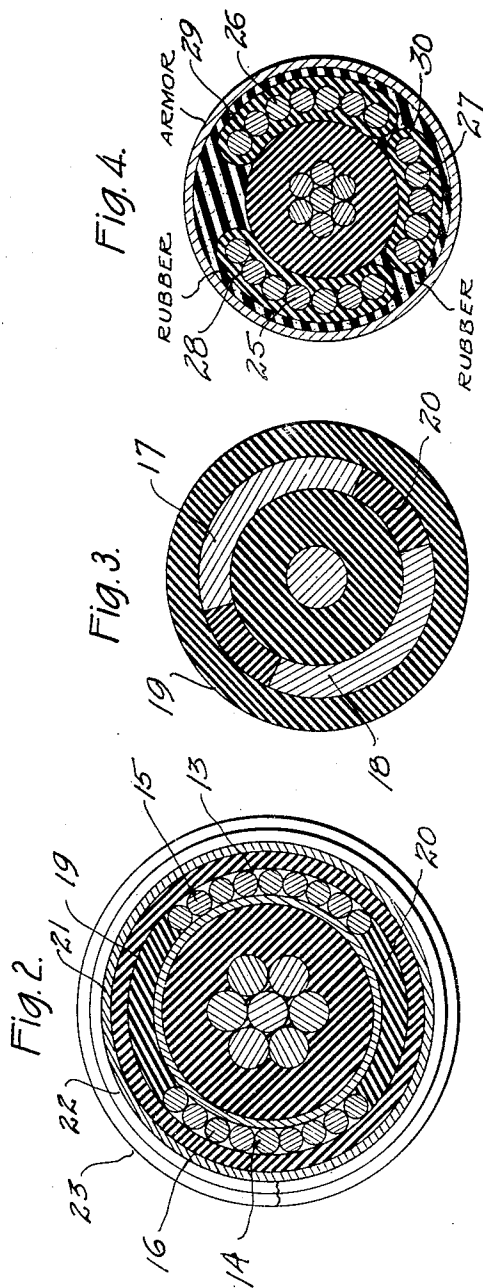
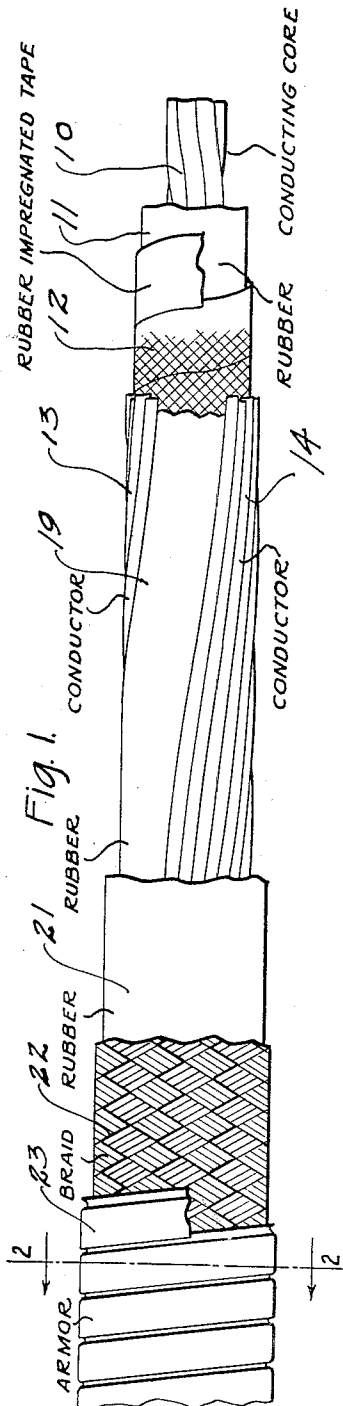
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MULTIPLE CONDUCTOR CABLE

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MULTIPLE CONDUCTOR CABLE

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1 Claim. (Cl. 174—102)

This invention relates to insulated electric cables in which two or more conductors are included within a common sheath. It is common practice to insulate conductors, and then either lay them parallel or twist them together; the valleys so formed are filled with jute, rubber compound, etc. and belts, binders, sheaths or the like are usually applied as coverings. Another construction of cable is that commonly designated as "concentric"; generally small wires are laid helically about the surface of an insulated conductor core to serve as a second conductor, and sometimes the insulated concentric layer is again surrounded by a third conductor layer. Each of these types of construction have their disadvantages; for example, in the twisted or parallel type a large percentage of its cross-sectional area is not used to any advantage, and in the concentric type there are difficulties in splicing.

The present invention provides a cable structure of the concentric type having a multiple of conductors insulated from each other in a single concentric layer and over the insulation of an axial conductive core whereby simplified construction, small cross-sectional area and reduced cost are obtained; each of the concentric conductors in the preferred form is a layer of wires in a single thickness in order that the twist which occurs in laying the wires will not distort the lay. An insulating jacket encloses the concentric layer of conductors, and a covering of a belt or binding sheath is applied. The cable is primarily intended for deep oil wells to supply current to a motor-driven pump, or for electrical survey and for this purpose the central core is "straight-through" designed to carry the weight of the cable and the load without undue stretching and radial contraction within the jacket as hereinafter explained; the insulation throughout is preferably of rubber and vulcanized into an integral whole to provide a firm union between the core insulation, the insulation separating the concentric conductors and the jacket insulation with the absence of channels for transmitting gas pressures, oil or the like, and the outside sheath is of material importance in maintaining the absence of channels or valleys by constricting the rubber insulating jacket and preventing its deterioration under the action of the oil.

In order that the invention may be described and understood reference is made to the accompanying drawing in which:

Fig. 1 illustrates a cable embodying the invention with parts broken away to disclose the different elements;

Fig. 2 is a cross-section on the line 2—2 of Fig. 1;

Fig. 3 is a similar cross-section of a modified embodiment of the invention; and

Fig. 4 is a similar cross-section of a third embodiment.

The cable illustrated consists of a central conductor 10 which can be solid or stranded and covered with rubber insulation 11; with rubber there is customarily present a rubber impregnated tape 12 wound about the rubber prior to its vulcanization. The conductor and its insulation form the core of the cable.

Over the core there are placed in the form of arcuate segments two or more concentric conductors 13, 14; each of these preferably consists of a single layer of fine wires 15, 16 as shown in Figs. 1 and 2, or they can for some installations be arched metal strips 17, 18 as shown in Fig. 3. The concentric conductors are separated from each other by insulation such as the concentrically arranged strips or fillers 19, 20 of rubber or other material equivalent to rubber. Over the concentric conductors and fillers is placed a jacket of insulation 21 of any conventional form; this can for instance be a rubber insulation layer, and over it a braided covering 22 and armor 23 as illustrated in Figs. 1 and 2.

In the embodiment shown in Fig. 4 each concentric conductor or group of wires forming a conductor 25, 26 and 27 is individually enclosed in insulation 28, 29, 30 before its application to the core; each wire of a group can be separately insulated. As illustrated the insulation for each conductor consists of an interior or underside portion in contact with the core with lateral portions extending around the conductor edges and an exterior portion folded over the conductor, thus providing edge insulation between conductors lying in the concentric layer by folding from the underside and over the conductor edges. Edge insulation for each concentric conductor provided in this manner can take the place of separating strips to insulate one conductor from the other.

In making the cable the concentric conductors or wires forming them, with or without previously applied insulation, can be helically laid about the insulated core and the separate fillers laid simultaneously. Practically any degree of pitch can be given the concentric conductors when the jacket is applied to hold them in place.

For withstanding high voltages it has been found preferable to vulcanize the separating strips of insulation of rubber or vulcanizable

compound to the core and to the jacket insulation. In this case, the tape supporting the core insulation can be removed or omitted to insure the absence of any leakage paths over the tape surface; the whole structure after its assembly is then submitted to vulcanization so that there will be a firm union between the core, the insulating strips and the jacket. Essentially the same results are accomplished by providing a body of insulation extending from the underside of a concentric conductor and over the edges as described in connection with the embodiment of Fig. 4.

A cable such as illustrated in Figs. 1 and 2 is intended for a 3-phase circuit. Since it is not symmetrical, it may be desirable to make splices at periodic intervals in which there are suitable cross-overs so that the current will not always flow in an outer conductor.

Any of the conventional forms of insulation can be used in carrying out this invention. The insulation strip fillers separating the concentric conductors can, for instance, be of rubber insulated strings or wires. For over-all insulation and protective covering any of the usual types can be employed including fibrous coverings, lead sheath, round wire armor, flat strip steel, interlocking armor, etc.

Numerous advantages follow from the cable structure herein disclosed. The split or separated concentric conductors about the insulated core considerably reduce the cable volume so that the cable is adapted for use in restricted spaces. The reduced volume also reduces the covering required for the same protection and electrical properties. Electrically, the inductance between conductors is reduced because the spacings between conductors are less than in the conventional types of cables, the central conductor has not capacity to ground, and external injuries to the cable are not likely to cause short circuits between an outer conductor and the central conductor which is well protected by the insulation and the outer concentric conductors.

The cable finds particular use for instance in supplying current for deep well oil pumping. Here strength with small cross-sectional area are demanded, and the split concentric conductors fulfil this demand. The central "straight through" core member can be designed to carry the weight of the cable and additional load without undue stretching, untwisting, straining of insulation, etc. The concentric conductors also

provide strength, as well as additional circuits insulated from one another. There are practically no valleys which usually give trouble in oil well operation by providing channels through which pressures of gas, oil or the like are transmitted; this comes about from the vulcanization of the core insulation, concentric conductor insulation and the surrounding rubber jacket into an integral whole together with the binding action of the outer covering or armor over a core not subject to reduction in diameter when under tension which prevents swelling or distortion of the rubber insulation to form pockets or valleys.

In cables of the "split concentric" class as defined by this invention, splicing of an oil well cable is greatly simplified. Usually the core member is spliced, and then insulation applied over it. The concentric conductors are then laid over the insulated core and suitably joined while separated electrically by insulating material. The entire structure is then insulated in much the same manner as the cable proper. As an alternate method of splicing, the core and concentric members may be fanned out into one plane, and the three or more separately insulated groups spliced and covered over all. These relatively simple expedients are possible with the cable construction of this invention. If the cable is damaged and develops an electrical failure without destroying the conductors, it is comparatively simple to reinsulate all the members (it may be necessary to untwist the cable to expose all members) and rebuild the cable for further operation.

What is claimed is:

Electric cable for use under high pressure or at great depths comprising in combination a straight through conducting and weight supporting core including rubber insulation, a plurality of insulated outer conductors arranged in a concentric layer with a helical lay about the core, each outer conductor in the layer being composed of a flat rubber insulated conductor structure wherein a single layer of round wires is arranged as an arcuate segment, filler strips in the valleys, the rubber insulation being vulcanized as a whole into an integrally united structure with the absence of valleys, and an outer metal armoring sheath over the insulation to constrict the insulation and prevent deterioration.

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