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(54) **Twisted flat cable**

Verdrilltes Flachkabel

Câble plat torsadé

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**EP-A- 0 642 138** **CH-A- 543 800**  
**US-A- 3 609 216** **US-A- 4 767 891**  
**US-A- 4 992 625**

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## Description

**[0001]** The present invention relates to a power cable for carrying power current and formed from an initially flat cable which is folded and retained as a substantially round cable, where the flat cable comprises a plurality of parallel, solid, electric conductors which are embedded at a mutual distance in a ribbon made of an insulating plastic material. Such a cable is described in WO-A-90/08388.

**[0002]** GB Patent Application No. GB-A-2,241,374 describes a folded flat elongate structure, and more specifically a flat cable folded over where the conductors are twisted in alternate direction of twisting. The bi-directionally twisted cable is formed by a wavy or zigzag flat cable, where the zigzag shape represents the basis of shaping the coiled cable with two directions of twisting. The publication does not describe how the flat cable is retained in its closed round shape, but only that the flat cable shown can form part of a composite coaxial cable in form of one layer among several layers. The cable is a low power and/or optical fibre cable.

**[0003]** DE-A-3,141,636 discloses a cable in which at least one flat cable is helically wound round a coaxial cable forming a central core in such a manner that the flat cable can be installed with the advantages obtained by means of a round cable. The illustrated type of cable can include a high number of conductors intended for low power signals.

**[0004]** US-A-3609216 describes a cable in form of a twisted flat cable. The individual conductors of the cable and the form of the cable is maintained by means of a surrounding retaining jacket. Removing the jacket permits the terminated end to untwist so as the end portion flattens.

**[0005]** Flat cables to be rolled up are furthermore described in the European Patent Applications Nos. EP-A-0,257,855, and EP-A2-0,619,583, and in the German Patent Specifications Nos. DE 3,417,400 C2, DE 3,921,032 A1, DE 3,527,846 A1, and DE 3,527,847 A1.

**[0006]** It is furthermore known to insert flat cables and bundles of conductors and cables in protective sheaths by the so-called zipper technique, i.e. inserted in tubular sheaths which can be zipped up and down or opened and closed in another manner.

**[0007]** Round cables are preferred to flat cables when laying electric cables in connection with electric installations in buildings, inter alia because it is easier to drill a round hole than to produce an elongate slit for a flat cable when said cable is to pass through a wall or a horizontal division. Furthermore it is much easier to change the direction of a round cable than of a flat cable, especially when a horizontal change follows immediately after a vertical change. The establishing of branches for lamps and socket outlets involves, however, a demand for a possibility of using piercing modules structured for flat cables. Accordingly, a demand applies for a flat cable which can be folded into a substantially round cable,

and which is easy to open and roll out into a flat shape over a short length of the cable on the locations where it is desired to mount piercing modules.

**[0008]** The object of the invention is to provide a cable of the above type which is folded into a substantially round cable, which is easy to install in buildings and consequently easy to use for installing electrics, which is easy to operate with and inexpensive to manufacture. It must be possible to open and flatten the cable, preferably without necessitating the use of tools.

**[0009]** According to the invention a cable of the above type is characterised in the subject matter stated in the characterising clause of claim 1.

**[0010]** The resulting cable is retained in the folded state by the rigidity of the solid conductors and the plastic insulation, and at the same time the cable is particularly easy to open and to terminate.

**[0011]** A further advantage is found in the fact that it is easy to remove a previously performed termination and to restore the original shape of the cable. As a result, the cable need not be discarded in connection with minor rebuilding procedures.

**[0012]** The spiralling is preferably performed in such a manner that each conductor in a spiralled cable forms an angle of approximately 20° to 40° with the central axis of the cable.

**[0013]** The invention is explained in details in the following based on some embodiments and with reference to the drawings, in which

Figure 1 illustrates a preferred embodiment of a flat cable according to the invention in natural size,

Figure 2 is a sectional, enlarged view through the cable of Figure 1 in the unfolded state,

Figure 3 is a sectional, enlarged view through the cable of Figures 1 and 2 in a folded state,

Figure 4 is an enlarged view of a second embodiment of a cable according to the invention, and

Figure 5 is an enlarged view of the cable of Figure 4 in the folded state.

**[0014]** A cable 10 according to the invention comprises according to a preferred embodiment a plurality (usually five) of solid conductors 12 with an insulation 13, cf. Figures 1 to 5. The insulation 13 is surrounded by an insulating material 14 to form a coherent flexible ribbon.

**[0015]** According to the invention the flexible ribbon may be made of plastics, and during the manufacturing process it is folded into a helical shape, preferably in such a manner that the cable is turned one turn for every approximately 100 to 1000 mm, preferably for every 200 to 600 mm, and especially for every approximately 300 mm, in case of a cable being fully insulated for operation and intended to work at a rated voltage of 220 volt to 1

kV and having solid conductors of a square of 2.5 mm<sup>2</sup>. Such a cable may be provided with an inner and outer insulation which result in a final ribbon being approximately 40 mm wide and approximately 6 mm high. In other words, when considered separately the diameter of each insulated conductor is approximately 6 mm. It is, however, within the scope of the invention to use a cable of other dimensions. It is for instance possible to use conductors of a square of up to 6 mm<sup>2</sup>.

**[0016]** The solid conductors and the strong plastic insulation are deformed during the spiralling in such a manner that the cable is maintained tightly folded up, cf. the cross sections of the cable shown in Figures 3 and 5.

**[0017]** The criterion of the choice of number of helical windings per length unit, or in other words of the angle formed by each conductor with the central axis of the cable is that said cable must be wound so tightly that it forms a closed surface during the spiralling process, but nevertheless so loose that it is easy to turn it further (increase the number of turns per meter) without forming a second greater spiral. The latter feature is necessary when units are to be mounted on the completely laid cable, which must therefore be folded out and flattened over a portion. The flattening procedure implies that the helical windings of the adjacent lengths of cable can be arranged very close to one another.

**[0018]** A preferred embodiment of the spiralled cable appears from Figure 1, in which the portions 21 and 24 of the cable are shown with helical windings, and the portions 22 to 23 are unfolded and provided with a piercing module 25 (as described in PCT/DK/94/00385, where voltage carrying conductors extend from said module and can be connected to various plugs and plug outlets). It should be added that the helical windings appearing from Figure 1 are arranged more close to the adjacent inserted piercing module because the unfolding of the portion of cable to be flattened for the mounting of the piercing module (or another device to be mounted on cables) implies that said helical windings of the adjacent portions are more closely arranged because the adjacent portions must absorb the helical winding which is pushed aside by the unfolding.

**[0019]** The resulting cable is very easy to open and to terminate. A further advantage is found in the fact that it is easy to remove a previously performed termination and to restore the cable in its original shape. As a result, the cable need not be discarded in connection with minor rebuildings.

**[0020]** The manufacture of the cable involves the following steps. First the flat cable is made of a plurality of solid conductors 12, onto which an insulating jacket 13 is initially applied according to a preferred embodiment. Subsequently, the conductors 12 are carried in parallel at predetermined mutual distances through an extruder which provides the five conductors with a coherent flat jacket 14 so as to form the flat cable.

**[0021]** After the spiralling, the spiralled cable can optionally be provided with a screen and/or an inserted cor-

rugated drain wire.

**[0022]** The electric conductors 12 can be of 0.75 to 6 mm<sup>2</sup> and typically for instance of a diameter of approximately 1 to 2 mm and be surrounded by an insulation 13 of an outer diameter of approximately 3 to 4 mm. The insulated conductors are then further coated with an insulating plastics, which for instance can be of a thickness of from approximately 0.2 mm to approximately 3 mm so as to form a coherent ribbon. It must, however, be understood that the invention is not limited to the illustrated and described dimensions, and that the number of conductors for instance can be 3, 4 or 5.

**[0023]** In the second embodiment illustrated in Figures 4 and 5, the insulated conductors 12 have the same dimensions as above and are spaced the same mutual distances. The surrounding plastics 14 forming the coherent ribbon is in this embodiment somewhat thinner than the ribbon of Figures 2 and 3. The resulting cable is particularly easy to work with because it is very flexible and easy to penetrate by means of a cutting contact means in connection with the mounting in piercing modules. In addition, the cavity inside the folded cable is larger than in the first embodiment, which is obvious from a comparison of Figures 3 and 5.

**[0024]** The cavity 30 at the centre of the coiled flat cable 10 can remain empty or may be used for carrying a data cable, a signal cable or an optical fibre cable. The cavity can optionally be screened on the inner side, or the said cables may be inserted in a screen. The cavity can optionally be filled with a filler string, such as a plastic string.

**[0025]** One or more of the insulating electric conductors 12 can be provided either individually or all together with a screen. The screen can be folded/coiled/extruded/plaited or coated. The screen can be accommodated on the inner and/or outer side seen relative to the folded cable. Finally, the folded flat cable can optionally be surrounded by an extruded jacket cut up and removed on the locations where access is desired to the flat cable.

**[0026]** The folded cable can be provided with auxiliary means, such as rings, resilient means or ribbons of plastics arranged at suitable intervals and intended to assist in maintaining the cable pressed into its round shape.

## Claims

1. A cable for carrying power current and formed from an initially flat cable (10) which is folded and retained as a substantially round cable, where the flat cable comprises a plurality of parallel, solid electric conductors (12) which are embedded at a mutual distance in a ribbon made of an insulating plastic material, **characterised** in that during the manufacturing process the cable is subjected to a deformation in such a manner that the flat cable is shaped as a cylindrical helix, and in such a manner that each of the solid conductors of the cable follows a

cylindrical, helical course, where the deformation implies that the cable maintains the cylindrical helix shape after deformation and possesses the appearance of a round cable.

2. A cable as claimed in claim 1, **characterised** in that the pitch of the cylindrical helix assumes from 100 to 1000 mm per rotation, preferably between 200 and 600 mm, and especially between approximately 250 and 400 mm per rotation.
3. A cable as claimed in claim 1, characterised in that each conductor in the cable forms an angle of approximately 15° to 45°, preferably approximately 20° to 40°, and especially approximately 25° to 35°, especially approximately 28° to 32° with the central axis of the cable.
4. A cable as claimed in claim 1 or 2, **characterised** in that the helical winding is supported by auxiliary means, such as circumferential ribbons of plastics or resilient materials, connectable ring-forming means and the like, said auxiliary means being capable of surrounding and holding together the helically wound cable.
5. A cable as claimed in one or more of the preceding claims 1 to 4, **characterised** in that an inner and/or outer screen is provided.
6. A cable as claimed in claim 5, **characterised** in that the screen is folded, wound, extruded, braided or coated.

#### Patentansprüche

1. Kabel zum Führen von Starkstrom, das aus einem anfangs flachen Kabel (10) gebildet und gefaltet und als im wesentlichen rundes Kabel festgehalten ist, wobei das Flachkabel mehrere parallele, massive elektrische Leiter (12) aufweist, die in einem gegenseitigen Abstand in ein Band eingebettet sind, das aus einem Isolierkunststoffmaterial hergestellt ist, dadurch gekennzeichnet, daß während des Herstellungsverfahrens das Kabel einer Verformung so unterzogen wird, daß das Flachkabel als zylindrische Wendel geformt wird, und so, daß jeder der massiven Leiter des Kabels einem zylindrischen, wendelförmigen Verlauf folgt, wobei Verformung bedeutet, daß das Kabel die zylindrische Wendel form nach Verformung beibehält und das Aussehen eines Rundkabels hat.
2. Kabel nach Anspruch 1, dadurch gekennzeichnet, daß die Ganghöhe der zylindrischen Wendel 100 bis 1000 mm je Drehung, vorzugsweise zwischen 200 und 600 mm und insbesondere zwischen etwa

250 und 400 mm je Drehung beträgt.

3. Kabel nach Anspruch 1, dadurch gekennzeichnet, daß jeder Leiter im Kabel einen Winkel von etwa 15° bis 45°, vorzugsweise etwa 20° bis 40° und insbesondere etwa 25 bis 35°, besonders etwa 28° bis 32°, mit der Mittelachse des Kabels bildet.
4. Kabel nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die wendelförmige Wicklung durch Hilfseinrichtungen gestützt wird, z. B. Umfangsbändern aus Kunststoff oder elastischen Materialien, verbindungs-fähigen ringbildenden Einrichtungen u. ä., wobei die Hilfseinrichtungen das wendelförmig gewickelte Kabel umgeben und zusammenhalten können.
5. Kabel nach einem oder mehreren der vorstehenden Ansprüche 1 bis 4, dadurch gekennzeichnet, daß ein Innen- und/ oder Außenschirm vorgesehen ist.
6. Kabel nach Anspruch 5, dadurch gekennzeichnet, daß der Schirm gefaltet, gewickelt, extrudiert, geflochten oder durch Beschichten aufgebracht ist.

#### Revendications

1. Câble destiné à transporter du courant électrique et qui est formé à partir d'un câble initialement plat (10) qui est plié et maintenu en place sous forme de câble sensiblement rond, le câble plat comprenant une pluralité de conducteurs électriques plats parallèles (12) qui sont logés à une certaine distance entre eux dans un ruban réalisé en un matériau plastique isolant, caractérisé en ce que pendant l'opération de fabrication le câble est soumis à une déformation de façon à former le câble plat en hélice cylindrique et de façon que chacun des conducteurs plats du câble suive un trajet hélicoïdal cylindrique, la déformation impliquant que le câble conserve la forme d'hélice cylindrique après déformation et présente l'aspect d'un câble rond.
2. Câble selon la revendication 1, caractérisé en ce que le pas de l'hélice cylindrique est de 100 à 1000 mm par rotation, de préférence entre 200 et 600 mm, et en particulier entre environ 250 et 400 mm par rotation.
3. Câble selon la revendication 1, caractérisé en ce que chaque conducteur du câble forme un angle d'environ 15 à 45° de préférence d'environ 20° à 40° et en particulier d'environ 25° à 35°, en particulier d'environ 28° à 32° par rapport à l'axe central du câble.
4. Câble selon la revendication 1 ou 2, caractérisé en

ce que l'enroulement hélicoïdal est supporté par des moyens auxiliaires tels que des rubans circonférentiels en un matériau souple ou élastique, des moyens formant des anneaux pouvant être raccordés et analogues, des moyens auxiliaires étant aptes à entourer et à retenir en place le câble enroulé hélicoïdalement. 5

5. Câble selon l'une ou plusieurs des revendications précédentes 1 à 4, caractérisé en ce qu'il est prévu un écran intérieur et/ou extérieur. 10

6. Câble selon la revendication 5, caractérisé en ce que l'écran est plié, enroulé, extrudé, tressé ou revêtu. 15

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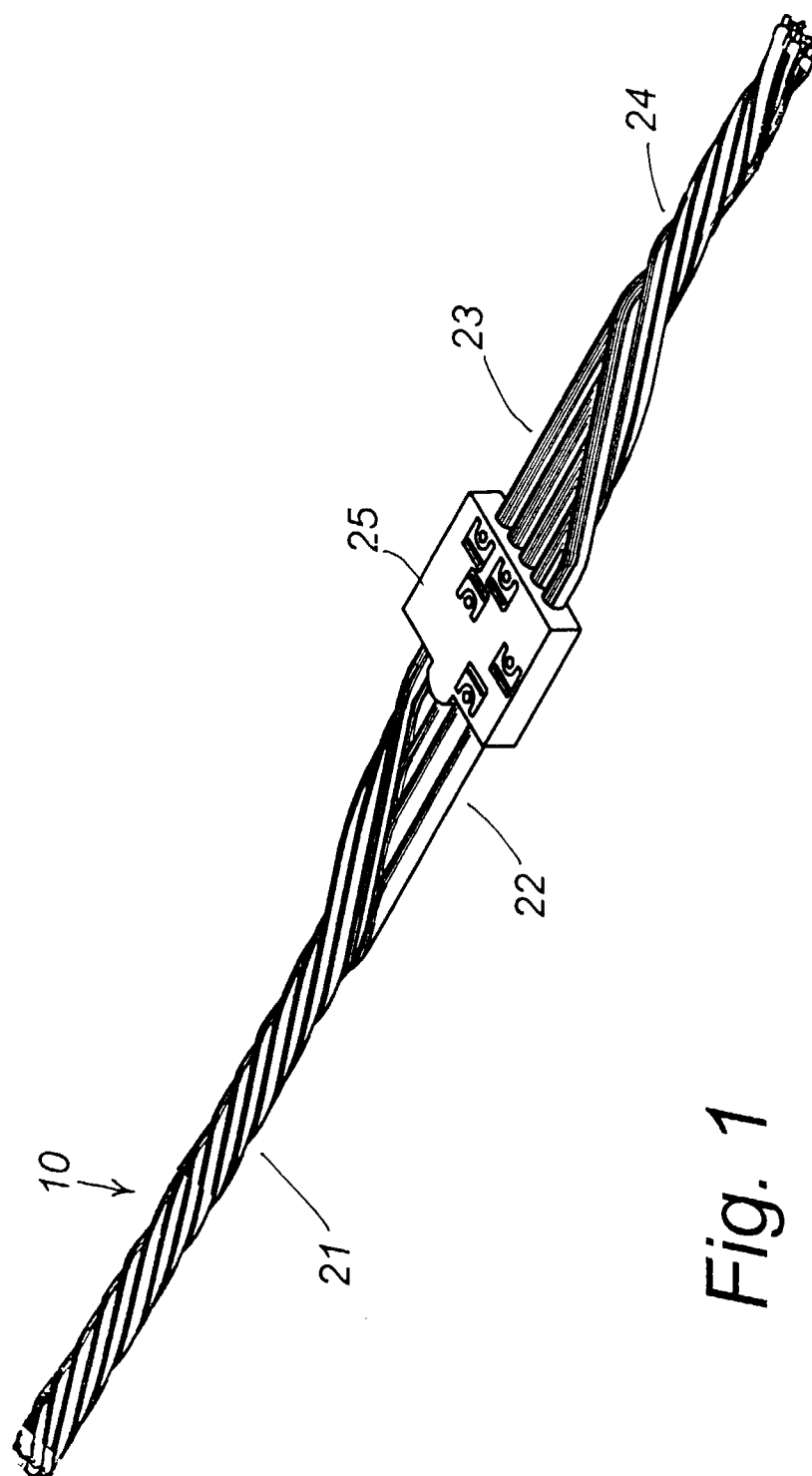
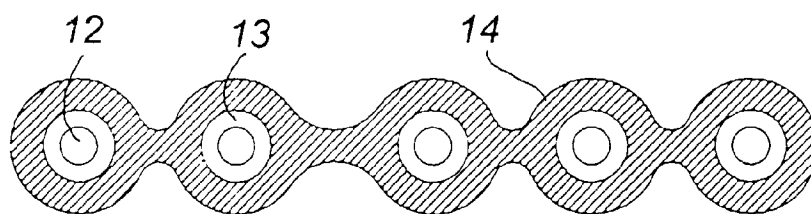
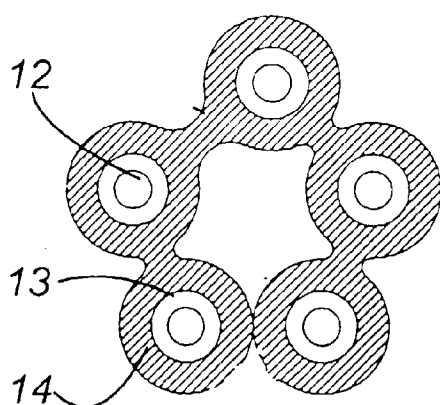


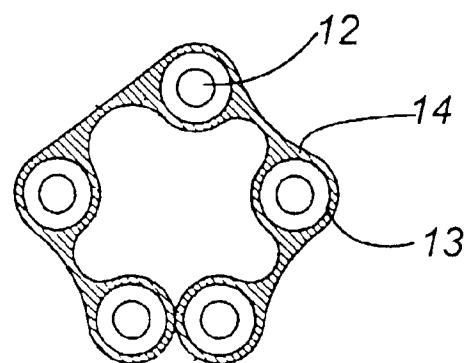
Fig. 1



*Fig. 2*



*Fig. 3*



*Fig. 5*

*Fig. 4*

