United States Patent

Sennett et al.

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[54] FOLDABLE WOVEN MULTISTRAND ELECTRICAL CABLE

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[52] **U.S. Cl.** ..... **174/117 M**, 174/110 N

[51] **Int. Cl.** **H01b 7/08**

[58] **Field of Search** ..... 174/117 R, 117 F, 117 M

[56] **References Cited**

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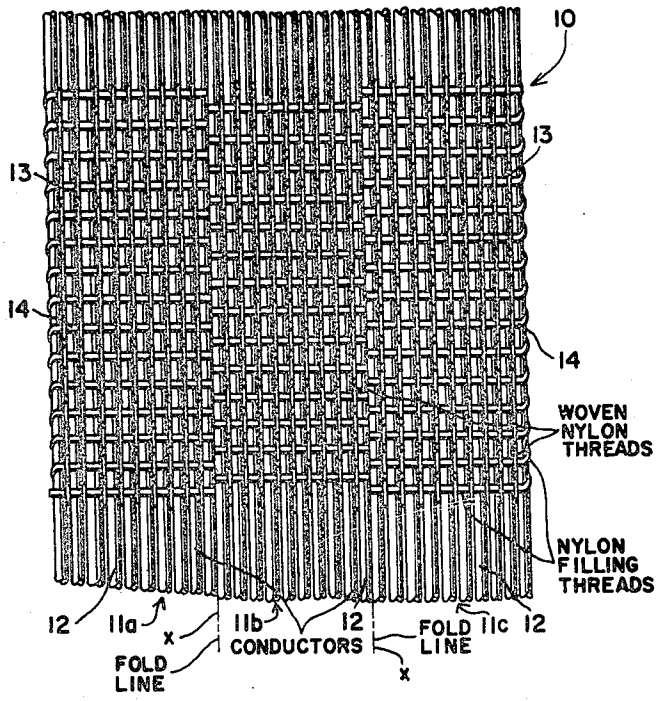
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[57] **ABSTRACT**

A longitudinally foldable woven multiconductor cable includes side-by-side sections joined along a longitudinal fold line, each section including single or multiple insulator sheathed conductor warps with or without alternating nonconducting yarn warps. The warps are interwoven by a weft in a common pattern which is altered or shifted at the fold lines to provide hinges between the sections. The weave pattern alteration may be accomplished with a box weave where the warps include alternate conductor and yarn warps by omitting the yarn warp between a pair of successive conductor warps at the fold line or it may be accomplished with a twill weave by reversing the weave pattern at the fold lines.

9 Claims, 6 Drawing Figures



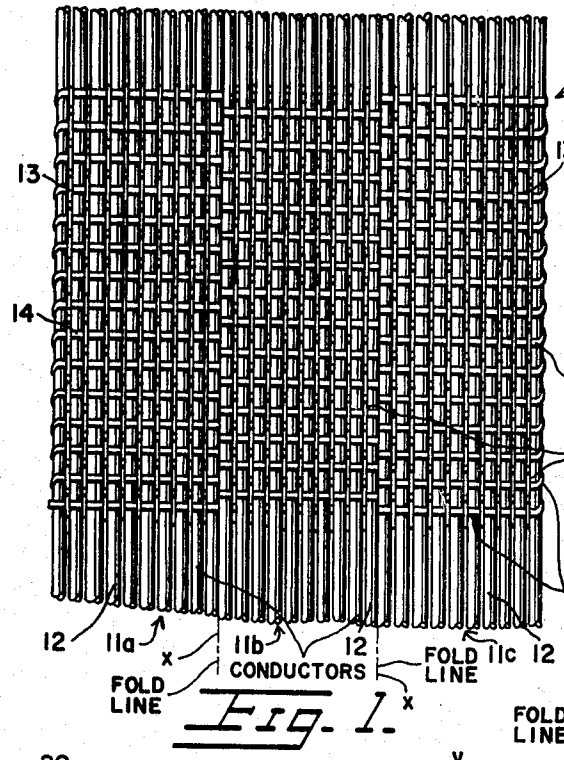


Fig. 1.

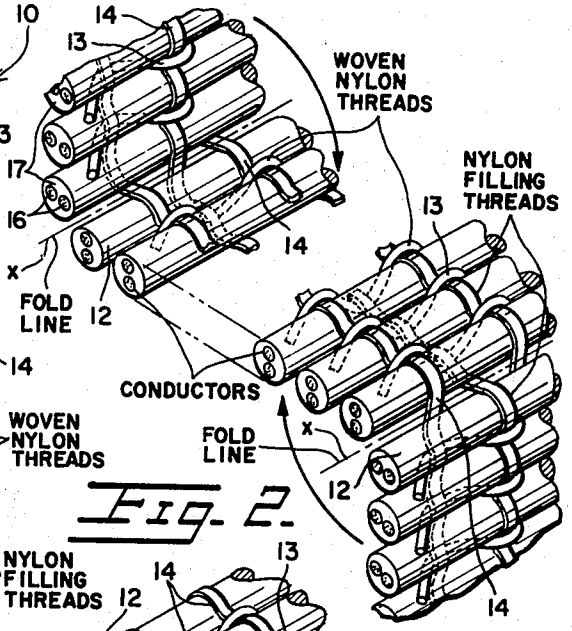


Fig. 2.

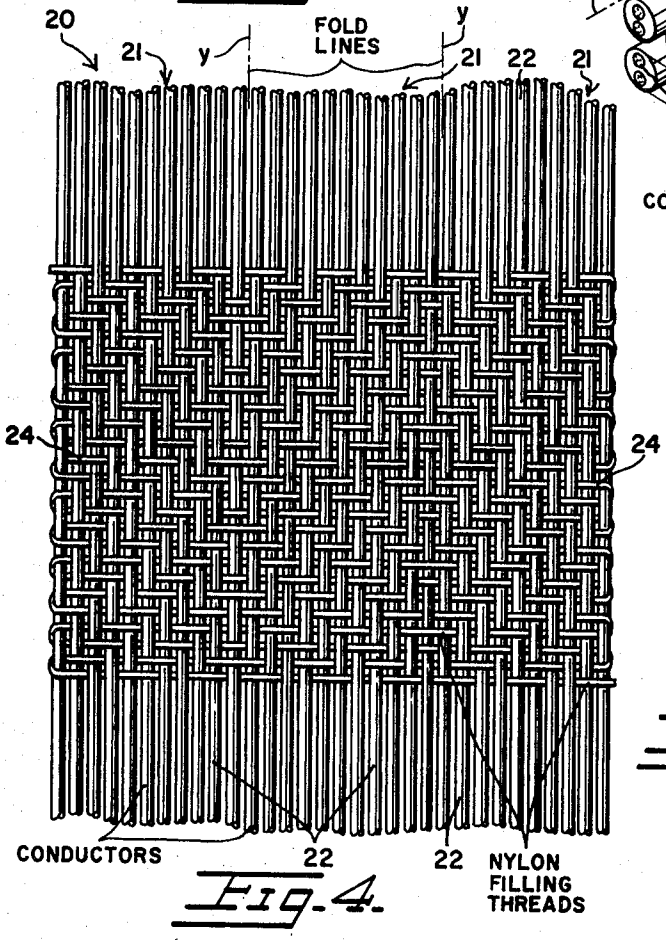


Fig. 4.

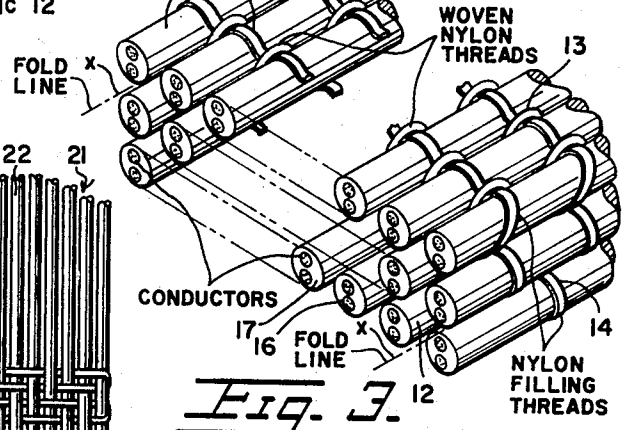


Fig. 3.

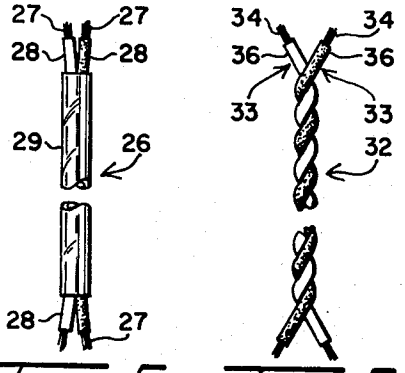


Fig. 5.

Fig. 6.

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FOLDABLE WOVEN MULTISTRAND ELECTRICAL CABLE

BACKGROUND OF THE INVENTION

The present invention relates generally to improvements in multiconductor cables and it relates particularly to an improved longitudinally foldable or collapsible woven multiconductor cable.

In many types of electrical and electronic equipment such as computors, communication equipment, automation control equipment, radar, fire control equipment or the like, many of the components, subassemblies and control panels possess numerous terminals which must be connected to terminals at other remotely positioned components, subassemblies and control panels. Multiconductor harnesses and cables are commonly employed for accomplishing these connections but such devices possess numerous drawbacks and disadvantages. They are generally difficult and expensive to assemble and connect, are bulky and greatly space consuming, and are of little versatility and adaptability. While the woven flat types of multiconductor cables overcome many of the drawbacks of the conventional cables and harnesses, they likewise are frequently greatly space consuming, of little versatility and adaptability and otherwise leave much to be desired.

SUMMARY OF THE INVENTION

It is a principal object of the present invention to provide an improved multiconductor cable.

Another object of the present invention is to provide an improved woven multiconductor cable.

Still another object of the present invention is to provide an improved woven multiconductor cable which may be employed in a flat or single layer-extended condition or may easily be folded along preformed longitudinal hinge lines in accordion fashion to a compact condition of considerably reduced width.

A further object of the present invention is to provide an improved multiconductor cable of the above nature characterized by its high versatility, adaptability, compactness, ruggedness, reliability and low cost.

The above and other objects of the present invention will become apparent from a reading of the following description taken in conjunction with the accompanying drawing which illustrates preferred embodiments thereof.

In a sense the present invention contemplates the provision of a longitudinally foldable woven multiconductor cable comprising a plurality of longitudinally extending side-by-side sections, successive sections being delineated by an intervening fold line, each of said sections including a plurality of longitudinally extending warp defining conductors, and a common weft interwoven with said conductor warps in a predetermined weaving pattern, said weft conductor warp-weaving pattern being altered between successive sections at said respective intervening fold line.

The conductor warps are advantageously insulator covered or sheathed flexible multistrand wires and each of the conductor warps may include one or more mutually insulated conductors enclosed in a common insulating sheath or a twisted plurality of individually insulator covered wires. The cable fabric warp may be formed with only conductor warps or may include nonconducting yarn warps, preferably more flexible and lighter than the conductor warps and alternating with the conductor warps. In a preferred weaving pattern of the improved cable, the weft or filler, advantageously a light, flexible yarn, is interwoven in a plain or box weave with the warps which include alternate conductor and yarn warps, the yarn warps being omitted at the fold lines to form hinge lines along the fold line. The weft, as it traverses the fold line, changes from one face of the conductor warps to an opposite face thereof. According to another embodiment of the present invention the weft is interwoven with the warps, which consist of conductor warps, in a twill weave. At the fold lines a pick is altered so that the twill pattern reverses from section to section at the intervening fold line.

The improved woven multiconductor cable can be employed as a single layer or may be easily compacted by the accordion folding thereof which is facilitated by the weaving pattern which provides a longitudinal hinge along the respective fold line. The cable, even in its fully extended condition, is of minimum width, rugged and highly flexible.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a section of woven cable embodying the present invention;

FIG. 2 is a fragmentary enlarged perspective view thereof illustrated in an extended partially folded condition;

FIG. 3 is a view similar to FIG. 2 illustrating the cable in a fully contracted folded condition;

FIG. 4 is a plan view similar to FIG. 1 of another embodiment of the present invention;

FIG. 5 is a fragmentary elevational view of another form of conductor warp which may be employed in the structures shown in FIGS. 1 to 4; and

FIG. 6 is a view similar to FIG. 5 of still another form of conductor warp.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, and particularly to FIGS. 1 to 3 thereof which illustrate a preferred embodiment of the present invention, reference numeral **10** generally designates the improved woven cable which is illustrated as a band comprising three side-by-side longitudinally extending panels or sections **11**, including sections **11***a*, **11***b* and **11***c*, which are delineated from each other by respective parallel longitudinally extending transversely spaced fold lines X which define hinges as a consequence of the conductor web-weaving pattern. While cable **10** is illustrated as including three hinged sections **11** it should be understood that it may be constructed with two or more than three hinged sections **11**. Each hinged section **11** is woven in a similar weaving pattern, the pattern shifting longitudinally in phase relative to the conductor warp at the respective fold line.

Cable **10** may be woven in the known manner on a conventional band-weaving loom and includes as warps longitudinally extending flexible conductor warps **12**, highly flexible light yarn warps **13** and a highly flexible light weft or filler yarn **14**. Yarn warps **13**, except at fold lines X, alternate with conductor warps **12** and at each fold line X yarn warp **13** is omitted to provide adjacent successive conductor warps **12**. Weft **14** is common to all sections **11** and is interwoven with warps **12** and **13** in a plain or box pattern. Accordingly, as weft **14** crosses a fold line X it passes from one face of the conductor warps **12** in a section **11** to the opposite face of the conductor warps in the next successive section **11**. Thus the weaving pattern of weft **14** relative to warps **12** and **13** shifts longitudinally at the fold line the distance between successive weft runs.

Conductor warp **12** includes a pair of longitudinally extending transversely spaced conductor cores **16** for example, of single or multistrand copper, and an insulator sheath or cover **17** which is advantageously a synthetic polymeric resin, for example polyvinylchloride, a polyolefin, a fluorinated polyolefin or the like. Warp yarns **13** and weft **14** may be of any suitable yarn, either monofilament or twisted single or multiple ply continuous filament or staple fiber yarns, for example of synthetic fibers such as nylon, polyester, polyolefins and the like.

In woven cable of the above described construction, each section **11** is relatively stiff across the width thereof but successive adjacent sections **11** are easily foldable or swingable relative to each other in both directions about the hinge-delineating fold lines X. Thus, woven cable **10** may be accordion folded about hinge lines X into a compact condition with sections **11** in superimposed positions and the cable may be spread to any degree to a fully extended condition where and when desired. Moreover, cable **10** may be shaped to any desired contour, and may be employed in any desired manner, opposite ends of the conductors in cable **10** being connected

by plug and socket or otherwise to corresponding terminals in the respective electrical assemblies and components. It should be noted that electrical breakout areas can be effected by programming in at predetermined areas the breaking out from the woven structure of the insulated conductors to facilitate the preparation for connection in an electrical system.

In FIG. 4 of the drawings there is illustrated another embodiment of the present invention in which the improved woven cable 20 differs from that first described primarily in that a twill weave construction is employed and the warp yarns are omitted and only conductor warps are used. Specifically, cable 20 includes three longitudinal side-by-side sections 21 delineated from each other by longitudinal fold lines Y. The cable 20 includes conductor warps 22 of the structure of conductor warps 12 and a common weft yarn 24 similar to weft yarn 14 and interweaving conductor warps 22 in a twill construction. Weft 24, in traversing a run along each section 21, passes above and below successive pairs of warps 22 and in the next successive weft run in the respective section 21 the sequence is advanced in a predetermined direction a unit warp. However, the direction of advance of the weft run sequence reverses as the weft 24 crosses each fold line Y so that the twill weave pattern reverses in successive sections 21 and the weave pattern is thus altered across each fold line Y. It should be noted that the reversal in weave is effected at the fold line Y by providing that each conductor warp 22 in one section 11 is one pick behind the preceding conductor warp and that in the adjacent section each conductor warp 22 is one pick ahead of the preceding conductor warp 22.

Adjacent sections 21 are easily foldable relative to each other along an intervening hinge-defining fold line Y across which the weaving pattern is disturbed or altered. The cable 20 is employed and applied in the manner of cable 10 first described.

While both conductor warps 12 and 22 have been illustrated as containing a pair of spaced wires 16 directly embedded in an insulator sheath 17 they may be of other construction, including one or more individual wires which are preferably individually insulator covered or covered by a common insulator sheath. Thus, in FIG. 5 of the drawing there is illustrated a conductor 26 which may be employed as the conductor warp. The conductor warp 26 includes a pair of multistrand conductors 27, each of which is individually covered by a corresponding insulating cover 28 which are preferably of different colors for coding or identification purposes. The pair of insulator-covered conductors 27 are covered by a common outer insulator sheath 29. The insulator sheaths may be of a composition similar to sheath 17 as early described.

An alternative conductor warp construction is illustrated in FIG. 6 and is designated by the reference numeral 32. The conductor warp 32 includes a twisted pair of conductors 33. Each conductor 33 includes a multistrand wire core covered by an insulator sheath 36, the sheaths 36 advantageously being differently color coded.

While there have been described and illustrated preferred embodiments of the present invention it is apparent that numerous alterations, omissions and additions may be made without departure from the spirit thereof. For example, while the conductor warps are of the same construction in each cable, conductor warps of a plurality of constructions may be employed in the woven cable. Further, the various cable constructions may be modified by varying the presence and absence of the nonconductor warps and their arrangement.

We claim:

1. A longitudinally foldable woven multiconductor cable comprising a plurality of longitudinally extending side-by-side sections, successive sections being delineated by an intervening fold line, each of said sections including a plurality of longitudinally extending warp defining conductors, and a common weft interwoven with said conductor warps in a predetermined weaving pattern, said weft conductor warp weaving pattern being altered between successive sections at said respective intervening fold line.

2. The multiconductor cable of claim 1 wherein each of said conductor warps comprises an insulator sheathed multistrand conductor.

3. The multiconductor cable of claim 1 wherein each of said conductor warps comprises a plurality of twisted, insulator covered wires.

4. The multiconductor cable of claim 1 including longitudinally extending nonconducting warp yarns positioned in said sections between conductor warps, said weft interweaving said conductor and nonconductor warps.

5. The multiconductor cable of claim 1 including a longitudinally extending nonconducting yarn warp between each pair of successive conductor warps in each of said cable sections, the space between adjacent conductor warps on opposite sides of said fold line being free of said yarn warp, said weft being interwoven with said conductor and yarn warps in a box weave whereby said weft along a transverse run thereof is disposed along opposite faces of said conductor warps at successive cable sections.

6. The multiconductor cable of claim 1 wherein said weft is interwoven with said warp in a twill pattern, said weaving pattern being reversed at said fold line between successive sections.

7. The multiconductor cable of claim 1 wherein said weft is interwoven with said warp in a twill pattern with said weft interweaving said warp successively two over and two under said warp successive weft runs being advanced in a predetermined direction a unit warp, said weft advancing between successive warps at said fold line in a pattern opposite said normal twill weave pattern.

8. The multiconductor cable of claim 1 including a plurality of transversely spaced fold lines delineating corresponding successive cable sections.

9. The multiconductor cable of claim 1 wherein each of said conductor warps includes a plurality of mutually insulated conductors.

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