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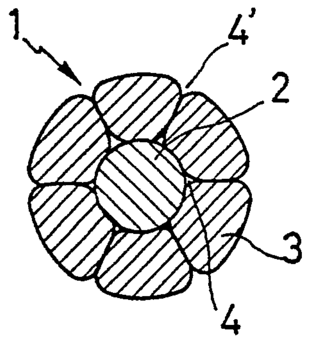
(54) Compact-stranded wire conductor for wire harnesses.

(57) A compact-stranded wire conductor (1) made by circularly compressing peripheral element wires (3) provided around a central element wire (2), in which the central element wire (2) is selected to have a hardness higher than that of the peripheral element wire (3) in order to achieve higher strengths for small diameters of the wire conductor.

FIG.2



EP 0 331 182 A1

COMPACT-STRANDED WIRE CONDUCTOR FOR WIRE HARNESSES

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a compact-stranded wire conductor, and in particular to a compact-stranded wire conductor to be used in wire harnesses for motor vehicles.

Description of the Prior Art

Wire harnesses are typically used in the various electrical systems of motor vehicles, and with the growing advancement in the technology of such electrical systems, the number and complexity of associated wirings has had to increase accordingly. This increase in complexity is especially evident for the growing number electrical systems that operate on low electrical currents, such as indicator lights and the like. For this reason, the current trend has been to try to reduce the overall weight of the wire harness by making reducing the diameter of the individual wire conductors comprising the wire harness.

In response to the current trends mentioned above, a thinner wire harness was proposed by making use of compacted-stranded wire conductors, that is, wire conductors made by circularly compressing a bundle of individual wires (Japanese Laid-Open Patent Application No. 60-91573). The reasoning behind this suggestion was that since the diameters of the compact-stranded wire conductors can be made relatively small, there use would therefore lead to an overall reduction in the size of the wire harness.

Now, in order to gain a better understanding of the prior art compact-stranded conductor, a cross sectional view of one example of such a conductor is illustrated in Fig. 1. As shown in this figure, a compact-stranded wire conductor 1 comprises a central element wire 2 and peripheral element wires 3 provided around the central element wire 2, with spaces 4 and 4′ existing between the element wires 3 and the central element wire 2 and between the element wires 3 themselves, respectively.

In the example described above, Fig. 1 further illustrates that the element wires 2 and 3, having originally been circular in cross section, become deformed when they are circularly compressed, such as by die drawing, to form the the compact-stranded wire conductor 1. As a result of this deformation, the spaces 4 and 4′ are reduced in size relative to what they were before the element wires 2 and 3 were circular compressed, thus leading to reduction in the overall size of the wire conductor 1.

Unfortunately, however, the prior art compact-stranded wire conductors have many inherent disadvantages because they employ wires made from the same material (such as hard or soft copper) and having the same physical properties for both the central element wire 2 and the peripheral element wires 3. These disadvantages can best be explained by referring once again to Fig. 1.

Namely, as shown in Fig. 1, both the central element wire 2 and the peripheral element wires 3 undergo deformation and thereby take on somewhat random shapes, which in turn causes the spaces 4 and 4′ to become a little scattered and also take on somewhat random patterns. As a result, the compact-stranded wire conductor so produced does not possess sufficient overall strength if its diameter is made relatively small, and it is even possible that the electrical conductivity of one or more of the element wires could be adversely affected due to such deformations. Moreover, the slightly random nature of the deformations tends to give rise to a loss in the overall circularity of the wire conductor, which necessitates the provision of a thicker layer of insulating material in order to properly cover the wire conductor.

SUMMARY OF THE INVENTION

In view of the disadvantages of the prior art compact-stranded wire conductors, it is an object of the present invention to provide a compact-stranded wire conductor having sufficient strength and electrical characteristics even when the wire conductor is formed to have a relatively small diameter.

It is another object of the present invention to provide a compact-stranded wire conductor having high circularity.

It is still another object of the present invention to provide a compact-stranded wire conductor requiring only a thin layer of an insulation covering.

It is still a further object of the present invention to provide a compact-stranded wire conductor in which only the peripheral element wires undergo substantial deformation when the compact-stranded wire conductor is manufactured.

In order to achieve the objects stated above, the compact-stranded wire conductor according to the present invention comprises a central element wire having a high hardness and peripheral element wires each having a relatively low hardness with respect to the hardness of the central element wire.

The foregoing, and other objects, features, and advantages of the present invention will become more apparent from the detailed description of the preferred embodiments taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross-sectional view of a prior art compact-stranded wire conductor.

Fig. 2 is a cross-sectional view of a compact-stranded wire conductor according to the present invention.

Fig. 3 is graph showing the associated breaking loads for various diameters of two compact-stranded wire conductors according to the present invention in comparison with defined standards.

Fig. 4 is a graph showing the associated limiting currents for the various diameters of the same wire conductors shown in Fig. 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to Fig. 2, one embodiment of the present invention will be described.

Namely, as shown in Fig. 2, a compact-stranded wire conductor 1 comprises a central element wire 2 and peripheral element wires 3 concentrically placed around the central element wire 2. In this construction, either single or stranded wires can be employed for both the central element wire 2 and the peripheral element wires 3, but any and all choices made must be such that the central element wire 2 has a higher hardness than that of the peripheral element wires 3.

In the embodiment described above, the use a wire having both high hardness and high strength for the central element wire 2 is preferred, such as a wire made from stainless steel, copper alloy or the like. In this connection, it should be noted that the choice should be made even at the sacrifice of a small loss in the limiting current, because for low currect electrical systems such a minor loss will have no adverse effect.

For the peripheral element wires 3, soft or hard copper wires or copper alloy wires may be used so long as they have hardnesses smaller than that of the wire chosen for the central element wire 2. However, it is recommended that wires having slightly high hardnesses, such as stainless steel wires, be used for the peripheral element wires 3 when a high-hardness copper alloy wire is being employed for the central element wire 2.

As a direct consequence of the choices for wires based on hardness mentioned above, it can be seen from Fig. 2 that only the peripheral wires 3 undergo substantial deformation when the wire conductor 1 is circularly compressed during its manufacture. Moreover, since these deformations are roughly uniform for each of the peripheral wires 3, there occurs a reduction in the dispersion and size of spaces 4 and 4′ existing between the element wires 3 and the central element wire 2 and between the element wires 3 themselves, respectively. The end result is that the wire conductor 1 will have both high strength and high circularity.

Now, for the purpose of demonstrating the features and advantages of the present invention described above, several examples of the present invention were made and tested against prior art standards both in terms of strength and limiting current for various diameters thereof. The particular construction of these examples and standards, i.e., examples A and B and standards C and D, is listed in Table 1, with the resulting test data thereof being displayed in Figs. 3 and 4.

TABLE 1

	Central Element Wire	Peripheral Element Wires	Circular Compactification	Insulating Cover Sheath
Example A	1 Stainless Steel Wire	6 Copper Alloy Wires	Die Drawing	0.25mm of Polyvinyl Chloride
Example B	1 Stainless Steel Wire	6 Soft Copper Wires	Die Drawing	0.25mm of Polyvinyl Chloride
Standard C	1 Soft Copper Wire	6 Soft Copper Wires	Die Drawing	0.25mm of Polyvinyl Chloride
Standard D	1 Soft Copper Wire	6 Soft Copper Wires	No Circular Compactification	0.25mm of Polyvinyl Chloride

With reference first to Fig. 3, the limiting currents of examples A and B and standards C and D are shown for various diameters, with the dashed line P indicating a minimum limiting current of 3 amperes required for wire conductors which are to be used in wire harnesses for motor vehicles. For the data shown, tests were carried out under conditions in which the maximum temperature and the ambient temperature of the conductor during use were 80° C and 60° C, respectively.

From Fig. 3, it can be seen that even though the limiting currents of examples A and B are slightly smaller than those of standards C and D, these currents are still above the minimum limiting current line P. Thus, these examples show that the wire conductors made according to the present invention can achieve sufficient electrical current flow, even when the diameter of the wire conductor is reduced to about 0.5mm.

Next, with reference to Fig. 4, there is shown the associated breaking loads for various diameters of the examples A and B and standards C and D. In this graph, L represents a minimum breaking load of 10kgf that must be achieved in order for the wire conductor to be considered to have adequate strength characteristics.

As can be seen from Fig. 4, in order for standard C to have sufficient strength so as to meet the minimum breaking load requirement of 10kgf, it must have a diameter of at least 0.7mm. However, a direct comparison reveals that example A can achieve the same strength requirement with a diameter of only 0.5mm. This means that it is possible to achieve a reduction in diameter of about 29%, and consequently a reduction in cross-sectional area of about 50%. Thus, it is quite clear that present invention allows high strength to realized for very small diameters of a wire conductor.

Finally, it is to be understood that even though the present invention has been described in its preferred embodiments, many modifications and improvements may be made without departing from the scope of the invention as defined by the appended claims.

Claims

1. A compact-stranded wire conductor, comprising:
a central element wire having a characteristic hardness; and
a plurality of peripheral element wires provided around the central element wire and circularly compacted thereto, the peripheral element wires having characteristic hardnesses that are lower than the hardness of the central element wire.

2. The wire conductor of Claim 1, wherein the central element wire comprises a solid wire made from a metal selected from the group consisting of stainless steel and copper alloy.

3. The wire conductor of Claim 1, wherein the central element wire comprises a stranded wire made from a metal selected from the group consisting of stainless steel and copper alloy.

4. The wire conductor of Claim 2, wherein the peripheral element wires comprise solid wires made from a metal selected from the group consisting of soft copper, hard copper, copper alloy and stainless steel.

5. The wire conductor of Claim 3, wherein the peripheral element wires comprise solid wires made from a metal selected from the group consisting of soft copper, hard copper, copper alloy and stainless steel.

6. The wire conductor of Claim 2, wherein the peripheral element wires comprise stranded wires made from a metal selected from the group consisting of soft copper, hard copper, copper alloy and stainless steel.

7. The wire conductor of Claim 3, wherein the peripheral element wires comprise stranded wires made from a metal selected from the group consisting of soft copper, hard copper, copper alloy and stainless steel.

FIG.1
PRIOR ART

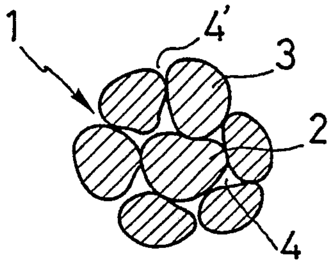


FIG.2

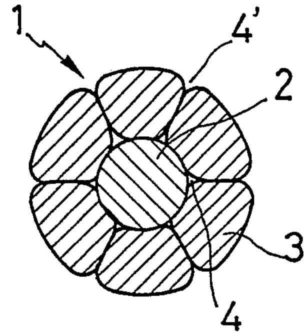


FIG.3

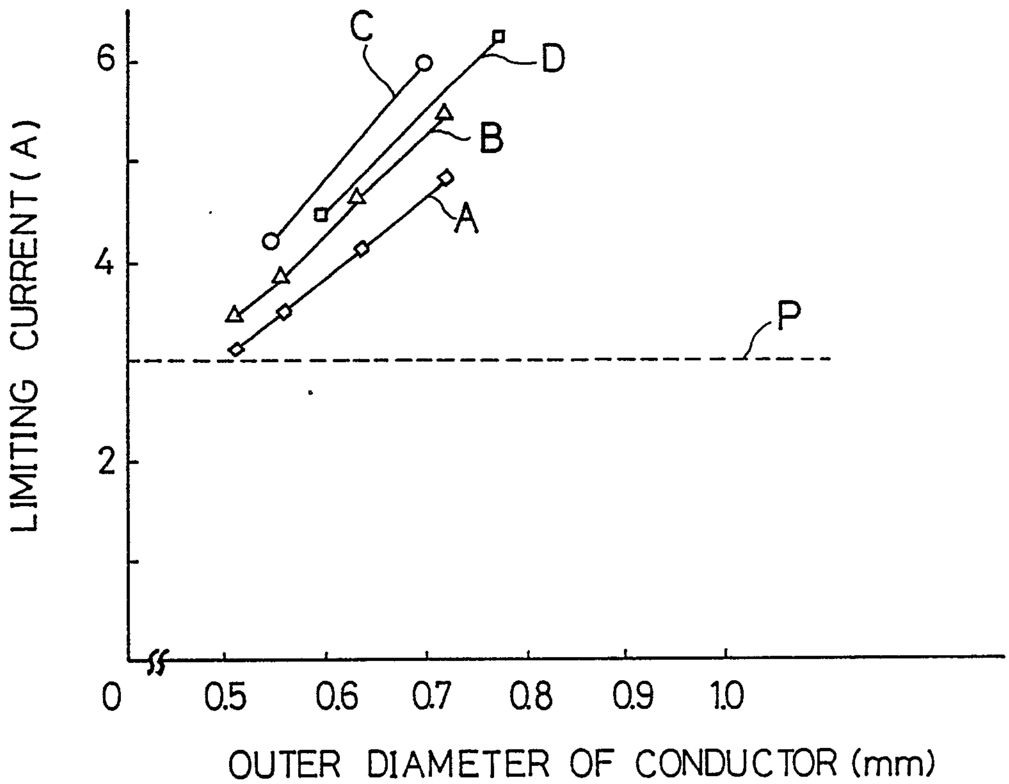
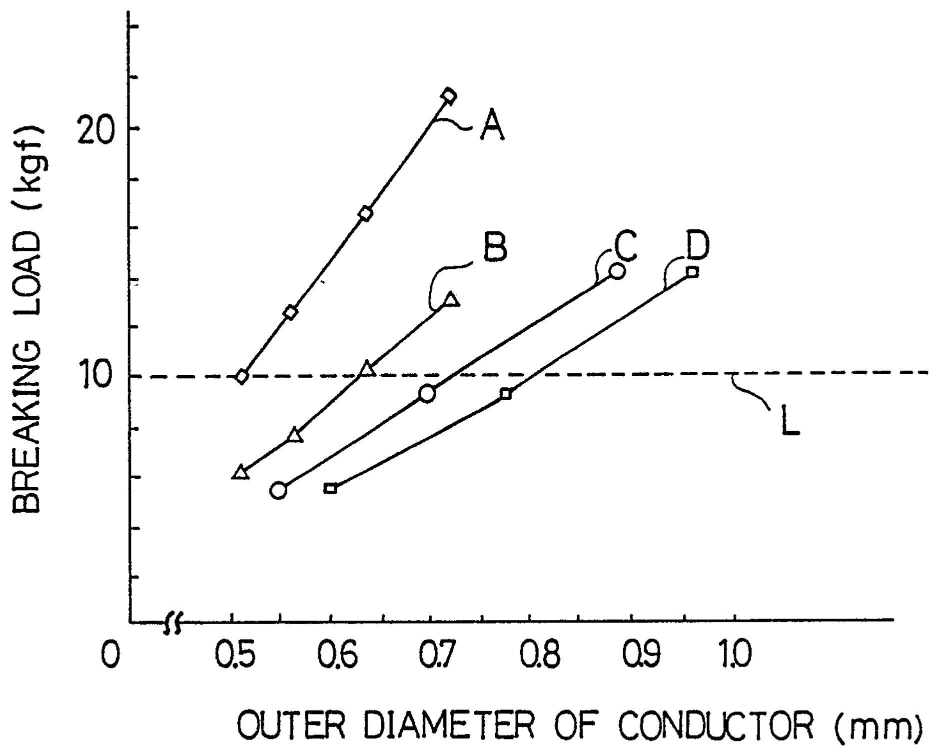

LIMITING CURRENT (A)
6
4
2
0
0.5
0.6
0.7
0.8
0.9
1.0
C
D
B
A
P
OUTER DIAMETER OF CONDUCTOR (mm)

FIG.4


BREAKING LOAD (kgf)
20
10
0
0.5
0.6
0.7
0.8
0.9
1.0
A
B
C
D
L
OUTER DIAMETER OF CONDUCTOR (mm)

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 89103752.5

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X;Y	GB - A - 2 160 554 (CEECO) * Page 2, lines 39-43; page 4, lines 89-114; fig. 4 *	1;2,4, 6	H 01 B 5/08 H 01 B 7/04
Y	DE - B - 1 117 677 (APELT) * Column 2, line 54 - column 4, line 10; fig. *	2-7	
X;Y	GB - A - 1 413 665 (REYNOLDS) * Page 5, lines 13-23; fig. 4 *	1;3,5, 7	
A	US - A - 4 593 963 (ENDO et al.) * Fig. 4b *	1	
D	& JP-A2-60-91 573		
A	FR - A1 - 2 430 069 (ERICO-FRANCE) * Page 6, lines 14-35; fig. 4 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl.4) H 01 B D 07 B B 60 R 16/00 A 61 N 1/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	05-06-1989	KUTZELNIGG

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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