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(11) Publication number:

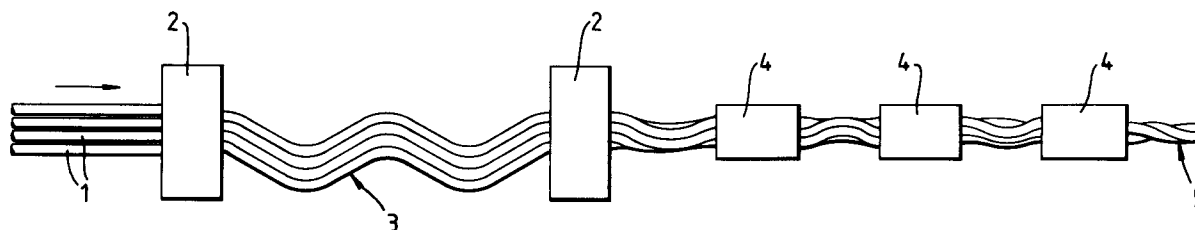
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EUROPEAN PATENT APPLICATION(21) Application number: **91307549.5**(51) Int. Cl.⁵: **D07B 3/00**(22) Date of filing: **15.08.91**(43) Date of publication of application:
24.02.93 Bulletin 93/08(84) Designated Contracting States:
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Quantum House Maylands Avenue
Hemel Hempstead, Herts. HP2 4SJ (GB)(54) **Manufacture of a reversed lay stranded assembly.**

(57) In the manufacture of a stranded assembly 5 separately formed flexible elongate elements 1 in which the direction of lay of the elements is reversed along the length of the assembly at regular intervals no greater in length than a single turn of an element, the flexible elongate elements 1 are caused to advance side by side in the direction of their lengths with their axes in a common plane and to follow regular wavy paths in the plane so as to form a flat assembly 3 of flexible elongate elements in which adjacent elements are in continuous contact and follow wavy paths. The advancing wavy flat assembly 3 is transversely folded about a longitudinal axis

parallel to the direction of advance of the assembly to form a stranded assembly 5 of flexible elongate elements in which the direction of lay of the elements is reversed at regular intervals along the length of the assembly. The amplitude of the waves of the wavy flat assembly 3 having regard to the cross-sectional size of the flat assembly is such that, when the wavy flat assembly is transversely folded about the longitudinal axis, the regular intervals at which the direction of lay of the elements 1 is reversed are each no greater in length than a single turn of an element.

Fig. 1.**EP 0 528 083 A1**

This invention relates to the manufacture of a stranded assembly of separately formed flexible elongate elements in which the direction of lay of the elements along the length of the assembly is reversed at regular intervals.

It is common practice in the manufacture of a stranded assembly of separately formed flexible elongate elements, such as a multi-core electric power or communication cable, multi-core optical cable, an overhead electric conductor and a steel hawser, to "lay-up" or helically wind separately formed flexible elongate elements in a layer or in each of two or more layers in a single direction of lay. Where the stranded assembly comprises two or more layers of such helically wound elongate elements, it is also common practice for the direction of lay of the elements of adjacent layers to be of opposite hand.

With a view to improving manufacturing output, it is sometimes the practice to helically wind the separately formed flexible elongate elements of a layer in such a way that the elements are wound a plurality of times in one direction of lay and are then wound a like plurality of times in the reverse direction of lay, this cycle being repeated throughout manufacture of the stranded assembly.

In some circumstances, it may be desirable that the regular intervals between the positions at which the direction of lay of the flexible elongate elements is reversed are each no greater in length than a single turn of an element, thereby providing ample spare length of elements at positions along the stranded assembly where T-joints are to be made and producing a stranded assembly more likely to be capable of withstanding subsidence and the like.

Manufacture of a stranded assembly of separately formed flexible elongate elements in which the direction of lay of the elements is reversed along the length of the assembly at regular intervals no greater in length than a single turn of an element by methods hitherto proposed and used has the major difficulty that whilst parts of the flexible elongate elements are helically wound in one direction, those parts of the elements which are immediately downstream and which have just been helically wound in the reverse direction tend to unwind. Holding of the assembly to prevent unwinding of parts of the elements as adjoining parts of the elements are helically wound in the opposite direction is feasible but can cause damage to the elements and will result in a reduction in the speed of manufacture.

It is an object of the present invention to provide an improved method of manufacturing a stranded assembly of separately formed flexible elongate elements in which the direction of lay of the elements is reversed along the length of the

assembly at regular intervals no greater in length than a single turn of an element.

According to the invention, the improved method comprises causing a plurality of separately formed flexible elongate elements to advance side-by-side in the direction of their lengths with their axes in a substantially common plane and to follow substantially regular wavy paths in said plane so as to form a substantially flat assembly of flexible elongate elements in which adjacent elements are in substantially continuous contact and follow said wavy paths; and transversely folding said advancing wavy flat assembly about a longitudinal axis substantially parallel to the direction of advance of the assembly to form a stranded assembly of flexible elongate elements in which the direction of lay of the elements is reversed at regular intervals along the length of the assembly, the amplitude of the waves of said wavy flat assembly having regard to the cross-sectional size of the flat assembly being such that, when the wavy flat assembly is transversely folded about said longitudinal axis, the regular intervals at which the direction of lay of the elements is reversed are each no greater in length than a single turn of an element.

Preferably, the amplitude of the waves of the wavy flat assembly of flexible elongate elements having regard to the cross-sectional size of the flat assembly is so selected that, when the wavy flat assembly is transversely folded about said longitudinal axis, the regular intervals at which the direction of lay of the elements is reversed are each substantially equal to a single turn of an element or are each substantially equal to one half of a single turn of an element.

The advancing separately formed flexible elongate elements may be caused to follow said substantially regular wavy paths in said common plane by any convenient means but, preferably, whilst advancing between two longitudinally spaced pairs of rotatably driven rollers or endless belts, the advancing elements are caused to move transversely from side to side to a predetermined extent, e.g. by causing the pairs of rotatably driven rollers or endless belts to move to and fro in a rectilinear direction substantially normal to the direction of advance of the flexible elongate elements. If desired, immediately upstream of the first of the longitudinally spaced pairs of rotatably driven rollers or endless belts, adjacent flexible elongate elements may be secured in continuous line contact, e.g. by extruding a thin layer of plastics material overall so that adjacent elements are joined by a web of plastics material.

Transverse folding of the advancing wavy flat assembly of flexible elongate elements about said longitudinal axis may be effected in any convenient manner, for example, by causing the flat assembly

to pass through a rolling mill comprising a plurality of pairs of shaping rolls or appropriately disposed pairs of endless belts, through a plurality of forming dies or through a single former having a bore of a shape approximating to a frustum of a cone.

During manufacture of the stranded assembly, at least one elongate member of high tensile strength - hereinafter, for convenience, referred to as a tensile-resistant elongate member - may be assembled with the stranded assembly. The tensile-resistant elongate member may be at least one tensile-resistant elongate element which is caused to travel in the direction of its length and around which the wavy flat assembly of flexible elongate elements is transversely folded, or one or more than one longitudinally extending tensile-resistant elongate member, e.g. a tape of tensile-resistant material, may be assembled with the plurality of separately formed flexible elongate elements. Alternatively, the tensile-resistant member may comprise a sheath of tensile-resistant material which surrounds the stranded assembly of flexible elongate elements and which is formed by extrusion or by helically winding a plurality of interlocking elongate elements of tensile-resistant material around the stranded assembly. In some circumstances, a combination of at least one central tensile-resistant element and a sheath of tensile-resistant material may be employed.

Where at least one central tensile-resistant element is not employed, the wavy flat assembly of flexible elongate elements may be transversely folded around at least one stranded assembly of flexible elongate elements which has been manufactured by the improved method hereinbefore described and which is advancing in the direction of its length.

Two or more stranded assemblies of flexible elongate elements, each of which has been manufactured by the improved method hereinbefore described, may be laid-up or otherwise assembled together to form a multi-assembly product.

Preferably, in all cases, the separately formed flexible elongate elements of the or each wavy flat assembly are of the same cross-sectional shape and size as one another.

Separately formed flexible elongate elements that may be assembled using the improved method of the present invention include bare wires or assemblies of two or more bare wires, insulated electrical conductors which may be a single wire or a plurality of wires, optical cables or optical fibre elements comprising at least one optical fibre and pipes or tubes of metal or metal alloy or of rubber or plastics material.

The invention also includes a stranded assembly of separately formed flexible elongate elements in which the direction of lay of the elements is

reversed along the length of the assembly at regular intervals no greater in length than a single turn of an element, which stranded assembly has been manufactured by the improved method hereinbefore described.

The invention is further illustrated by a description, by way of example, of a preferred method of manufacturing a four core electric cable with reference to the accompanying drawings, in which:-

Figure 1 is a schematic representation of the preferred method of and apparatus for manufacturing a four core electric cable;

Figure 2 is a fragmental plan view of a wavy flat assembly of four cores advancing in the direction of its length;

Figure 3 is a fragmental plan view of the advancing wavy flat assembly as the advancing wavy flat assembly is gradually transversely folded about a longitudinal axis, the apparatus employed to effect transverse folding of the advancing wavy flat assembly being omitted for the sake of clarity, and

Figures 4 to 7, respectively, are transverse cross-sectional views of the advancing wavy flat assembly taken on the lines IV-IV, V-V, VI-VI and VII-VII in Figure 3.

Referring to the drawings, four electric cable cores 1, each consisting of a multi-wire electric conductor having an overall extruded layer of electrically insulating material, are drawn side by side in the direction of their lengths with their axes in a common plane through two longitudinally spaced pairs 2 of rotatably driven rollers. Whilst travelling between the pairs 2 of rotatably driven rollers, the advancing cable cores 1 are caused to move transversely from side to side in said plane so as to form a flat assembly 3 of cable cores in which adjacent cores 1 are in continuous contact and follow wavy paths. The amplitude of the waves of the wavy flat assembly 3 having regard to the cross-sectional size of the flat assembly is such that, when the wavy flat assembly is transversely folded about a longitudinal axis extending parallel to its direction of travel, the direction of lay of the cable cores 1 of the transversely folded assembly will be reversed at regular intervals each substantially equal to a single turn of a cable core around the folded assembly. Downstream of the last of the pairs of rotatably driven rollers 2, the advancing wavy flat assembly 3 of cable cores passes through a plurality of longitudinally spaced pairs of rollers 4 which transversely fold the advancing wavy flat assembly about said longitudinal axis to form a stranded assembly 5 of cable cores 1 in which the direction of lay of the cores is reversed at regular intervals each equal to a single turn of a core around the stranded assembly.

If desired, the advancing wavy flat assembly 3 of cable cores emerging from the last of the pairs of rotatably driven rollers 2 may be transversely folded around a tensile-resistant elongate element which is caused to travel in the direction of its length so that the stranded assembly of cable cores has a central tensile-resistant element within the stranded assembly. Alternatively, or additionally, downstream of the last of the pairs of shaping rollers 5, a sheath of tensile-resistant material may be formed by extrusion or by helically winding a plurality of interlocking elongate elements of tensile-resistant material around the stranded assembly.

Claims

1. A method of manufacturing a stranded assembly of separately formed flexible elongate elements in which the direction of lay of the elements is reversed along the length of the assembly at regular intervals no greater in length than a single turn of an element, characterised in that the method comprises causing a plurality of separately formed flexible elongate elements (1) to advance side by side in the direction of their lengths with their axes in a substantially common plane and to follow substantially regular wavy paths in said plane so as to form a substantially flat assembly (3) of flexible elongate elements in which adjacent elements are in substantially continuous contact and follow said wavy paths; and transversely folding said advancing wavy flat assembly about a longitudinal axis substantially parallel to the direction of advance of the assembly to form a stranded assembly (5) of flexible elongate elements in which the direction of lay of the elements is reversed at regular intervals along the length of the assembly, the amplitude of the waves of said wavy flat assembly having regard to the cross-sectional size of the flat assembly being such that, when the wavy flat assembly is transversely folded about said longitudinal axis, the regular intervals at which the direction of lay of the elements is reversed are each no greater in length than a single turn of an element.
2. A method as claimed in Claim 1, characterised in that the amplitude of the waves of the wavy flat assembly (3) of flexible elongate elements having regard to the cross-sectional size of the flat assembly is so selected that, when the wavy flat assembly is transversely folded about said longitudinal axis, the regular intervals at which the direction of lay of the elements (1) is reversed are each substantially equal to a single turn of an element or are each substantially equal to one half of a single turn of an element.
3. A method as claimed in Claim 1 or 2, characterised in that the advancing separately formed flexible elongate elements (1) are caused to follow said substantially regular wavy paths in said common plane by causing the advancing elements to move transversely from side to side to a predetermined extent whilst advancing between two longitudinally spaced pairs (2) of rotatably driven rollers or endless belts.
4. A method as claimed in any one of the preceding Claims, characterised in that transverse folding of the advancing wavy flat assembly (3) of flexible elongate elements about said longitudinal axis is effected by causing the flat assembly to pass through a rolling mill comprising a plurality of pairs of shaping rolls or appropriately disposed pairs of endless belts, through a plurality of forming dies (4) or through a single former having a bore of a shape approximating to a frustum of a cone.
5. A method as claimed in any one of the preceding Claims, characterised in that, during manufacture of the stranded assembly, at least one tensile-resistant member is assembled with the stranded assembly.
6. A method as claimed in Claim 5, characterised in that the tensile-resistant member is at least one tensile-resistant elongate element which is caused to travel in the direction of its length and around which the wavy flat assembly of flexible elongate elements is transversely folded.
7. A method as claimed in Claim 5, characterised in that the tensile-resistant member comprises a sheath of tensile-resistant material which surrounds the stranded assembly of flexible elongate elements and which is formed by extrusion or by helically winding a plurality of interlocking elongate elements of tensile-resistant material around the stranded assembly.
8. A method as claimed in any one of Claims 1 to 4, characterised in that the wavy flat assembly of flexible elongate elements is transversely folded around at least one stranded assembly of flexible elongate elements which has been manufactured by the method claimed in any one of the preceding Claims and which is advancing in the direction of its length.

9. A method as claimed in any one of the preceding Claims, characterised in that the separately formed flexible elongate elements (1) of the or each wavy flat assembly (3) are of the same cross-sectional shape and size as one another. 5

10. A method as claimed in any one of the preceding Claims, characterised in that the separately formed flexible elongate elements (1) assembled together to form said flat assembly (3) are selected from the group consisting of bare wires, assemblies of at least two bare wires, insulated electrical conductors, optical cables, optical fibre elements comprising at least one optical fibre, pipes and tubes of metal or metal alloy, pipes and tubes of rubber and pipes and tubes of plastics material. 10
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Fig. 1.

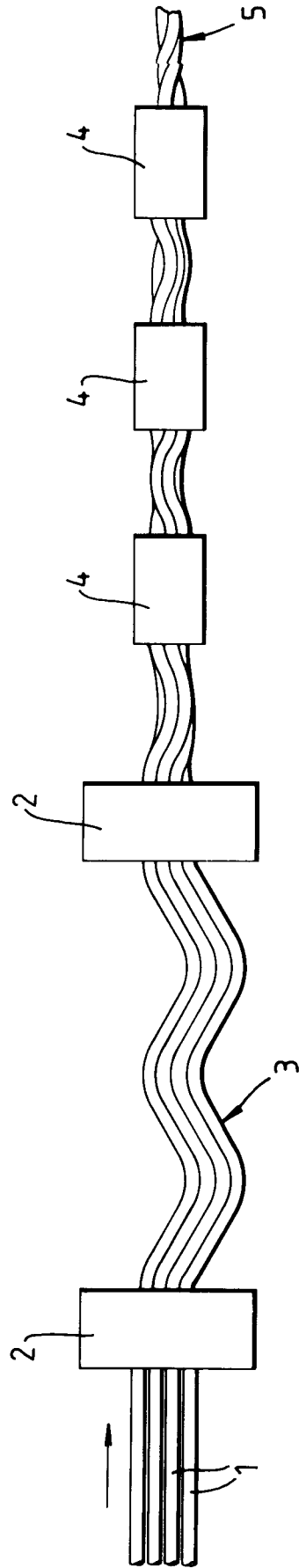


Fig. 2.

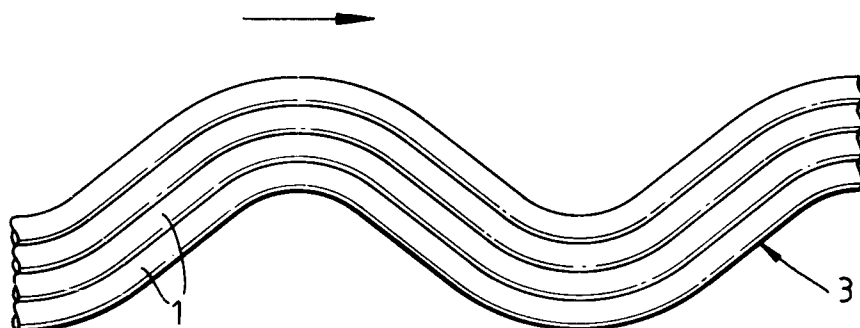


Fig. 3.

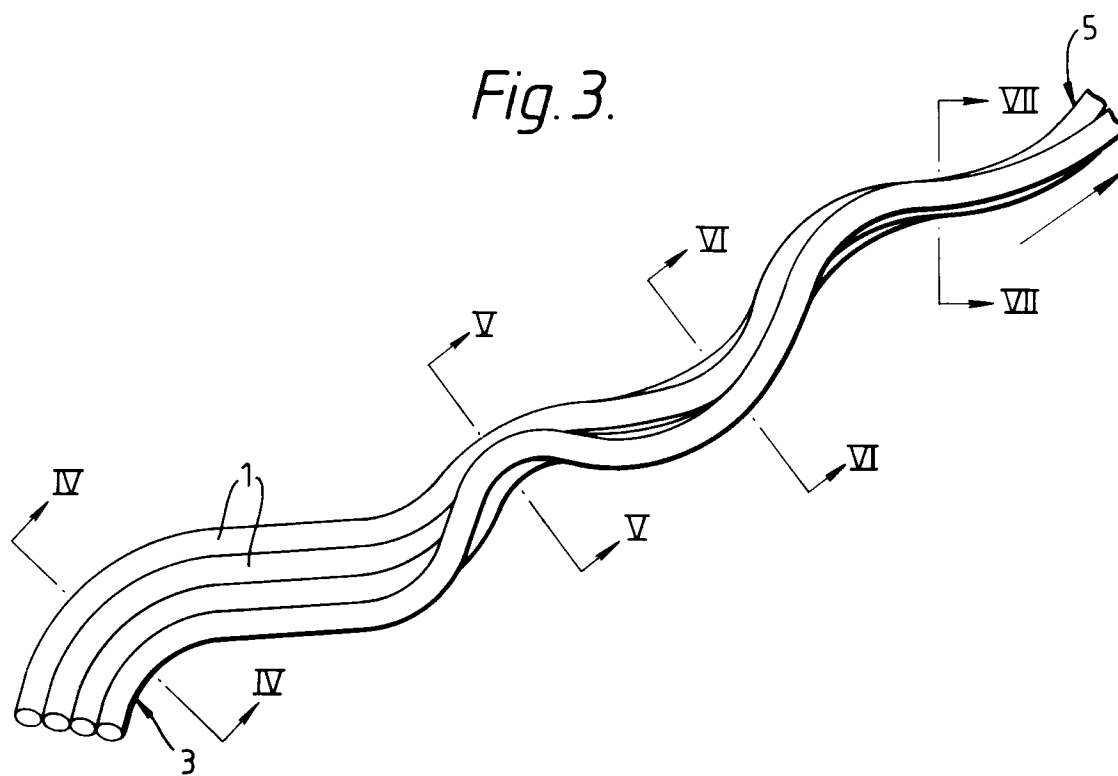


Fig. 4.

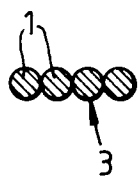


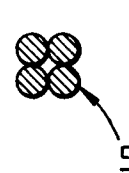
Fig. 5.



Fig. 6.



Fig. 7.





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EUROPEAN SEARCH REPORT

Application Number

EP 91 30 7549

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.5)
A	US-A-4 577 403 (J. N. GARNER) -----		D07B3/00
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			D07B H01B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 16 APRIL 1992	Examiner GOODALL C. J.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application I : document cited for other reasons & : member of the same patent family, corresponding document	