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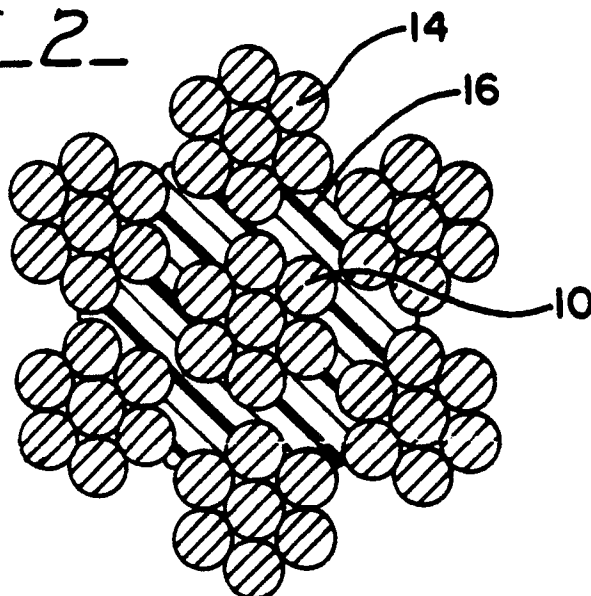
EUROPEAN PATENT APPLICATION

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D-8000 München 2(DE)(54) **Wire rope with compacted plastic filler elements.**

(57) The present invention provides a plastic filled wire rope. The wire rope includes a core and plastic elements surrounding the core. Outer strands surround the plastic elements, and the outer strands are compacted into the plastic elements. The plastic

elements are thusly squeezed to form a plastic layer surrounding the core. The plastic layer further provides a support for the outer strands and keeps the outer strands spaced from the core and from each other.

FIG. 2



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Background of the Invention

The present invention relates generally to wire ropes and, more particularly to a wire rope having compacted plastic filler elements.

Wire rope can have several different configurations, two of the most common being a rope having a fiber core surrounded by a plurality of outer strands each comprised of several metal wires and a rope having a core comprised of a plurality of metal wires surrounded by outer strands also comprising a plurality of metal wires. A wire rope with a metal wire core is frequently referred to as having an independent wire rope core.

It is known to infill wire rope with a variety of plastics, thermoplastics, or elastomers as such materials reduce contact stress between strands, improve strand load sharing, seal in lubricant within the strands and seal out corrosive and abrasive materials. The thermoplastic impregnation of wire rope is disclosed in U.S. Patent 3,824,777. It is also known from U.S. Patent 4,509,319 to provide precisely shaped plastic or thermoplastic filler elements into a wire rope during final forming. Such filler elements are chosen to conform to the shape of the interstices between the independent wire rope core and the outer strands and also between outer strands such that upon final closing of the rope, the preformed filler elements conform in cross section to such interstices and provide seating for the outer strands around the core and also adjacent to each other.

One possible disadvantage in the plastic impregnation of a completed wire rope or the laying of precisely shaped elements in the interstices of a wire rope at closing is that contact may occur after such processing between the core and the outer strands and between adjacent outer strands. Such contact is not desirable as it can lead to notching of individual wires and eventual rope failure.

Another method of providing a thermoplastic impregnated wire rope is to coat a wire rope core with a jacket of plastic, thermoplastic, or elastomer and then compress outer strands into the jacket as shown in U.S. Patent 4,120,145. This method requires considerable radial pressure and is difficult to control such that an even filling with plastic material is formed between the core and the outer strands and between the adjacent outer strands.

Summary of the Invention

Accordingly, it is an object of the present invention to provide a wire rope with plastic filler elements that can be compacted to form a uniform plastic spacing element in the wire rope. A wire rope is provided which comprises a core which is

usually an independent wire rope core. A plurality of plastic, thermoplastic or elastomer elements, collectively referred to as plastic filler elements, are laid in a spirally twisted relationship about the core, usually simultaneously with the closing of outer wire strands about the core. The resultant wire rope is compacted by die forming to final size usually in a single operation directly downstream of the closing die. The plastic elements may be circular in cross section or of some other selected shape, but in the compacting operation the plastic elements are compressed and squeezed to flow together to fill the interstices between the core and the outer strands of the wire rope. Depending on the relative size of the plastic elements and the desired final wire rope configuration, the plastic formed by the squeezing of the plastic filler elements may extend partially or totally to the outer rope diameter. The resultant rope has a predetermined or pre-selected wall thickness of plastic between the core and the outer strands. If desired, the plastic elements may be so selected such that a pre-selected thickness of plastic also flows between the outer rope strands such that the outer strands are equally spaced from each other. Due to the high compressive forces used to compact and position the outer strands, no further compaction will take place during the service life of the rope. Outer strand to core contact as well as outer strand to adjacent outer strand contact will be negligible or virtually nonexistent thereby eliminating one of the major causes of internal rope failure. The fatigue life of the core will also be extended because the core is surrounded by plastic material thereby insuring that appropriate lubricant is retained in the core.

The plastic filler elements may be of various cross section shapes, and such shapes include a round cross section forming a rod or wirelike plastic filler element, a combination of a rod with rectangular extension therefrom, a plain rectangular shape element, a triangular shape or some combination thereof. The initial shape of the plastic filler element is a consideration, but of greater concern is the overall volume of plastic material in the filler elements in relation to the final desired wire rope configuration. In the final wire rope configuration, the volume of the interstices in relation to the volume of the plastic filler elements will dictate the degree of compression of such plastic filler elements and the resulting flow of the plastic filler elements to form a composite plastic layer. The plastic layer forms a spacing between the core and the outer strands of uniform predetermined dimensions. Further, the plastic filler elements can be pre-selected to flow outwardly between the outer strands to a desired degree. If only minor degree of outward flowing is desired, the plastic layer would only form a seat for the outer strands. How-

ever, if a greater degree of outward flowing of the plastic layer is desired, the plastic layer can flow outwardly to form uniform spacing between adjacent outer strands and extend partially or just to the outer diameter of the outer strands themselves. In such case where the plastic layer extends to the outer diameter of the wire rope, the plastic layer would significantly seal the lubricant in the outer strands and also prevent the ingress of corrosive or abrasive materials into the outer strands. This is in addition to the plastic layer completely sealing the lubricant in the core.

Brief Description of the Drawings

In the drawings,

Figure 1 is a sectional view of a wire rope in accordance with a first embodiment of the present invention prior to compaction;

Figure 2 is a sectional view of the wire rope of Figure 1 after compaction;

Figure 3 is a sectional view of the wire rope of Figure 2 after further compaction to a swaged configuration;

Figure 4 is a sectional view of the wire rope in accordance with a second embodiment of the present invention prior to compaction;

Figure 5 is a sectional view of the wire rope of Figure 4 after compaction;

Figure 6 is a sectional view of the wire rope in accordance with a third embodiment of the present invention including flattened outer strands prior to compaction;

Figure 7 is a sectional view of the wire rope of Figure 6 after compaction, and

Figure 8 is a sectional view of various plastic filler elements.

Detailed Description of the Preferred Embodiments

Referring now to Figures 1-3 of the drawings, a wire rope in accordance with a first embodiment of the present invention is shown in cross section. The rope comprises an independent wire rope core 10 which is comprised of individual wires. Core 10 is surrounded by plastic filler elements 12 which are twisted about core 10 in a spiral fashion. Plastic filler elements 12 may be comprised of a suitable plastic, thermoplastic or elastomer as desired. Outer strands 14 are comprised of individual wires, and outer strands 14 are wound about core 10 and plastic filler elements 12 in a manner such that each of outer strands 14 is in contact with two of plastic filler elements 12. The number of outer strands 14 accordingly equals the number of plastic filler elements 12. The wire rope shown in

Figure 1 is shown prior to any compacting of outer strands 14 into plastic filler elements 12. Both core 10 and outer strands 14 are usually lubricated.

In Figure 2, the same wire rope shown in Figure 1 is shown after compacting of outer strands 14 inwardly into plastic filler elements 12. Such compacting is usually done by drawing the rope through a roller compactor or a die such that outer strands 14 compress and squeeze plastic filler elements 12 to form a homogenous single plastic layer 16. The degree of plastic extension will depend on the pre-selected diameter of plastic filler elements 12, the desired final rope diameter as well as the diameter of core 10 and outer strands 14. Plastic layer 16 is seen to form a spacing between core 10 and outer strands 14 which can be of a predetermined and uniform dimension. Plastic layer 16 is also seen to extend outwardly to form a spacing between adjacent outer strands 14 such that outer strands 14 are seated in depressions formed in plastic layer 16. Plastic layer 16 also acts to keep outer strands 14 at predetermined and desired spacing from each other to avoid contact between adjacent outer strands. Such uniform spacing between core 10 and outer strands 14 as well as between adjacent outer strands 14 assures increased wear life for the wire rope due to prevention of contact between component core and outer strands and also due to better equalization of load sharing between outer strands 14 and core strand 10.

Referring now to Figure 3, the wire rope of Figure 2 is shown after further compacting or swaging whereby outer strands 14 are flattened on their outer periphery and forced further inwardly toward core 10. Such further compaction of the wire rope causes plastic layer 16 to extend outwardly further between outer strands 14 such that it approaches the final outer diameter of the outer rope. Such further compaction of the wire rope is desirable in certain applications and provides a lower diameter final wire rope. The plastic layer 16 extending outwardly to near the final diameter of the rope, provides further seating for outer strands 14 and assures their even spacing throughout the rope life. It also assures to a greater degree the retention of lubricant not only within core 10 but also within outer strands 14.

Referring now to Figures 4 and 5, a wire rope in accordance with the second embodiment of the present invention is shown. In Figure 4, core 20 is comprised of individual wires and is surrounded by plastic filler elements 22 which are wound about core 20 in a spiral manner. Outer strands 24 are also comprised of individual wires and are wound about plastic filler elements 22 in a manner such that each of outer strands 24 contacts two of plastic filler elements 22. Both core 20 and outer

strands 24 are usually lubricated. Plastic filler elements 22 are shown as comprising circular elements in cross section and in essence comprise round wires of plastic, thermoplastic, or elastomer. Plastic filler elements 22 and outer strands 24 are usually wound about core 20 in a single closing operation. The wire rope shown in Figure 4 is shown prior to compaction. Plastic filler elements 22 are of a larger diameter than plastic filler elements 12 in Figure 1. Accordingly, as shown in Figure 5, during compaction when outer strands 24 are die compacted to move inwardly to squeeze plastic filler elements 22, plastic filler elements 22 combine to form a composite plastic layer 26 which expands outwardly to near the outer diameter of outer strands 24. A lesser degree of compaction of outer strands 24 than the compaction provided outer strands 14 in Figure 2 results in a greater extent of plastic layer 26 extending outwardly due to the greater diameter of plastic filler elements 22 in relation to the diameter of core 20 and outer strands 24. Further, the design or pre-selected final rope configuration shown in Figure 5 is planned to have interstices between core 20 and outer strands 24 and also between outer strands 24 such that plastic filler elements 22 are of a sufficient volume to fill such interstices to the point near the outer diameter of outer strands 24. Plastic layer 26 provides the usual already described functions of retaining lubricant in core 20 and also within outer strands 24. Further plastic layer 26 provides a uniform, pre-selected spacing between core 20 and outer strands 24 and also between adjacent outer strands 24. The usual desirable properties of such uniform spacing leading to greater rope life are provided by such plastic layer 26.

Referring now to Figure 6 and 7, wire rope in accordance with a further embodiment of the present invention is shown. Referring to Figure 6, a core 30 is comprised of individual wires. Plastic filler elements 32 are wound about core 30 in a spiral manner. Plastic filler elements 32 include a head portion which is generally tubular as well as an extended somewhat rectangular body portion 33 extending radially outwardly from the tubular head portion. Outer strands 34 are also comprised of individual wires and are wound about and between plastic filler elements 32. The view of the wire rope shown in Figure 6 is prior to compaction of outer strands 34; however, outer strands 34 are of a flattened, profiled cross section.

Referring now to Figure 7, the wire rope of Figure 6 is shown after outer strands 34 have been compacted inwardly toward core 30. Such compaction causes the squeezing of plastic filler elements 32 such that the plastic forms a homogenous plastic layer 36 which extends around core 30 and

between adjacent outer strands 34 to a point just less than the outer diameter of outer strands 34. The shape and volume of plastic filler elements 32 is chosen in relation to the desired final rope configuration such that the interstices or spaces between core 30 and outer strands 34 and also between outer strands 34 are such that the volume of plastic filler elements 32 will fill such spaces in the final rope configuration as shown in Figure 7. The spacing between core 30 and outer strands and also between adjacent outer strands 34 is predetermined and uniform to provide the usual improvements in wire rope performance. Further, plastic layer 36 acts to retain lubricant within core 30.

Referring now to Figure 8, various cross sections of plastic filler elements are shown at "A", "B", "C", "D", and "E". The initial cross sectional configuration of plastic filler elements can be chosen such as at "A" and "C" to include depressions to act as seats against the core and between adjacent outer strands, if desired during the rope forming operation. However, it is not necessary that plastic filler elements include such seating properties, for example, plastic filler elements, "B", "D", and "E" do not provide such depressions for core and outer strand seating. However, all the plastic filler element configurations are adaptable to acceptable performance during outer strand compaction such that, with appropriate selection of plastic filler element volume versus the final volume of interstices in the wire rope, that the plastic filler elements will combine to form a uniform, homogenous plastic layer extending around the wire rope core and to the desired degree outwardly between outer strands. The important point is that the resulting plastic layer will be uniform and will provide uniform spacing between the core and the outer strands and between adjacent outer strands to provide the desired improved wire rope performance.

Claims

1. A wire rope comprising a core of lubricated wire strands, a plurality of plastic filler elements surrounding said core, a plurality of lubricated outer strands each of said outer strands being adjacent two of said plastic filler elements such that, upon compaction of said outer strands, said plastic filler elements are squeezed to spread and surround said core and to extend between said core and said outer strands.

2. The wire rope of claim 1 wherein said plastic filler elements comprise cylindrical wires prior to their compaction, the number of said plastic filler elements being equal to the number of outer strands such that each of said outer strands con-

tacts two of said plastic filler elements prior to their compaction.

3. The wire rope of claim 1 wherein said plastic filler elements are of a pre-selected size such that, upon compaction, said plastic filler elements spread to extend as a whole within the wire rope to a diameter less than the center of said outer strands.

4. The wire rope of claim 1 wherein said plastic filler elements are of pre-selected size such that, upon compaction, said plastic filler elements spread to extend as a whole within the wire rope to a diameter just less than the outer diameter of said outer strands.

5. The wire rope of claim 1 wherein, after compaction, said plastic filler elements form a spacing between said core and said outer strands.

6. A method of manufacturing a wire rope comprising the steps of forming individual wire strands to form a core, surrounding said core with a plurality of plastic filler elements in the form of continuous elongated strands, surrounding said core and said plastic filler elements with a plurality of outer strands to form a wire rope, compacting said wire rope such that said outer strands are forced into said plastic filler elements to cause said plastic filler elements to deform and spread to form a plastic layer between said core and said outer strands.

7. The method of claim 6 wherein said compacting is performed in a closing die.

8. The method of claim 6 wherein said plastic filler elements spread to extend between said outer strands as a whole within the wire rope to a diameter less than the center of said outer strands.

9. The method of claim 6 wherein said plastic filler elements spread to extend between said outer strands as a whole within the wire rope to a diameter less than the outer diameter of said outer strands.

10. The method of claim 6 wherein said core and said outer strands are lubricated prior to compaction, and said plastic layer seals the lubricated core.

11. The method of claim 6 wherein said plastic layer forms a cushioning barrier between said core and said outer strands.

12. The method of claim 6 wherein said compacting results in the deforming of said outer strands such that an outer surface of said outer strands is partially flattened.

13. A wire rope produced by forming a plurality of wires into a core, winding a plurality of elongated plastic elements to surround said core, and winding a plurality of outer strands to surround said plastic elements, each of said outer strands contacting certain of said plastic elements such that such outer strands are spaced from said core and from

each other, compacting said outer strands such that said plastic elements are compressed to form a plastic layer that surrounds said core and that forms a plurality of depressions each of which receive one of said outer strands.

14. The wire rope of claim 13 wherein each of said elongated plastic elements is comprised of a cylindrical plastic wire, said plastic wire being wound around said core in a helical manner.

15. The wire rope of claim 13 wherein each of said outer strands contact two of said plastic elements prior to said compacting.

16. The wire rope of claim 13 wherein each of said plastic elements comprises a shaped member having a tubular head section adjacent said core and an extension from said head section extending between said adjacent outer strands.

17. The wire rope of claim 13 wherein each of said plastic elements comprises a generally rectangular bar in cross section, said bar extending from adjacent said core almost to the outer diameter of the outer strands.

FIG. 1

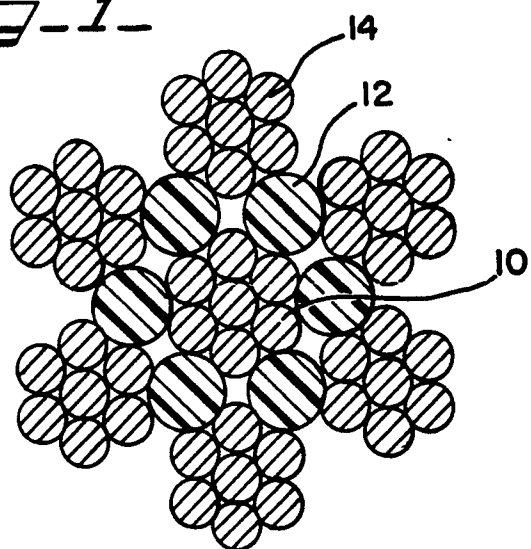


FIG. 2

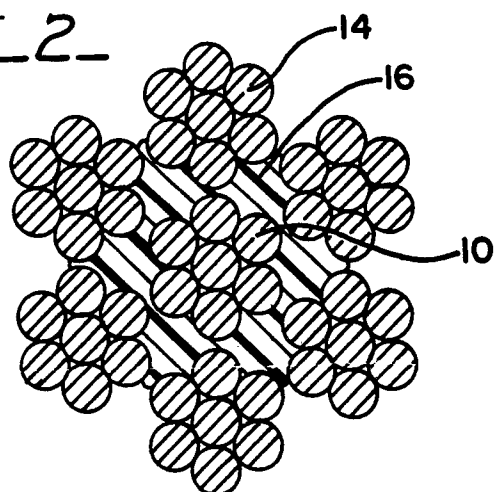


FIG. 3

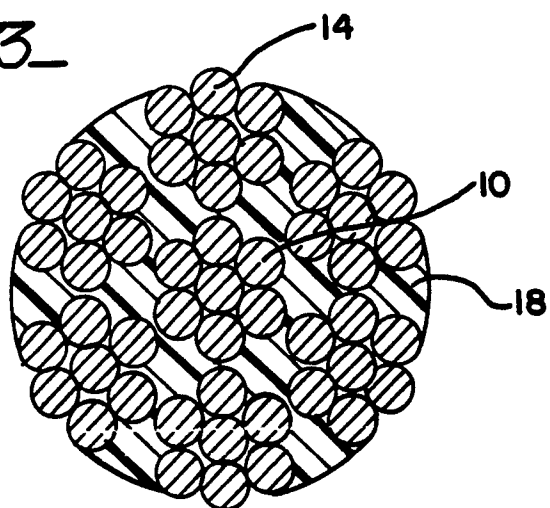


FIG. 4

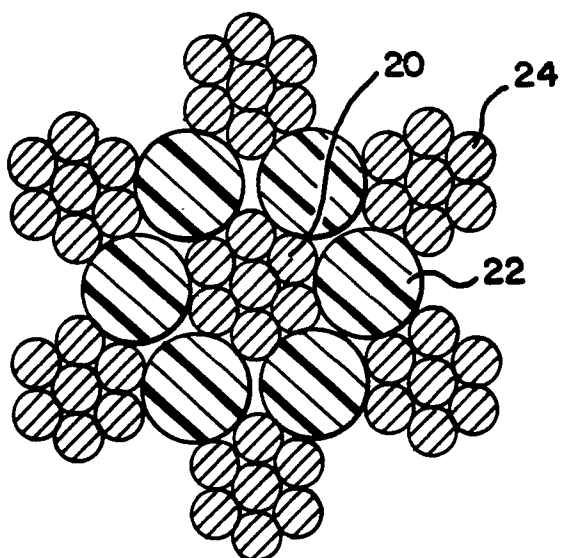


FIG. 5

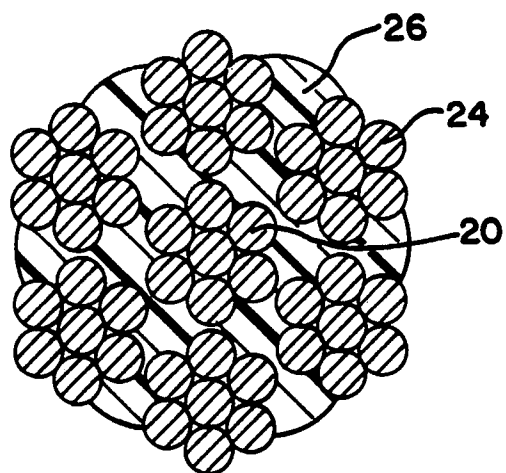


FIG. 8

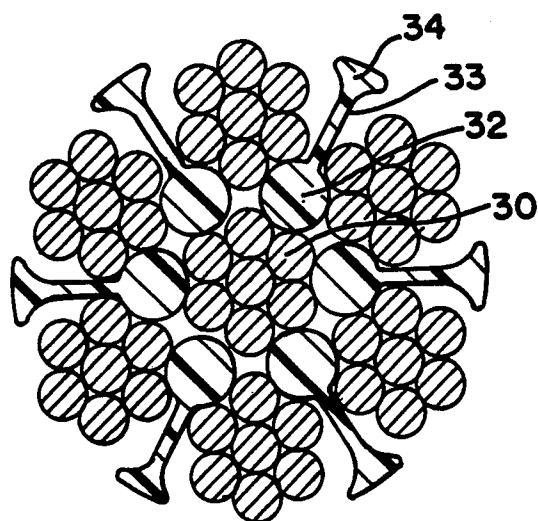
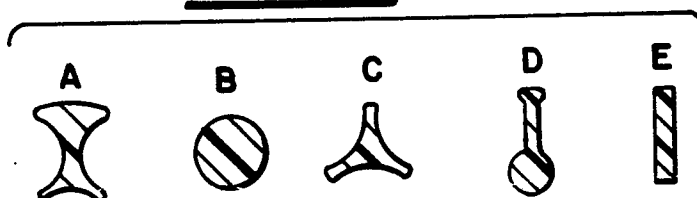


FIG. 6

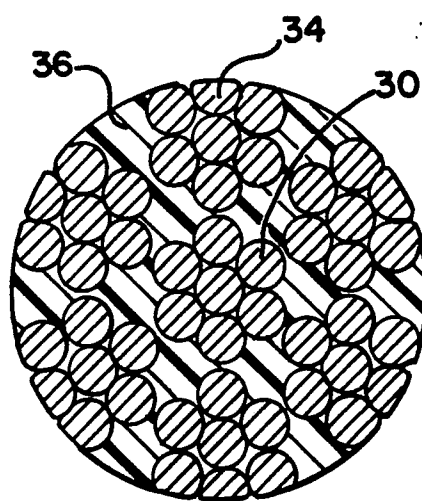


FIG. 7