CONSTRUCTION AND PROCESS OF ALL-PLASTIC CABLES FOR POWER AND MANUAL DRIVING APPLICATIONS

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Abstract
A plastic driving cable for attachment and use in driving systems. The plastic driving cable is comprised of an all-plastic inner core, with or without an outer jacket, and all-plastic molded end fittings. The inner core has a configuration of interwoven or bundled fibers of high performance polymer providing a cable of increased strength and flexibility that fits a smaller bending radius and has high performance at low temperatures. The outer jacket comprises a non-metallic material that surrounds the inner core providing improved performance at low temperatures.
CONSTRUCTION AND PROCESS OF ALL-PLASTIC CABLES FOR POWER AND MANUAL DRIVING APPLICATIONS

CROSS REFERENCE TO RELATED APPLICATIONS


TECHNICAL FIELD

[0002] The present invention relates generally to driving cables and more specifically to driving cables for power and manual driving applications.

BACKGROUND OF THE INVENTION

[0003] Driving cables are often used in power and manual products for automotive systems, and are typically constructed of a metal wire core with metal end fittings. The metal wire core and the end fittings are usually constructed of steel or stainless steel. Moreover, some metal wire cores have been coated with an outer layer of plastic or elastomer to form an outer jacket. One drawback of this type of cable assembly is that at low temperatures, the outer jacket flexibility is reduced. Also, these prior steel cables, with or without an outer jacket, lack the bending strength and flexibility required for use with the smaller pulleys that are needed to accommodate smaller packaging requirements. When use at smaller bending radius, the metal cable introduces higher bending stress. Thus, there exists a need for a driving cable which can perform at lower temperatures and also possesses the strength and flexibility required for use with smaller bending radius.

[0004] In automotive systems, a driving cable is used in a variety of applications including sliding doors, lift gates, hood and trunk openers, and windows and latches. Thus, the driving cables need greater flexibility and bending strength than the typical metal cable. Also, current metal cables often create vibrations and noise in use. Thus, there is a need for a driving cable that reduces the noise and vibrations inherent with swaged metal cables, while simplifying the driving systems and increasing performance.

SUMMARY OF THE INVENTION

[0005] It is an object of the present invention to provide an improved driving cable for use with manual and automatic driving systems.

[0006] It is another object of the present invention to provide a driving cable with increased bending strength and flexibility.

[0007] It is another object of the present invention to provide a driving cable that performs with less noise and vibrations.

[0008] It is still another object of the present invention to provide a driving cable that is lighter in weight and provides improved performance.

[0009] It is a further object of the present invention to provide a method for constructing an improved driving cable for use within manual and automatic driving systems.

[0010] In accordance with the above and other objects of the present invention, an improved driving cable is disclosed. The driving cable includes an inner core that is comprised almost entirely of a plastic material. The inner core has two end portions which are attached in unique ways to end fittings. The inner core is comprised of polymer fibers which are configured to provide the necessary strength. The inner core may include a surrounding outer jacket that is also formed of a non-metallic material. The disclosed cable provides improved performance at low temperatures, as well as increased flexibility and strength.

[0011] Further objects and advantages of the invention will be apparent from the following description and appended claims, reference being made to the accompanying drawings forming a part of the specification, wherein like reference characters designate corresponding parts in several view.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a partial cross-sectional perspective view of a driving cable in accordance with the present invention;

[0013] FIG. 2A illustrates a driving cable end fitting configuration with a knot and a loop in accordance with a preferred embodiment of the present invention;

[0014] FIGS. 2B and 2C each illustrate a driving cable end fitting configuration with a loop portion in accordance with an embodiment present invention;

[0015] FIGS. 3A and 3B each show a portion of a driving cable with an end fitting configuration that has a knot and a tail extending inside of the end fitting member in accordance with a preferred embodiment of the present invention;

[0016] FIGS. 3C and 3D illustrate additional end fitting configurations for a driving cable that have a core tail extending outside of the end fitting member in alternate embodiments of the present invention;

[0017] FIGS. 4A and 4B are illustrations of a driving cable with an end fitting member that has an opening in two different embodiments of the present invention; and

[0018] FIG. 4C is a cross-sectional view of a portion of the end fitting member shown in FIGS. 4A and 4B.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] The present invention refers to a plastic driving cable particularly for use with manual and automatic driving systems. Although the plastic cable is preferably utilized in connection with automotive systems, it will be understood that it can have a variety of other uses and applications. Therefore, the present invention is not limited to use only in automotive or driving systems. The terms “plastic” or “all-plastic” as used herein, when referring to the driving cable, means that the driving cable is comprised substantially of a plastic or polymeric material. However, the driving cable may contain other materials so long as it achieves the objects of the present invention.

[0020] Turning first to FIG. 1, there is shown a partial cross-sectional perspective view of a preferred plastic cable which is referred to generally to be the reference numeral 10. The plastic cable 10 has an inner core member 16 preferably
constructed of high-performance fibers 15. The fibers 15 are preferably intertwined to provide increased strength and flexibility over conventional metal cables. The inner core fibers 15 may alternatively be braided, twisted or uni-directed bundles of yarn, strand or threadline, as desired. In a preferred embodiment, the inner core member 16 is comprised of high performance polymer fibers 15 such as Tim liquid crystal polymer Vectran™, aromatic polyester, aromatic polyamide, and ultra-high molecular weight polyethylene for high tensile strength and better flexibility. A variety of other materials, including synthetic fibers of polyamide, such as Nylon 6 and Nylon 66, polyester, liquid crystal polymer, and compositions of polypropylene, and polyethylene may comprise the inner core member 16 to achieve the desired tensile strength and flexibility. The fibers 15 may alternatively be formed of natural fibers, such as cotton, wool, silk, jute and various other materials. The configuration and material of the fibers 15 can vary and will be within the knowledge of those skilled in the art.

[0021] The inner core member 16 has a first end portion 11 and a second end portion 12. The inner core member 16 may be formed in a variety of configurations. The inner core member 16 may be comprised of continuous filament fibers which can be uni-directed, twisted, or braided yarn, strand, or threadline. The fashion in which the fibers are interwoven affects the strength of the driving cable 10. Preferably, a braided inner core member 16 often provides the bending strength and flexibility for high load applications, such as power sliding doors, as well as other automotive and non-automotive applications. Generally, inner core members 16 constructed of uni-directed fibers may be less costly to produce than the braided inner core member. The uni-directed inner core member may be applicable for automotive window systems. An all-plastic core with a twisted inner core member may exhibit a variety of applications depending in part upon the twist angle and frequency. As the twist angle and frequency increase, the inner core member is more solid and less flexible than an inner core member with a lower twist angle and less twist frequency. Although the twisted inner core member may be complex to construct, this inner core configuration may offer a wide range of applications.

[0022] Depending on the particular application of the driving cable 10, the exterior surface 16A of the inner core member 16 may be further treated with a lubricant layer shown as reference number 18 and/or environmental protection coating 19. In a preferred embodiment, the exterior surface 16A of the inner core member 16 is coated with a dry lubricant, in order to allow the driving cable to slide more easily over a mechanism, such as a pulley, to decrease the wear on the cable and the mating components during use. It will be understood, the driving cable is typically movable between a retracted and unretracted position.

[0023] The inner core member 16 preferably has an outer jacket 12 disposed thereon. The interior surface 12B of the outer jacket 12 is preferably in contact with the exterior surface 16A of the inner core member 16. A lubricant layer 18 and/or environmental protection layer 19 may be applied between the exterior surface 16A of the inner core member 16 and the interior surface 12B of the outer jacket 12.

[0024] The outer jacket 12, as viewed in FIG. 1 may be an outlayer of braided fibers 14, either in yarn, strands or threadline. The composition of these fibers 14 may be chosen from the materials which comprise the inner core fibers 15, as discussed above, which preferably include high performance polymer fibers 15 such as liquid crystal polymer Vectran™, aromatic polyester, aromatic polyamide, and ultra-high molecular weight polyethylene for high tensile strength and better flexibility. A variety of other materials, including synthetic fibers of polyamide, such as Nylon 6 and Nylon 66, polyester, liquid crystal polymer, and compositions of polypropylene, and polyethylene may comprise the outlayer of braided fibers 14 to achieve the desired tensile strength and flexibility. The fibers 14 may alternatively be formed of natural fibers, such as cotton, wool, silk, jute and various other. The outer jacket 12 may also be comprised of a coating layer of plastic, including but not limited to a nylon composition or a liquid crystal polymer, such as Vectra™. Alternatively, the outer jacket 12 can be comprised of an elastomer, such as rubber or thermoplastic olefin. Again, the precise selection of the material is within the knowledge of those of ordinary skill in the art. However, it is preferred that the outer jacket 12 be comprised of a non-metallic material.

[0025] An advantage of including an outer jacket 12 in the construction of the plastic driving cable 10, is that the diameter of the plastic driving cable 10 can be adjusted to a variety of desirable dimensions. The materials that comprise the outer jacket 12 may be less costly than the configuration of high performance polymers that are preferably used to construct the inner core member 16, and can be relatively easily applied to make a plastic driving cable 10 of a precise diameter. Another advantage of an all-plastic driving cable 10 with an outer jacket 12 is that the outer jacket may separate from the inner core member 16 at the exterior surface 16A of the inner core member 16, if so desired. The relative movement between the inner core member 16 and outer jacket 12 can reduce the bending stress upon the cable and increase the cable flexibility. If a preferred application requires, the outer jacket 12 may be completely separated and removed from the inner core member 16. Coating the exterior surface 16A of the inner core 16 with a dry lubricant eases the movement between the inner core member 16 and outer jacket 12, and, if required, allows the inner core member 16 and outer jacket 12 to separate more efficiently.

[0026] As with the inner core member 16, the exterior surface 12A of the outer jacket 12 may be coated with a lubricant 18 and/or environmental protection coating 19, depending upon the application in order to increase the life span and performance of the driving cable 10.

[0027] Turning now to FIG. 2A which illustrates a driving cable assembly 20A having an end-fitting configuration 21A. The end-fitting configuration 21A in this embodiment includes a loop 23 and a knot 26. An end-fitting member 24 is comprised of molded plastic and may be formed into a variety of shapes, such as oval, cylindrical and square, as required by the desired application. In the preferred embodiment shown in FIG. 2A, the driving cable 22 forms a spliced eye loop 23 which may be a connecting site for the cable assembly 20A to connect with another device. The cable knot 26 may be preformed into a variety of shapes capable of providing resistance and thereby increasing the strength of the driving cable 20A. The knot 26 is preferably located within the end fitting 24 with the loop 23 extending outside of the end fitting 24 opposite the remainder of the driving
cable 22. While only one end fitting is shown and described, it will be appreciated that the other end fitting preferably has the same configuration.

[0028] FIG. 2B illustrates another embodiment of the driving cable assembly 20B having an end-fitting configuration 21B. In this embodiment, the end fitting configuration 21B is comprised of an end fitting member 24 and a spliced eye loop 23. The driving cable 22 has a core tail 25 which is formed or cramped within the end fitting member 24.

[0029] Turning to FIG. 2C which illustrates another embodiment of the driving cable assembly 20C having an end-fitting configuration 21C. The end fitting member 24 is positioned so that the driving cable 22 forms a spliced eye loop 23 and the core tail 25 extends outside of the end fitting member 24 opposite the loop 23. By extending the core tail 25 outside of the end fitting member 24 this embodiment of the driving cable assembly 20C provides increased strength and versatility of applications.

[0030] Turning now to FIGS. 3A and 3B another embodiment of the present invention is shown. FIG. 3A illustrates a driving cable assembly 30A having a different end fitting configuration 31A. FIG. 3A depicts a driving cable 34 and a knot 36. In this embodiment, the knot 36 is located within an end fitting member 38. The knot 36 has a core tail 35 extending therefrom. The core tail 35 is also located within the end fitting member 38. The end fitting member 38 is positioned perpendicularly to the length of the driving cable 34. FIG. 3B illustrates another embodiment of a driving cable assembly 30B. This particular embodiment includes a driving cable 34 and a knot 36. The knot 36 is located within an end fitting member 38 positioned on the driving cable 34. The knot 36 has a core tail 35 extending therefrom. In this end-fitting configuration 31B, the end fitting member 38 is positioned lengthwise with the driving cable 34.

[0031] FIG. 3C illustrates another embodiment of a driving cable assembly 30C having an end-fitting configuration 31C. In this embodiment, a driving cable 34 has an end fitting member 38 positioned perpendicularly to the driving cable 34. The driving cable 34 has a core tail 35 extending therefrom. The core tail 35 further extends outside of the end-fitting member 38. Further, in FIG. 3D, an alternate driving cable assembly 30D is shown. In this embodiment, an end fitting configuration 31D is comprised of a driving cable 34 with an end fitting member 38 positioned lengthwise along the end of the driving cable 34. The driving cable assembly 30D, the driving cable 34 has a core tail 35 extending therefrom. The core tail 35 further extends outside of the end-fitting member 38.

[0032] The length of the core tail 25, 35 may vary from being hidden inside the end fitting 24, 38 to extending outside of the end fitting 24, 38. The precise length and position of the core tail 25, 35 will correspond to the requirements of the desired application.

[0033] As shown in FIG. 4A, a driving cable assembly 40 with an end fitting configuration 41A may include an end fitting member 46 which includes an opening 48 for placement of a device, such as a pin or shaft. As shown in FIG. 4A, a driving cable 42 having a knot 44 and end fitting member 46 with a circular opening or hole is shown. The knot 44 and a core tail 47 are located within the end fitting member 46. The distance L from the edge of the end fitting member 46 to the epicenter of the opening 48 of the end fitting member 44, and distance L from the edge of the end fitting member 46 to the core tail 47 may be adjusted to meet the requirements of the desired application.

[0034] Further, as shown in FIG. 4B, another embodiment of the present invention may include a driving cable 42 and an end fitting member 46 with an opening 48 suitable for attaching a pin or shaft. FIG. 4B illustrates an end-fitting configuration 40B wherein a core tail 47 of the driving cable 42 is located within the end-fitting member 46. FIG. 4C further illustrates a cross-sectional view of the end-fitting member 46 as viewed through the opening 48 in the end-fitting member 46.

[0035] The driving cable of the present invention may be used in the production of a driving system that moves one object into closer proximity to another object. The objects will have, or themselves be, points of connection for the driving cable which traverses the space between the objects. In automotive applications, the driving cable may serve to open and close windows, doors, and trunks and a variety of other applications.

[0036] Constructing the plastic driving cable 10 includes providing an inner core member 16 having end fittings 24, 38, 46 placed at one or both ends of the plastic driving cable 10. The end fittings 24, 38, 46 can be molded on to the inner core member 16 directly, or molded separately and attached to the inner core member 16 during an assembly process. An outer jacket 12 may be located in a position to surround the inner core member 16.

[0037] Several end-fitting configurations 21A, 31A, 31B, 41A include knots 26, 36, 44 which are formed on the inner core member 16 where the end-fitting members 24, 38, 46 are located. The knots 26, 36, 44 must be formed after mating components, if used, are installed, and before the end fitting member 24, 38, 46 being over-molded on or attached to the inner core member 16 as a finished cable assembly. Further, the end-fitting member 24, 38, 46 may be attached by clamping the end fitting into position on the plastic driving cable 10.

[0038] The inclusion and type of mating component depends upon the design and application of the driving cable 10. In a typical driving system, such as a power sliding door assembly, typical mating components may include a conduit, pulley, drum, track and seal. The all-plastic cable often will directly contact each of these to function within the driving system.

[0039] Driving systems which use all-plastic driving cable may have several advantages over driving systems currently using metal wire cables. For instance, the number of components of the system may be reduced. The inner core of the all-plastic cable is a novel configuration of intertwined or bundled fibers which can work together often providing a cable of increased flexibility and strength. When one specific design was tested, the all-plastic cable demonstrated a significant increase in flexibility and strength over some conventional metal cables. In this particular test, the plastic cable was capable of 200% specification requests which represents a 40% increase over current metal cables. These results are merely illustrative of the increased flexibility and strength of the all-plastic cable, and improvements of this scale may not be reported in each instance where the metal
cable is replaced with the all-plastic cable. Generally, however, due to the increased strength and flexibility of the all-plastic cable, it is usable with the smaller bending radius and therefore often meets packaging requirements more effectively.

[0040] Although it is not necessary, an outer jacket 12 may also be applied, which is also a novel configuration of non-metallic materials. When working with a smaller bending radius by replacing the metal wire with the plastic inner core, the all-plastic cable can often perform at temperatures as low as -40° C. The metal cable with an all-plastic outer jacket generally fails at approximately -30° C. Also, the diameter of the cable may be enlarged or reduced at a lower cost by adjusting the diameter outer jacket 12, providing a range of versatile applications at a lower cost.

[0041] Further, the all-plastic end fittings simplify the design and processing of the cable. Further, the plastic end fitting members may be strengthened by reinforcing the plastic resin with glass fiber, carbon fiber or other materials. Reinforcement of the end fittings provides strength and resistance, and often reduces the size of the end fitting while improving performance.

[0042] The lighter weight and high performance of the all-plastic cable is often an advantage which can simplify the driving systems, reduce wear and noise and increase performance.

[0043] While the invention has been described in terms of preferred embodiments, it will be understood, of course, that the invention is not limited thereto since modifications may be made by those skilled in the art, particularly in light of foregoing teachings.

What is claimed is:

1. A driving cable comprising:
   an inner core member; and
   a plurality of fibers, said fibers being comprised of non-metallic materials and forming said inner core member.

2. The driving cable of claim 1, wherein the plurality of fibers are comprised of a liquid crystal polymer.

3. The driving cable of claim 1, wherein the fibers are braided in an interwoven fashion to form said inner core member.

4. The driving cable of claim 1, wherein the fibers are twisted together to form said inner core member.

5. The driving cable of claim 1, wherein the fibers are positioned uni-directionally as a bundle, to form said inner core member.

6. The driving cable of claim 1 further comprising an outer jacket in contact with an outer surface of said inner core.

7. The driving cable of claim 6, wherein the outer jacket is comprised of a layer of braided non-metallic fibers.

8. A driving cable assembly comprising:
   an inner core member comprised of a plurality of non-metallic fibers;
   a first end portion and a second end portion of said inner core member; and
   a first end-fitting member comprised of non-metallic material, said first end fitting member being located adjacent to said first end portion of said inner core member.

9. The driving cable assembly of claim 7, wherein said first end portion of said inner core member further comprises a knot with said knot being positioned inside first end fitting.

10. The driving cable assembly of claim 8, wherein said first end portion of the inner core member further comprises a loop, with said loop extending outside of said first end fitting.

11. The driving cable assembly of claim 7, wherein said first end portion of the inner core member further comprises a core tail extending outside of said first end fitting member.

12. The driving cable assembly of claim 7, wherein the first end fitting member further comprises a hole for attachment of a device therein.

13. The driving cable of claim 7 further comprising a second end fitting member, said second end fitting member being located adjacent to said second end portion of said inner core member.

14. The driving cable of claim 7 further comprising a nonmetallic outer jacket surrounding the inner core member.

15. A method for making an improved driving cable assembly comprising:
   forming an inner core member comprised of a plurality of nonmetallic fibers, said inner core member having a first end portion and a second end portion;
   providing a first end-fitting member, said first end fitting member being comprised of a non-metallic material; and
   attaching said first end fitting member in a position adjacent to said first end portion of said inner core member.

16. The method of claim 14, wherein the step of forming the inner core member further comprises:
   braiding said plurality of non-metallic fibers.

17. The method of claim 14, wherein the step of forming said inner core member further comprises:
   twisting said plurality of non-metallic fibers.

18. The method of claim 14, wherein the step of forming said inner core member further comprises:
   positioning the plurality of non-metallic fibers in a uni-directional fashion.

19. The method of claim 14 further comprising:
   locating a non-metallic outer jacket surrounding the inner core member.

20. The method of claim 14 further comprising:
   positioning a second end fitting member adjacent to said second end portion of said inner core member.

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