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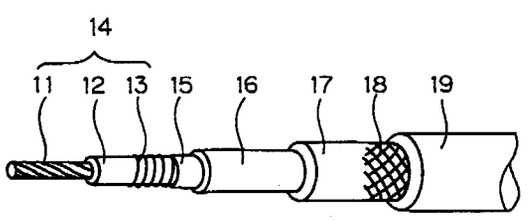
(54) Winding-type high-voltage resistant, resistive cord for preventing noises.

(57) There is disclosed a winding-type high-voltage resistant, resistive cord for preventing noises which comprises a fiber bundle (11), a core (12), a metal small-gage wire (13), a removal layer (15), an internal layer (16), an insulating layer (17), a braid (18), and a sheath (19), wherein the core (12) is formed by immersing the fiber bundle (11) in a fluorocarbon rubber coating containing fluorocarbon rubber filled with carbon and ferrite and regulated by a solvent which is MEK to impregnate the fiber bundle (11) therewith, and the internal layer (16) is made mainly of polyethylene (PE) similar to the insulating layer (17). The core (12) is not removed from the fiber bundle (11) during extrusion of the internal layer (16) which has good adhesion to the insulating layer (17), which prevents lowering of resistance to voltage due to corona discharge. The winding-type high-voltage resistant, resistive cord ensures sufficient resistance to voltage if a high voltage is required.

FIG. 1



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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a winding-type high-voltage resistant, resistive cord for preventing noises which is used as an ignition cable in an internal combustion engine of an automotive vehicle or the like and, more particularly, to a winding-type high-voltage resistant, resistive cord for preventing noises which is sufficiently resistant to voltage.

Description of the Prior Art

High-voltage resistant, resistive cords for transmitting a high voltage generated at an ignition coil to a spark plug directly or through a distributer are of two types: a string-type wherein fibers are impregnated with carbon; and a winding-type wherein a metal small-gage wire having a high specific resistance is wound about a core made of a magnetic material or the like. Both two types of high-voltage resistant, resistive cords are required to have reduced electric transmission losses, excellent noise prevention effects, and good resistance to heat and voltage.

The winding-type high-voltage resistant, resistive cords are disclosed in, for example, Japanese Patent Application Laid-Open No. 63-168915 (1988) and Japanese Patent Application Laid-Open No. 60-3809 (1985).

The former, as shown in Fig. 7, comprises a tension member 51 made of aramid fibers, glass fibers or the like, a core 52 formed by coating the tension member 51 with extruded fluorocarbon rubber in which a magnetic material such as ferrite powder is mixed, a resistance wire 53 wound about the core 52, an insulating layer 54 extruded and coating the core wire 52 and the resistance wire 53, a braid 55 coating the insulating layer 54, and an outermost sheath 56 coating the braid 55.

The latter, as shown in Fig. 8, comprises string-like fibers 61 formed by twisting glass fibers like the former, a core bundled layer 62 made of a synthetic resin such as silicone resin or the like and coating the string-like fibers 61, a metal resistance wire 63 such as a nichrome wire which is coiled around the core bundled layer 62, a conductive silicone rubber layer 64 extruded and coating the metal resistance wire 63, an insulating layer 65 coating the conductive silicone rubber layer 64, a braid 66 coating the insulating layer 65, and a sheath layer 67 coating the braid 66.

The former can prevent the resistance wire 53 from shifting since the resistance wire 53 is buried in the surface of the core 52. In the latter, the conductive silicone rubber layer 64 extruded and coating the metal resistance wire 63 allows the metal resistance wire 63 to have a stable resistance.

For increase in gas mileage or miles per gallon for the internal combustion engine, a voltage required in an ignition system gradually increases. However, the above-mentioned high-voltage resistant, resistive cords cannot insure sufficient resistance to voltage for the reasons to be described below.

In the high-voltage resistant, resistive cord disclosed in Japanese Patent Application Laid-Open No. 63-168915, there is provided no semiconductive internal layer between the resistance wire 53 and the insulating layer 54. For this reason, the unevenness of the resistance wire 53 increases the electric field strength, which generates a corona discharge in a space produced between the resistance wire 53 and the insulating layer 54, resulting in lowering of the resistance to voltage.

In the high-voltage resistant, resistive cord disclosed in Japanese Patent Application Laid-Open No. 60-3809, the silicone rubber layer 64 serving as the internal layer does not cause the foregoing problem. However, the insulating layer 65 covering the silicone rubber layer 64 is made of a material such as crosslinked polyethylene (PEX), ethylene-propylene-diene copolymer (EPDM) or the like, which is different from the material of the silicone rubber layer 64. This results in poor adhesion between the insulating layer 65 and the silicone rubber layer 64 and a gap generated therebetween, which lowers the resistance to voltage due to the corona discharge.

To improve the resistance to voltage, it is considered to form by extrusion an internal layer having a hard, smooth surface and made basically of a material which has good adhesion to the insulting layer and is the same as the material of the insulating layer such as PEX, EPDM or the like. The above-mentioned high-voltage resistant, resistive cords wherein the core 52 and the core bundled layer 62 covering the aramid fibers are made of a flexible material such as silicone resin or fluorocarbon rubber and do not permit stable extrusion of the foregoing hard internal layer, is disadvantageous in that the extrusion pressure of the internal layer causes the core wire 52 and the core bundled layer 62 to be removed from the fiber bundle.

SUMMARY OF THE INVENTION

The present invention is intended for a winding-type high-voltage resistant, resistive cord for preventing noises. According to the present invention, the resistive cord comprises: a conductor including a core and a metal small-gage wire having a high specific resistance and wound about the

core; a semiconductive internal layer for coating the conductor; and an insulating layer for coating the internal layer, the core being formed by impregnating a fiber bundle with a fluorocarbon rubber coating containing a conductive material such as carbon or a magnetic material such as ferrite, the internal layer being formed of a semiconductive material containing conductive particles such as carbon made mainly of the same material as the insulating layer.

In the above-mentioned winding-type high-voltage resistant, resistive cord for preventing noises, since the fiber bundle is impregnated with the fluorocarbon rubber coating forming the core, the core is not removed from the fiber bundle by a pressure of extrusion of the hard internal layer. The internal layer and the insulating layer which are made mainly of the same material have good adhesion to each other and form no gap therebetween.

The fluorocarbon rubber coating may contain either or both of the conductive material and magnetic material. The provision of the removal layer between the conductor and the internal layer facilitates the stripping of the coating layers including the internal layer outside the conductor during cutting and stripping operation.

It is an object of the present invention to provide a winding-type high-voltage resistant, resistive cord for preventing noises which is sufficiently resistant to voltage if a high voltage is required.

These and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a preferred embodiment of the present invention;

Figs. 2 to 6 are schematic views of fabrication processes of the preferred embodiment;

Fig. 7 is a sectional view of a resistive cord of the prior art; and

Fig. 8 is a perspective view of another resistive cord of the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment according to the present invention will now be described with reference to the drawings. As shown in Fig. 1, a winding-type high-voltage resistant, resistive cord for preventing noises of the preferred embodiment comprises a fiber bundle 11, a core 12, a metal small-gage wire 13, a removal layer 15, an internal layer 16, an insulating layer 17, a braid 18, and a sheath 19.

The fiber bundle 11 is made of 2250 denier aramid fibers (DuPont-made Kevlar fibers) and is twisted (100 T/m) for flexibility. The fiber bundle 11 is immersed in and impregnated with a fluorocarbon rubber coating 21 formed by filling fluorocarbon rubber with carbon and ferrite and regulating it by a solvent which is methyl ethyl ketone (MEK), and is then dried in a drying furnace 22, to form the core 12 on the outer periphery of the fiber bundle 11 as shown in Fig. 2.

The metal small-gage wire 13 having a high specific resistance is wound about the core 12 formed on the outer periphery of the fiber bundle 11 by means of a horizontal winding machine 23 as shown in Fig. 3. The horizontal winding machine 23 includes a bobbin 23a around which a 40 μm nichrome wire serving as the metal small-gage wire 13 is wound for passing the fiber bundle 11 therethrough, a guide 23b rotating for winding the metal small-gage wire 13 onto the core 12, and a reel 23c for reeling a winding conductor 14.

The removal layer 15 made of graphite or silicone is formed on the outer periphery of the winding conductor 14 by means of a removal layer forming machine 24 as shown in Fig. 4. The semiconductive, polyethylene (PE) based internal layer 16 filled with carbon and the insulating layer 17 in which a flexible PEX containing blended PEX and EP and a vulcanizing agent are mixed are sequentially made by extrusion by means of an internal layer extruding machine 25 and an insulating layer extruding machine 26. The insulating layer 17 which is non-vulcanized passes through a vulcanizing tube 27 to be vulcanized. The removal layer 15 is provided between the winding conductor 14 and the internal layer 16 for ease of stripping of coating layers including the internal layer 16 outside the winding conductor 14 during cutting and stripping operation.

Referring to Fig. 5, the insulating layer 17 is covered with the braid 18 made of glass fibers by means of a braiding machine 28. As shown in Fig. 6, the sheath 19 made of silicone rubber in which a vulcanizing agent is mixed is extruded to coat the braid 18 by means of a sheath extruding machine 29, and is vulcanized through a vulcanizing tube 30, thereby completing the winding-type high-voltage resistant, resistive cord for preventing noises as shown in Fig. 1.

While the invention has been shown and described in detail, the foregoing description is in all aspects illustrative and not restrictive. It is therefore understood that numberous modifications and variations can be devised without departing from the scope of the invention.

Claims

1. A winding-type high-voltage resistant, resistive cord for preventing noises, comprising:

   a conductor including a core formed by impregnating a fiber bundle with a fluorocarbon rubber coating containing a conductive material and/or a magnetic material, and a metal small-gage wire having a high specific resistance and wound about said core;

   an internal layer for coating said conductor; and

   an insulating layer for coating said internal layer,

   said internal layer being formed of a semiconductive material containing conductive particles made mainly of the same material as said insulating layer.

2. The winding-type high-voltage resistant, resistive cord for preventing noises of claim 1, wherein

   there is provided a removal layer between said conductor and said internal layer.

3. The winding-type high-voltage resistant, resistive cord for preventing noises of claim 1 or 2, wherein

   said insulating layer is coated with a braid, and said braid is coated with a sheath.

4. The winding-type high-voltage resistant, resistive cord for preventing noises of claim 1 or 2, wherein

   said fiber bundle is formed of aramid fibers.

5. The winding-type high-voltage resistant, resistive cord for preventing noises of claim 1 or 2, wherein

   said fluorocarbon rubber coating contains fluorocarbon rubber filled with a conductive material such as carbon and ferrite and regulated by a solvent which is methyl ethyl ketone.

6. The winding-type high-voltage resistant, resistive cord for preventing noises of claim 2, wherein

   said removal layer is formed of graphite or silicone.

7. The winding-type high-voltage resistant, resistive cord for preventing noises of claim 1 or 2, wherein

   said internal layer is made mainly of polyethylene.

8. The winding-type high-voltage resistant, resistive cord for preventing noises of claim 1 or 2, wherein

   said insulating layer is formed by mixing a vulcanizing agent in flexible crosslinked polyethylene in which non-crosslinked polyethylene and crosslinked polyethylene are blended.

FIG. 1

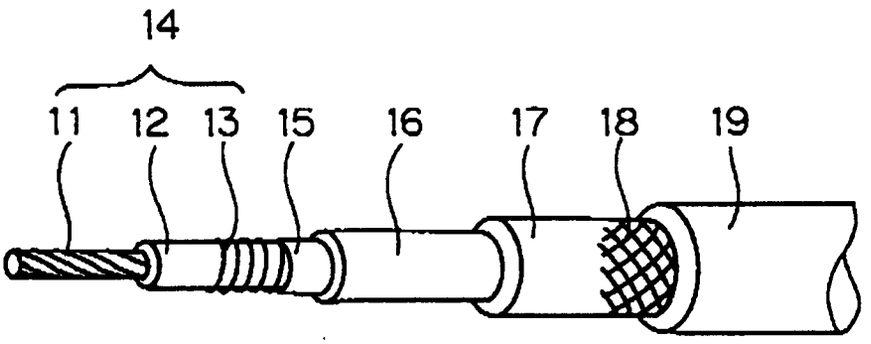

FIG. 2

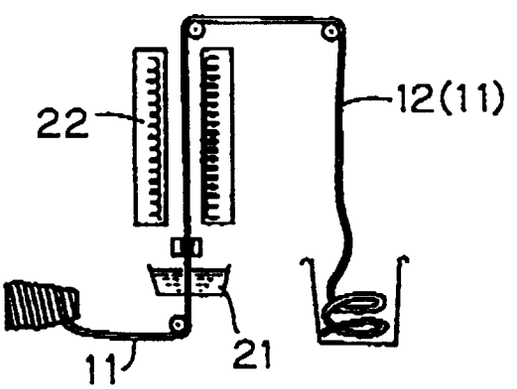

FIG. 3

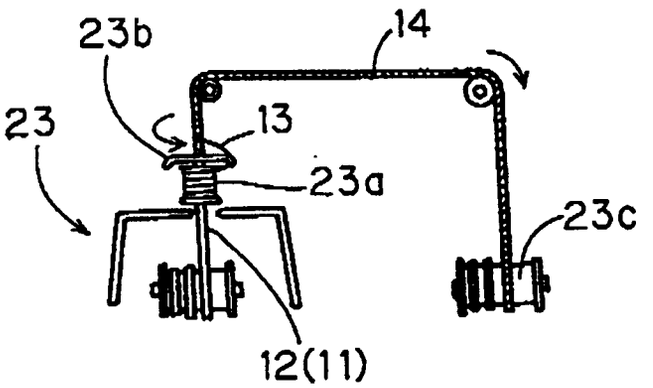

FIG. 4

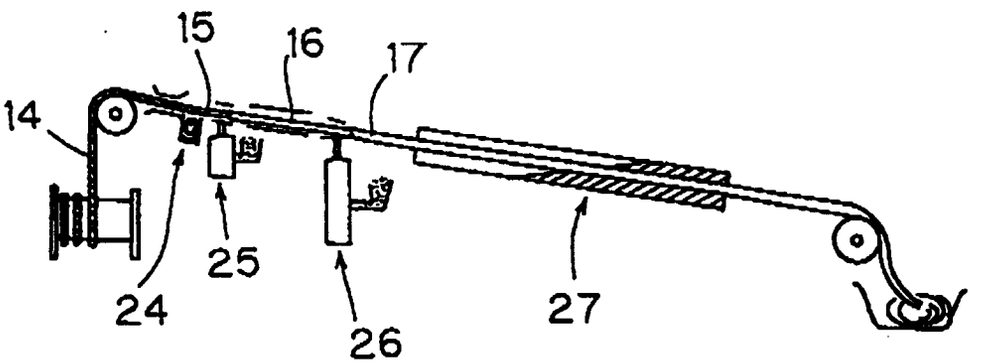

FIG. 5

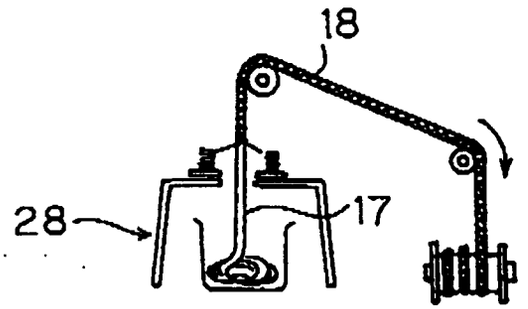

FIG. 6

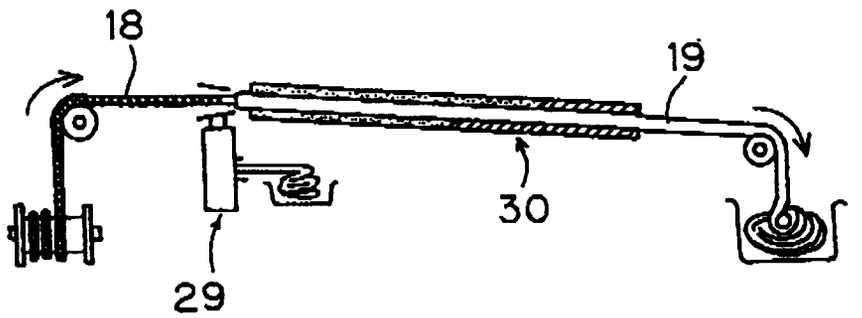

FIG. 7

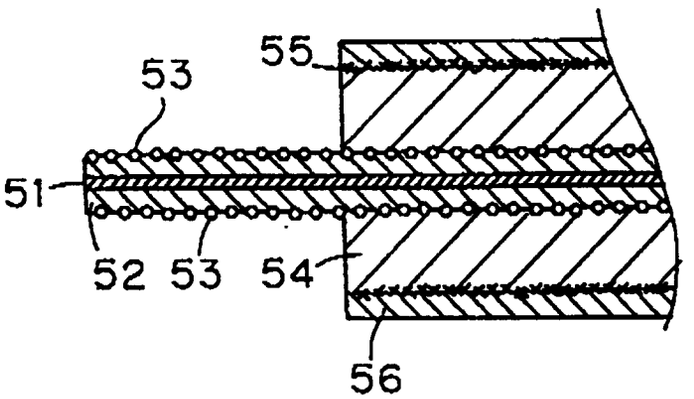

FIG. 8