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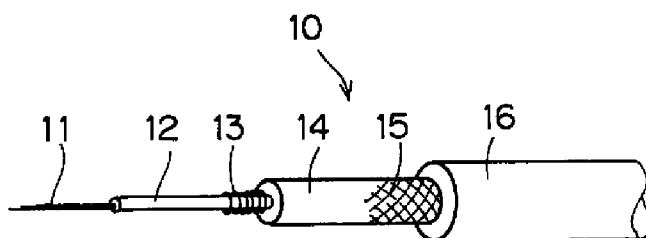
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**(54) Winding-type noise-suppressing high-tension resistive cord**

(57) There is disclosed a winding-type noise-suppressing high-tension resistive cord including a core having original characteristics and made of a base polymer which is less expensive EPR. The core (12) includes a polymer having ferrite powder mixed therein for extrusion-coating a reinforcing string (11), and a resistance wire (13) is coiled around the core (12) and then is sequentially coated with an insulating layer (14), a reinforcing braid (15) and a sheath (16). The polymer is a

blend of ethylene-propylene-diene terpolymer (EPDM) as a base polymer and ethylene-vinyl acetate copolymer (EVA) compatible with EPDM and to be covulcanized during vulcanization as a reinforcing polymer, in amounts of 60 parts by weight of EPDM to 40 parts by weight of EVA. The ferrite powder is mixed in an amount of 500 parts by weight per 100 parts by weight of the blend polymer.

**FIG. 1**



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**Description****BACKGROUND OF THE INVENTION**5 **Field of the Invention**

The present invention relates to a winding-type noise-suppressing high-tension resistive cord to be used as an ignition cable for an internal combustion engine of an automotive vehicle and the like.

10 **Description of the Prior Art**

High-tension resistive cords for transmitting a high voltage generated at an ignition coil to a spark plug directly or through a distributor have been required to have a low electric transmission loss, a good noise suppressing effect, and high resistance to heat and voltage. In general, currently used high-tension resistive cords are of two types: a string-type high-tension resistive cord which includes fibers impregnated with carbon; and a winding-type high-tension resistive cord which includes a metal small-gage wire having a high specific resistance and wound about a core made of a magnetic material or the like.

As shown in Fig. 3 is disclosed the winding-type high-tension resistive cord which comprises a reinforcing string 51 of aramid fibers, glass fibers or the like; a core 52 formed by extrusion-coating the reinforcing string 51 with a base polymer including ferrite powder mixed therein; a resistance wire 53 coiled around the core 52; an insulating layer 54 for extrusion-coating the core 52 and the resistance wire 53; a braid 55 for coating the insulating layer 54; and an outermost sheath 56 for coating the braid 55 (Japanese Utility Model Publication No. 1-32253 (1989)).

In this type of winding-type high-tension resistive cord, as shown in Fig. 4, the insulating layer 54 is stripped and the core 52 around which the resistance wire 53 is wound is bent along the outer surface of the cord in its longitudinal direction. Then a tubular metal terminal A is fitted on the cord, with the core 52 with the resistance wire 53 bent, for connection between the metal terminal A and the resistance wire 53. Thus, coils of the resistance wire 53 must be prevented from coming loose when the insulating layer 54 is stripped and from deviating to contact each other when the core 52 is bent which might result in changes in resistance. For this reason, it has been a common practice to coil the resistance wire 53 around the core 52, with the base polymer unvulcanized and inelastic, to embed the resistance wire 53 in the core 52, and then to vulcanize the base polymer to hold the resistance wire 53 resiliently denting the surface of the core 52.

In this type of winding-type high-tension resistive cord, the material of the core 52 generally used is fluororubber and silicone rubber which are a base polymer of high heat-resistance and high strength (Japanese Utility Model Publication No. 60-28002 (1985) and Japanese Utility Model Publication No. 5-20467 (1993)). However, the use of less expensive ethylene propylene rubber (EPR) as the base polymer of the core has been desired in place of fluororubber and silicone rubber which are costly.

The EPR used as the base polymer of the core, however, does not provide a suitable hardness when it is unvulcanized, failing to cause the resistance wire to suitably resiliently dent the surface of the core when the resistance wire is wound around the core of the unvulcanized base polymer. Further, vulcanized EPR has a low strength and low elongation, resulting in the core torn off during the removal of the insulating layer and cracks in the core when bent for connection to the terminal.

**SUMMARY OF THE INVENTION**

45 According to the present invention, a winding-type noise-suppressing high-tension resistive cord comprises: a core including a blend polymer made by blending ethylene propylene rubber as a base polymer with a reinforcing polymer having a good compatibility with the ethylene propylene rubber and to be covulcanized during vulcanization, the blend polymer including a magnetic material mixed therein; a resistance wire coiled around the core; and an insulating layer for coating the core around which the resistance wire is coiled.

50 Preferably, the reinforcing polymer is ethylene-vinyl acetate copolymer.

Preferably, the reinforcing polymer is polyethylene.

Preferably, the reinforcing polymer is polypropylene.

According to the winding-type noise-suppressing high-tension resistive cord of the present invention, the presence of the reinforcing polymer having the good compatibility with EPR allows the unvulcanized core to have a strength suitable to coil the resistance wire therearound. The vulcanization causes cross-linkage in the EPR, in the reinforcing polymer, and between the EPR and reinforcing polymer to increase the strength of the vulcanized core. Therefore, the winding-type noise-suppressing high-tension resistive cord having physical properties identical with those of the conventional cord including the core of fluororubber and silicone rubber is fabricated at low costs.

It is therefore an object of the present invention to improve a winding-type noise-suppressing high-tension resistive cord to use EPR as a base polymer of a core.

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 according to the present invention;

Fig. 2 is a detail sectional view of a core around which a resistance wire is wound according to the preferred embodiment;

Fig. 3 is a perspective view of the prior art; and

Fig. 4 is a sectional view illustrating connection between the prior art cord and a metal terminal.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment will now be described according to the present invention with reference to the drawings. Referring to Fig. 1, a winding-type noise-suppressing high-tension resistive cord 10 comprises a reinforcing string 11 including three twisted 1000-denier aramid yarns, and a core 12 of a 1.3 mm outer diameter formed by extrusion-coating the reinforcing string 11 with a polymer including ferrite powder mixed therein.

The ferrite powder preferably includes Mn-Zn based ferrite such as Mn-Zn-Fe (manganese-zinc-ferric oxide).

The polymer is a blend of ethylene-propylene-diene terpolymer (EPDM) which is one of the EPR as a base polymer and ethylene-vinyl acetate copolymer (EVA) which is EPDM-compatible and to be covulcanized during vulcanization as a reinforcing polymer. The blend ratio of EPDM to EVA is 60 parts by weight of the former to 40 parts by weight of the latter. The core 12 contains 100 parts by weight of the blend polymer and 500 parts by weight of the ferrite powder.

A 50  $\mu$ m Ni-Cr resistance wire 13 is coiled 7200 times per meter around the core 12, with the blend polymer unvulcanized. Since the unvulcanized blend polymer has a suitable hardness, the resistance wire 13 is half embedded in the core 12 as shown in Fig. 2. The resistance wire 13 is held half embedded in the core 12 by subsequent vulcanization (under conditions of 160°C.; 30 minutes).

An insulating layer 14 is formed by EPDM extrusion coating on the core 12 around which the resistance wire 13 is wound. The insulating layer 14 is coated with a reinforcing braid 15 made of glass yarn, and the reinforcing braid 15 is coated with a sheath 16 made of EPDM.

The reinforcing polymer is not limited to EVA but may be polypropylene (PP) and polyethylene (PE), for example. In particular, EVA and PE are suitable.

As shown in Table 1, when the blend ratio of EPDM to PE is within the range of about 80 to about 70 parts by weight of the former to, correspondingly, about 20 to about 30 parts by weight of the latter (that is, the blend polymer includes about 20 to about 30 % by weight of the PE) and the blend ratio of EPDM to EVA is within the range of about 80 to about 40 parts by weight of the former to, correspondingly, about 20 to about 60 parts by weight of the latter (that is, the blend polymer includes about 20 to about 60 % by weight of the EVA), satisfactory extrusion workability is obtained if about 100 to about 600 parts by weight of the ferrite powder is mixed, and the physical properties of the unvulcanized polymer are a hardness of 75 to 85 and an elongation of 50 % or more. This prevents the core 12 from being cracked when the resistance wire 13 is wound therearound and from being torn off.

Further, in the above described blend ratio ranges, the obtained physical properties of the vulcanized polymer are a strength of 5 MPa or more and an elongation of 50 % or more. This prevents the core 12 from being torn off and cracked when the insulating layer 14 is stripped and the core is bent for connection between the cord and the metal

terminal.

T A B L E 1

|                        |                                       | EPDM/PE<br>VARIATION |     |     |     | EPDM/EVA<br>VARIATION |     |     |     | FERRITE<br>VARIATION |                                                                            | SPECIFICATIONS |
|------------------------|---------------------------------------|----------------------|-----|-----|-----|-----------------------|-----|-----|-----|----------------------|----------------------------------------------------------------------------|----------------|
|                        |                                       | 100                  | 80  | 70  | 60  | 80                    | 60  | 40  | 60  | 60                   | 40                                                                         |                |
| BLEND                  | EPDM                                  | —                    | —   | 20  | 30  | —                     | —   | —   | —   | —                    | —                                                                          |                |
|                        | PE                                    | —                    | —   | —   | —   | —                     | —   | —   | —   | —                    | —                                                                          |                |
|                        | EVA                                   | —                    | —   | —   | —   | —                     | —   | —   | —   | —                    | —                                                                          |                |
|                        | FERRITE(Mn-Zn-Fe)<br>DICUMYL PEROXIDE | 500                  | 500 | 500 | 500 | 500                   | 500 | 500 | 500 | 700                  | 300                                                                        |                |
| PHYSICAL<br>PROPERTIES | TENSILE<br>STRENGTH (MPa)             | 3                    | 3   | 3   | 3   | 3                     | 3   | 3   | 3   | 3                    | 3                                                                          |                |
|                        | UNVULCA<br>-NIZED                     | 1.2                  | 2.7 | 3.3 | 3.9 | 2.0                   | 2.8 | 3.5 | 3.0 | 3.2                  | 1.0 OR MORE                                                                |                |
|                        | ELONGATION (%)                        | 220                  | 80  | 60  | 30  | 160                   | 100 | 60  | 33  | 170                  | 50 OR MORE<br>(NO CRACKS WHEN CORD IS BENT<br>DURING FABRICATION OF CORD.) |                |
|                        | HARDNESS (JISA)                       | 61                   | 83  | 84  | 85  | 75                    | 85  | 80  | 79  | 87                   | 75-85<br>(METAL RESISTANCE WIRE IS<br>SUITABLY EMBEDDED IN CORE.)          |                |
|                        | TENSILE<br>STRENGTH (MPa)             | 2.7                  | 5.2 | 6.0 | 6.9 | 5.2                   | 5.9 | 6.5 | 5.9 | 6.0                  | 5.0 OR MORE<br>(CORE IS NOT TORN OFF<br>DURING TERMINAL STRIPPING.)        |                |
|                        | ELONGATION (%)                        | 210                  | 80  | 60  | 30  | 100                   | 70  | 53  | 30  | 250                  | 50 OR MORE<br>(NO CRACKS WHEN CORE IS BENT.)                               |                |

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 numerous modifications and variations can be devised without departing from the scope of the invention.

Claims

1. A winding-type noise-suppressing high-tension resistive cord comprising:  
a core including a blend polymer made by blending ethylene propylene rubber as a base polymer with a reinforcing polymer having a good compatibility with the ethylene propylene rubber and to be covulcanized during vulcanization, said blend polymer including a magnetic material mixed therein;  
a resistance wire coiled around said core; and  
an insulating layer for coating said core around which said resistance wire is coiled.
2. The winding-type noise-suppressing high-tension resistive cord of claim 1, wherein  
said insulating layer is coated with a reinforcing braid, and said reinforcing braid is coated with a sheath.
3. The winding-type noise-suppressing high-tension resistive cord of claim 1 or 2, wherein  
said reinforcing polymer is ethylene-vinyl acetate copolymer.
4. The winding-type noise-suppressing high-tension resistive cord of claim 3, wherein  
said blend polymer includes about 20 to about 60 % by weight of said reinforcing polymer.
5. The winding-type noise-suppressing high-tension resistive cord of claim 1 or 2, wherein  
said reinforcing polymer is polyethylene.
6. The winding-type noise-suppressing high-tension resistive cord of claim 5, wherein  
said blend polymer includes about 20 to about 30 % by weight of said reinforcing polymer.
7. The winding-type noise-suppressing high-tension resistive cord of claim 1 or 2, wherein  
said reinforcing polymer is polypropylene.
8. The winding-type noise-suppressing high-tension resistive cord of claim 4 or 6, wherein  
said magnetic material includes ferrite powder in an amount of about 100 to about 600 parts by weight per 100 parts by weight of said blend polymer.

FIG. 1

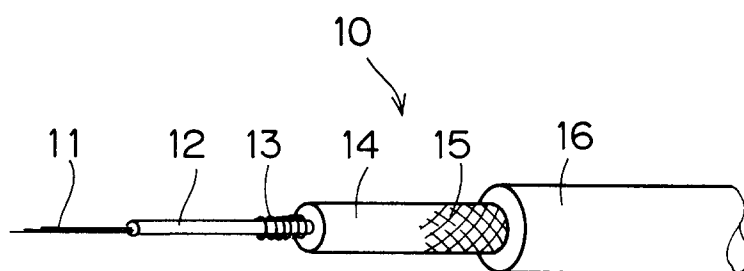


FIG. 2

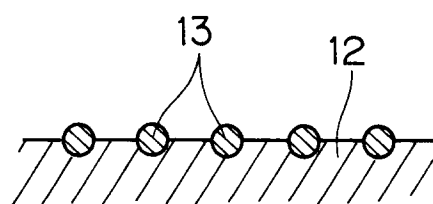


FIG. 3

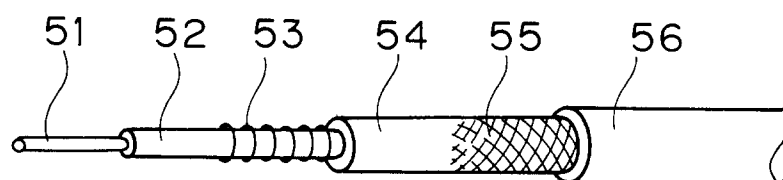


FIG. 4

