Jan. 27, 1970 MASAYUKI HAYASHI ET AL 3,492,622

HIGH TENSION CABLES FOR NOISE SUPPRESSION

Filed Jan. 18, 1967

FIG. 1

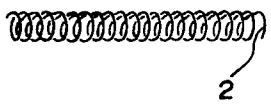


FIG. 2

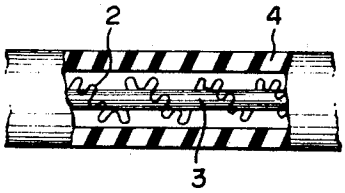


FIG. 3

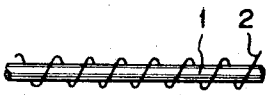


FIG. 4

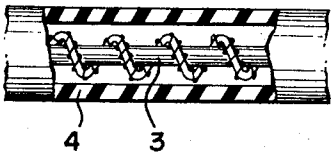


FIG. 7

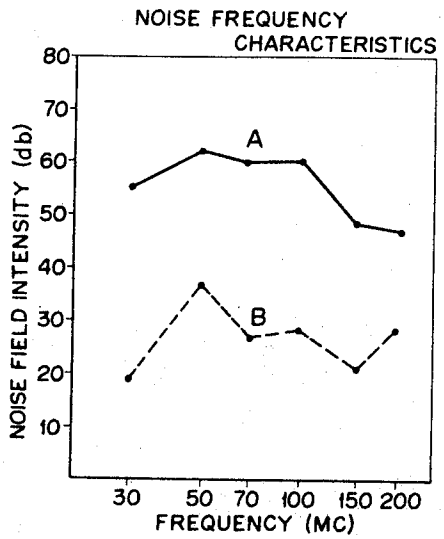


FIG. 5

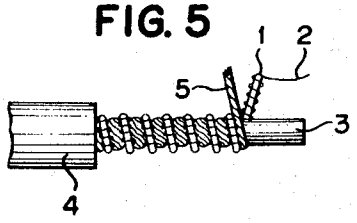
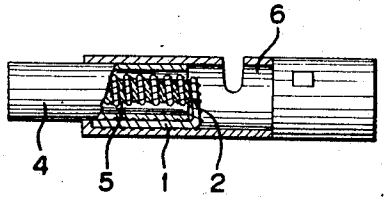


FIG. 6



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HIGH TENSION CABLES FOR NOISE SUPPRESSION

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Int. Cl. H01c 1/06; 3/00
U.S. Cl. 338—66 2 Claims

ABSTRACT OF THE DISCLOSURE

High tension cable for noise suppression in which a fine wire is spirally wound to form a wound conductor, the wound conductor being spirally wound about a core of insulating material to form a double wound conductor, and an insulating material covering the double wound conductor.

This invention relates to in a high tension cable for noise suppression used especially in ignition circuits of internal combustion engines. An automobile ignition system produces perhaps the highest noise levels, the frequency being wide and greatly interferes with various communication facilities such as radio, television and the like.

To suppress these interferences, it is conventional to insert a resistor in the ignition system. However, in such resistor, high frequency voltage is applied to the resistive body having a short length, which results in the reduction of effective resistance especially in the high frequency band above 100 mc., and deteriorates noise suppression efficiency.

It is therefore desirous to use the resistive cable having an electrical resistance as high as possible within a range which will not interfere with the ignition operation of the engines. However, in using a metallic wire as a resistive body which has a high resistivity of about 10 to 30 KΩ per meter with a diameter equal that of conventional copper wire it becomes very expensive and is therefore uneconomical and impractical for ordinary useage. It is therefore necessary to select a suitable resistive material having a diameter of about 0.1 mm. to 0.05 mm. and to arrange such fine wires to be contained in a complete cable as long as possible to increase the resistance thereof.

A conventional wound-wire type resistor is of the structure in which fine resistive wires are directly and closely wound around an insulating core material having a circular cross-section, and the thus formed wound-wire resistor is coated with an insulator such as vinyl. However, in such conventional resistor, the number of windings of resistive conductor to be wound around the core is restricted and consequently it is impossible to raise the resistance over a limited value. In other words, if the number of windings of fine resistive wires is much increased to raise the resistance, it would result in variation of resistance due to short circuit between wires by the displacement of the wound wires because of tension and bending directly imparted thereon when used. On the other hand, to decrease the size of wires for increasing resistance, the contact resistance at the connection terminal, the mechanical strength at the connecting portion of the wires with the terminal and the workability will be deteriorated due to the weakness of the wires having a diameter of more or less 0.1 mm.

An object of the present invention is to provide a resistive cable having a high resistance by significantly increasing the total length of the resistive wires to be wound by making it as a structure of double wound-wire type instead of conventional single wound-wire type.

Another object of the present invention is to provide a stable and reliable resistive cable in which the breakdown of the wires and variations in resistance value are minimized by making the cable as a double wound wire type which has high flexibility without imparting direct stress on the resistive conductive elements even when excess tension and bending are applied to the cable.

Further object of the present invention is to provide a stable connection of wires with a terminal by fixing one end of the double wound conductor comprising resistive wires wound around a fine insulating core which is more stable and reliable than conventional connection in which a fine resistive wire element itself is either directly or through a pin fixed to a terminal.

According to one illustrative embodiment of the present invention, fine metallic resistive wires are wound with small pitch and diameter to form a wound conductor, the wound conductors are further wound around an insulating core material to form a double wound conductor; the double wound conductors being coated with an insulating material to form an ignition cable.

According to another embodiment of the present invention, the wound conductor differ from those of the first embodiment in that they are wound around a fine insulating material.

The terminal portion of the ignition cable of the present invention has a structure in which the end portion of the wound conductor of which the wire elements being wound around the fine insulating material is fixed to a connector terminal.

Above and other objects, features and advantages of the present invention will be more apparent from the following description referring to the embodiments shown in the drawing, in which:

FIGS. 1 and 2 show a first embodiment of the present invention, FIG. 1 illustrating the primary winding conductor and FIG. 2 showing a front view of the resistive cable, a portion of which being cross-section thereof;

FIGS. 3 and 4 show a second embodiment of the present invention, FIG. 3 illustrating the primary winding conductor in which resistive wires are wound around the insulating fine core material, and FIG. 4 showing a front view of the resistive cable, a portion of which being cross-section thereof;

FIG. 5 shows a modification of the second embodiment in which separators are inserted between adjacent wound wires of the secondary winding conductor;

FIG. 6 is a cross-section of the terminal portion of the resistive cable; and

FIG. 7 shows a graph of noise frequency characteristics to compare the resistive cable of the present invention to a conventional cable.

The first embodiment shown in FIGS. 1 and 2 only differs from the second embodiment in that, in the first embodiment, the wires of the wound conductor are wound themselves without using the fine insulating material, and consequently, the explanation will be made in detail with respect to the second embodiment shown in FIGS. 3 and 4.

In FIG. 3, **1** is a fine insulating core material such as, for example, polyvinyl chloride, polyethylene, nylon, fishing gut, glass fibre and cotton thread, or the like, and metallic resistive wires **2** are wound around the fine insulating core material **1** as shown in FIG. 4 to form a wound conductor, and thus formed primary conductor is wound around an insulating core **3** of the material similar to that of the fine insulating core **1** to form a double wound conductor, around which is coated an insulating coating **4** of rubber (natural or synthetic rubber), or plastic (polyethylene or polyvinyl chloride).

As explained above, according to said embodiment, the wound conductor comprising resistive wires **2** wound around the fine insulating core **1** is further wound around the insulating core **3** to form the double wound conductor, and therefore, it is possible to elongate the length of the metallic resistive wires **2** included in the unit length of the ignition cable to the result that the resistance per unit length of the cable is increased and the noise suppression efficiency is elevated. When winding the metallic wires **2** around the fine insulator **1**, winding pitch is easily varied to obtain a desired resistance, which enables suppression not only of high frequency vibrating current but also noise current of relatively low frequency.

In the first embodiment shown in FIGS. 1 and 2, fine insulating core **1** is not used and metallic resistive wires **2** are wound themselves with the same pitch and diameter to form the wound conductor, which is wound around the insulating core **3** to form the double wound conductor, around which is coated with insulating coating **4**.

It is noted that although in the first and second embodiments bare wires are used, metallic resistive wires coated with insulating coating such as for example oily enamel, polyethylene, polyester, polyurethane, folmal resin is also used as well.

In the preferred embodiments of the present invention, separator **5** of for example cotton thread is wound around the insulating core **3** as spacers between adjacent windings of the double wound conductor, as shown in FIG. 5.

The terminal portion of the ignition cable of the present invention is made as shown in FIG. 6, where the end portion of the wound conductor having wires wound around the fine insulator is folded along the outside surface of the insulating coating **4** and thus folded portion is inserted into the terminal connector **6**.

An example of the second embodiment is shown below.

EXAMPLE

Resistive wire:
- Material—Ni-Cr wire: Ni 77% above, C 0.15% below, Mn 2.5% below, Cr 19~21%, Si 0.75~1.5%, Fe 1.0% below
- Diameter—0.05 mm. ϕ
- Electrical resistance—about 550 Ω m.

Primary fine core:
- Material—polypropylene string
- Diameter—0.47 mm. ϕ

Wound conductor:
- Resistive wires are wound around the primary fine core in the form of open-spiral.
- Outside diameter—0.57 mm. ϕ
- Number of windings of wires per unit length—34/cm.

Secondary insulating core:
- Material—glass fibre string or polyethylene glycol telphthalate (trade name Tetolon) fibre string.
- Diameter—1.0 mm. ϕ

Double wound conductor:
- Primary winding conductor is wound around the secondary insulating core alternately with cotton thread separator.
- Outside diameter—2.0 mm. ϕ

- Number of windings of the wound conductor per unit length—11/cm.

Insulating coating:
- Material—vinyl or rubber-polychloroprene
- Thickness—
  - Vinyl, 2.5 mm.
  - Rubber, 1.9 mm. } 2.5 mm.
  - Polychloroprene, 0.6 mm. }

Finished outside diameter—7 mm. ϕ

Electrical resistance—16 kΩ/m.

when this resistive cable is inserted in the ignition system of the automobile engine of 4-cylinder, 1,000 cc., the respective lengths of resistive cables are as follows:

From—	mm.
Ignition coil to distributor	380
First distributor to ignition plug	190
Second distributor to ignition plug	250
Third distributor to ignition plug	300
Fourth distributor to ignition plug	390

when this engine is rotated at 1,500 r.p.m., noise frequency characteristics obtained by not using resistive wires and using the resistive cable according to the present invention are shown in FIG. 7, with the solid line A being for the former case and dotted line B being for the latter case, respectively. The curves of FIG. 7 were plotted from noise measurements made at a distance of 10 meters from the automobile and at a height of 4 meters above the ground. As apparent from the graph, according to the present invention, the noise field intensity is significantly decreased in the wide frequency range.

What is claimed is:

1. An ignition cable, comprising

a first flexible core of small diameter and made of insulating material,

a fine resistance wire spirally wound about the flexible core to provide a wound conductor,

a second flexible core of insulating material about which the wound conductor is spirally wound to form a double wound conductor, and

an insulating coating covering the double wound conductor.

2. An ignition cable according to claim **1**, wherein

a spacer of insulating material is inserted between adjacent windings of the double wound conductor.

References Cited

UNITED STATES PATENTS

1,760,057	5/1930	Hawley	338—298
2,322,773	6/1943	Peters	123—148
3,284,751	11/1966	Barker et al.	338—66
1,209,568	12/1916	Dorceloh et al.	338—298

REUBEN EPSTEIN, Primary Examiner

U.S. Cl. X.R.

123—148; 338—298