Dec. 18, 1934. F. J. GIVEN 1,984,526

FILTER FOR SUPPRESSION OF HIGH FREQUENCY CURRENT

Filed July 18, 1928

FIG. 1

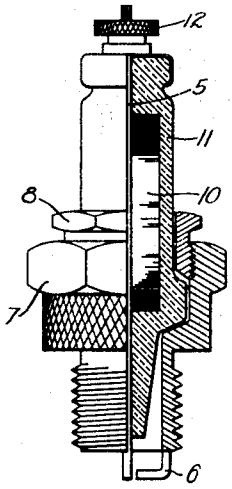


FIG. 5

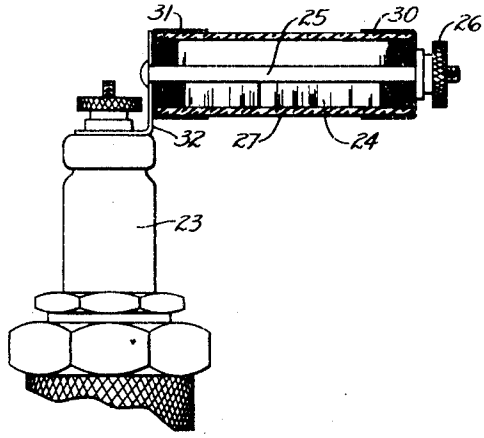


FIG. 2

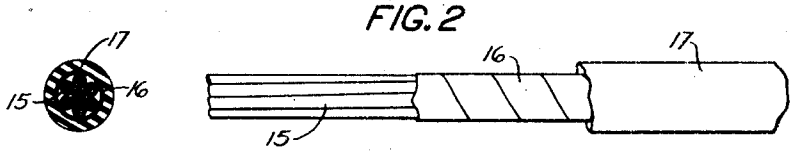


FIG. 3

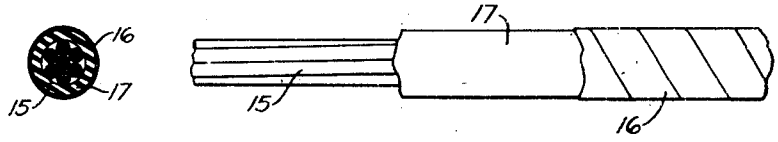
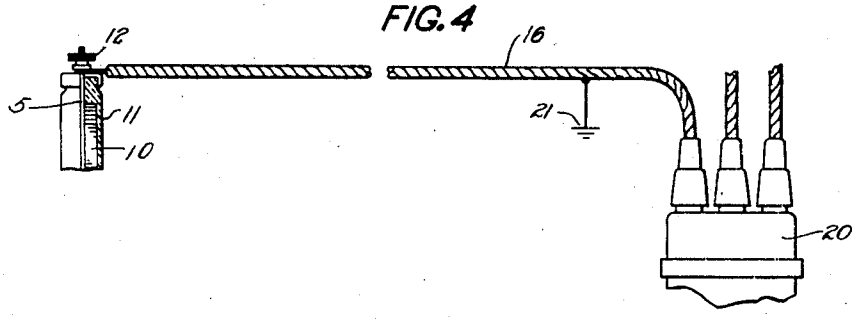


FIG. 4



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FILTER FOR SUPPRESSION OF HIGH FREQUENCY CURRENT

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7 Claims. (Cl. 123—148)

This invention relates to filter circuits and particularly to means for suppressing high frequency currents in any system where they are not desired, one instance being an ignition system for internal combustion engines for airplanes, automobiles and the like.

An object of the invention is to reduce interference to sensitive measuring or signaling apparatus such as radio receivers, due to the higher frequency components that may be present in any conductors within range of the apparatus, and specifically those generated by ignition systems during the sparking action.

It is well known that the voltage wave in a spark plug conductor increases rapidly until the spark gap is broken down and then decreases rapidly. As this wave is not sinusoidal but rich in the higher harmonics, these higher frequency components generated are picked up by adjacent radio receiving apparatus. The harmonics produce in the receiver units a sputtering sound sufficient to seriously interfere with radio reception.

Heretofore such methods as shielding the entire engine or only the ignition system have been tried and these methods have proved too inconvenient and bulky. Also filter systems have been used, these systems necessitating special coils and condensers which increase the weight of the motor element and the space required per horse power.

The present invention combines the effectiveness of the shield and filter methods with substantially no change in weight, space and convenience from the ordinary ignition wiring system.

In one embodiment, the filter of this invention is obtained by continuously loading with magnetic material the ignition wiring, especially those leads from the distributor to the spark plugs thereby providing the necessary series inductances. The magnetic material is then preferably grounded and the capacity between the material and the conductor it surrounds is utilized as a low impedance capacity shunt.

In another embodiment, the spark plug electrode itself may be loaded by constructing the plug with a sleeve of laminated magnetic material insulated from the housing and surrounding the electrode. Also a section of a loaded conductor may be inserted next the spark plug or elsewhere in the system to add inductance to the lead.

The magnetic material may be any high permeability material preferably in subdivided condition, for example in the form of tape, discs, beads or some such form as to reduce eddy current losses. The preferred magnetic material for this purpose is an alloy of nickel and iron heat treated to possess high initial permeability, commonly known in the art as permalloy, and disclosed and claimed in U. S. patent to G. W. Elmen No. 1,586,884, June 1, 1926. It was found that at a frequency of 1,000,000 cycles, an inch of conductor loaded with a laminated permalloy sleeve in the form of discs, provided an impedance of 185 ohms in the conductor. With the amount of conductors ordinarily available for loading, it is seen, therefore, that a very effective suppressing action can be obtained in this manner.

A better understanding of the invention will be had from the detailed description to follow, in connection with the attached drawing in which

Fig. 1 is a part sectional view of a spark plug with a loaded electrode according to this invention;

Figs. 2 and 3 show loaded cable structures embodying the invention;

Fig. 4 shows portions of a spark plug, a distributor and the connecting cable of Fig. 3 as used in an ignition system; and

Fig. 5 shows a loaded section according to this invention, for insertion in the leads of an ignition circuit.

The spark plug of Fig. 1 may be of any well known construction having a central electrode 5 and a grounded electrode 6 between the terminals of which a spark is formed for igniting the gases in an engine combustion chamber. The plug has an outer nut 7 for fastening the plug into the cylinder and an inner nut 8 for holding the assembled elements of the plug together. The plug of Fig. 1 differs from the well known type, however, in the provision of element 10 of laminated magnetic material which may be of permalloy or the like. This element is shown in the form of a laminated sleeve of discs encircling the electrode 5 over a portion of its length. The element 10 may be in any other form of laminations of any desired configuration such as square, beads or the like, the laminations being insulated from one another by an oxide or silica dust coating. The magnetic material in the form of insulated dust particles to form the sleeve may also be used. This type of construction is preferable to reduce eddy current losses in the magnetic material. An insulation 11 of porcelain or like material separates the electrode 5 and sleeve 10 from the grounded nuts 7 and 8. A conductor fastening

thumb nut 12 is fitted to the other terminal of the electrode 5.

In the form of the invention embodied in the construction of Figs. 2 and 3, loaded conductors in the form of flexible cable are used between the elements of an internal combustion engine ignition system. The cables in both figures have a core composed of a plurality of wires or strands 15. In Fig. 2 a wrapping 16 of magnetic material such as permalloy tape is shown placed next to the strands 15. This particular cable then has a layer of insulation 17 of rubber or the like placed over the magnetic tape 16. An alternative construction shown in Fig. 3 has the insulation 17 placed over the wires 15 and the tape then covering the insulation. The construction of Fig. 3 is advantageous in some instances where the usual conductors are already installed, where it may be used to load them by wrapping them in a layer of magnetic tape in this manner.

Fig. 4 shows the cable of Fig. 3 connected between a spark plug, which may be of the type shown in Fig. 1, and a distributor 20 representing another element of the ignition system. The magnetic loading material is shown grounded at 21.

In Fig. 5 a spark plug 23 which may be of the type shown in Fig. 1 or of any other type is shown connected to a loaded conductor section 24. This section may be rigid as shown in the drawing or non-rigid according to whichever form is more suitable for the particular purpose intended. The section 24 has a central conductor 25, on the threaded terminal of which, is a thumb nut 26 for connecting to a conductor or other element. Encircling the conductor 25 is a laminated column 24 of magnetic material which may be in the form of permalloy discs as shown or any other shape or type of lamination such as described in connection with Fig. 1. Covering the sleeve 24 is a layer of insulating material 27 which together with the sleeve is held in position by cup shape brackets 30 and 31. An arm 32 clamped at one end of the section 24 is used for connecting the section to spark plug 23 or to any other element of the ignition system in which this section is employed. It is preferable, however, to introduce the inductance as close to the spark gap as possible and this section should therefore be fastened or connected to the plug itself if accessible.

It will be understood, of course, that the disclosure herein has been to a particular means for carrying out the invention, but the appended claims are intended to cover such equivalent combinations as the state of the art will allow.

What is claimed is:

1. In an ignition system for internal combustion engines, a spark plug, an electrode traversing said plug, and a conductor from said plug to an element of said system, said conductor and the electrode of said plug each being covered with a sleeve of magnetic material to introduce inductance to currents in said conductor, said sleeve of the conductor being grounded to introduce a shunting capacity across the gap of said plug, said sleeve of said spark plug being comprised of a series of permalloy discs.

2. In an ignition system for internal combustion engines, a spark plug, an electrode traversing said plug, and a conductor from said plug to an element of said system, said conductor and the electrode of said plug each being covered with a sleeve of magnetic material to introduce inductance to currents in said conductor, the sleeve of the conductor being comprised of permalloy tape and being grounded to introduce a shunting capacity across the gap of said plug.

3. In an ignition system for internal combustion engines, a spark plug, a casing for said plug, and an electrode traversing said plug connected to a conductor of said system, said plug electrode being surrounded by a column of permalloy discs, said discs and electrode being insulated from said casing.

4. A spark plug for internal combustion engines comprising an outer casing, a central electrode, a sleeve of subdivided magnetic material surrounding said electrode, and an insulation between the magnetic material and said casing.

5. A spark plug in accordance with claim 4 in which said sleeve is comprised of a series of permalloy laminations.

6. In an ignition system for internal combustion engines, a spark plug, another element of said system, a conductor between said plug and said other element, and a filter for said ignition system having a series inductance formed by a sleeve of permalloy material surrounding said conductor, and a capacity formed by grounding said sleeve.

7. The combination with an ignition system for an internal combustion engine, of a conductor comprising an electrically conductive core, insulation for said core, and a covering of permalloy tape to introduce effective series impedance low to currents of frequencies essential for ignition purposes but so high as to suppress the principal harmonics of such currents.

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