May 21, 1968 E. A. HANYSZ 3,384,061

MEANS FOR SUPPRESSING IGNITION INTERFERENCE

Filed March 28, 1966

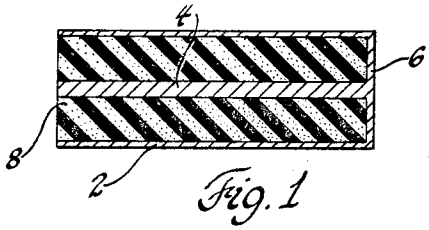


Fig. 1

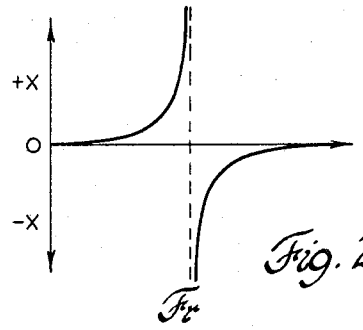


Fig. 2

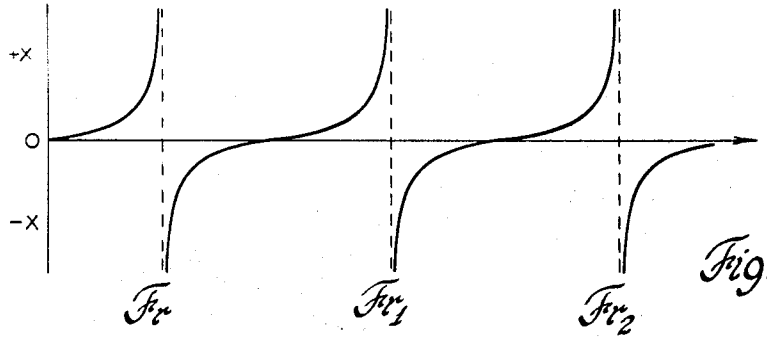


Fig. 3

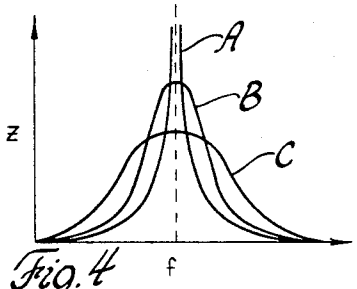


Fig. 4

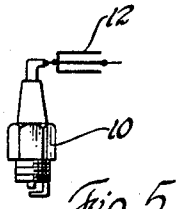


Fig. 5

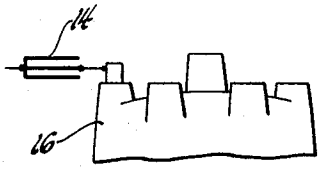


Fig. 6

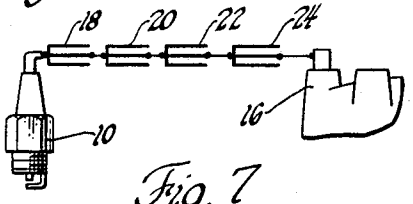


Fig. 7

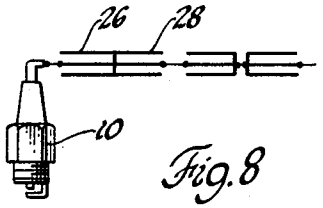


Fig. 8

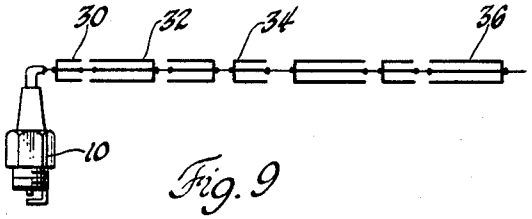


Fig. 9

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MEANS FOR SUPPRESSING IGNITION INTERFERENCE

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ABSTRACT OF THE DISCLOSURE

This invention relates to means built into the ignition system of an internal combustion engine to suppress high frequency radiation therein so that it will not interfere with radio reception in the vicinity.

State of the prior art

The problem of high frequency currents generated in ignition systems for internal combustion engines is not new. Fontaine, 3,041,498 discloses one form of suppressing means. Co-axial stubs per se for general filtering purposes are also old as shown by Von Baeyer, 2,297,512.

Description of the invention

The present invention is designed to suppress high frequency radiation in conductive electrical lines such, for example, as an ignition line for an internal combustion engine harness through the use of one or more lossy shorted co-axial stubs connected in said line. Throughout the specification, lossy shorted co-axial stubs will be referred to in abbreviated form as LSS.

Interference is understood to be generated in an ignition system by the discharge of distributed capacity of the cable and transformer secondary coil across the spark gap. This pulse discharge has a steep rise, short duration and random occurrence. It contains energy over a very wide frequency spectrum which it is necessary to filter out or suppress.

The formation and operation of such a system will be best understood by reference to the following specification and drawings in which:

FIGURE 1 is a longitudinal sectional view taken through a lossy shorted co-axial stub;

FIG. 2 is a graph of reactance vs. frequency of a lossless co-axial stub in the vicinity of the fundamental frequency;

FIG. 3 is a graph of reactance vs. frequency of a lossless stub showing the reactance curves for the fundamental and related frequencies;

FIG. 4 is a graph illustrating the effect of loss in the dielectric on the Q of a shorted co-axial stub at fundamental frequency;

FIG. 5 shows the use of an LSS adjacent the spark plug;

FIG. 6 shows the use of an LSS adjacent the distributor;

FIG. 7 shows the use of a plurality of LSS devices distributed along the cable between the spark and the distributor;

FIG. 8 shows the use of LSS devices oriented toward the plug and toward the distributor; and,

FIG. 9 shows the use of LSS devices which are stagger tuned to attenuate a wide band of frequencies.

The present problem deals with filtering out or attenuating energy having frequencies over relatively wide bands in order to prevent them from being radiated from an ignition cable to interfere with radio reception in the vicinity. Co-axial stubs are utilized as filter means in this instance. A co-axial stub is shown in FIG. 1 and it consists of a cylindrical body 2 having a central axial member 4 fixedly secured to one end plate 6. This member

may be connected in any circuit in which it is to be used as a filter by connecting the same directly to the line. A co-axial stub of the form shown in FIG. 1 has an electrical characteristic which is similar to that of an L-C circuit when lossless and its resonances are dependent upon its loss.

FIG. 2 is illustrative of the reactance of such a lossless stub wherein the anti-resonant frequency is shown at F_r and indicates an inductive reactance below to the left of F_r and a capacitive reactance above F_r. Its anti-resonant frequence F_r is determined by its length which is one-quarter wave length or $\lambda/4$ where λ is the wave length in the co-axial line. The co-axial stub, of course, is also resonant at various related or harmonic frequencies which will bear numerical relationship to the fundamental, and FIG. 3 discloses reactance vs. frequency curves for a certain lossless co-axial stub in which the first anti-resonant frequency F_r may be that of the fundamental, whereas the next two in proceeding to the right in the diagram may be the next harmonic anti-resonant frequencies in order F_{r1} and F_{r2}. Thus, such a device would not only filter out frequencies in the vicinity of the fundamental but also other frequencies in the vicinity of the higher harmonics.

Instead of maintaining a sharp resonance, such as would be the case if the co-axial stub were lossless, its resonant effect may be broadened through the use of a lossy dielectric. This may be obtained by packing the stub with a lossy material 8 which may be a ferrite, a titinate, or a graphite compound which will absorb energy in the frequency range in which the designer is concerned. The wave length in the LSS will be reduced through the use of lossy material so that the physical length of the stub may also be shortened to preserve the center frequency.

FIG. 4 illustrates the effect of the use of packing the co-axial stub with lossy material. In that case this graph is likewise a graph of frequency vs. absolute impedance, frequency being plotted as the abscissa and the absolute impedance as the ordinate. The curve A, which is the narrowest and highest of the curves, illustrates the response of the stub with little or no loss. As the stub is packed with material which tends to provide a certain loss, the curve can be broadened out to provide a response curve such as B, and if material is packed in the same to give it a great deal of loss it can be flattened down to produce a curve similar to C. Therefore, its characteristics are controllable with the characteristics of the lossy material used.

In using an LSS device in an ignition system to reduce or filter out the interfering energy, FIG. 5 illustrates one manner and one location in which this is accomplished. FIG. 5 shows a spark plug **10** which may be any one of the plugs of an internal combustion engine and an LSS **12** mounted adjacent the same to absorb or attenuate possible interfering energy which is generated in the line by mounting the same near the plug.

FIG. 6 illustrates another possible location in the ignition system and, therefore, shows an LSS **14** mounted adjacent the distributor cap **16**. It is also possible to mount a plurality of LSS devices along the line between the spark plug **10** and the distributor cap **16** and these are shown at **18**, **20**, **22** and **24** in FIG. 7. These may be adjusted to different center frequencies.

FIG. 8 illustrates a still further modification in use wherein the LSS devices **26** and **28** in the ignition cable near the spark plug **10** are oriented in opposite directions to prevent the reflection of energy which it is desired to attenuate.

Lastly, FIG. 9 shows the use of stagger tuned and oppositely oriented LSS devices **30**, **32**, **34** and **36** in the ignition cable wherein the same are tuned to different frequencies, inserted in different orders and are oriented in

opposite directions. The spacing between the LSS elements would also have an effect on the filtering and thus would have to be optimized. Such a grouping would cover the largest band of frequencies and be most effective.

It is, therefore, obvious that my invention is capable of considerable tailoring, use in the breadth, complication and number of units to be used. It could vary all the way from the use of a single LSS in the system if only a moderate amount of suppression is desired, to a more complicated multiple use of carefully selected and tailored LSS devices to cover carefully certain frequencies which it was required to remove. The LSS structure instead of being separate and independent and built into the cable could be designed and built into the spark plug or the distributor cap as well.

What is claimed is:

1. In a conductive line in which there periodically exist energy waves of short duration and random occurrence at a number of different frequencies in the high frequency band, suppressing means for such energy waves comprising a coaxial stub connected in said line, said coaxial stub including a central member and a concentric cylindrical member mounted therearound forming an annular cavity, and material having a preselected loss characteristic packed in the cavity to provide loss in the coaxial stub to broaden out the response curve thereof to attenuate wave energy in that vicinity.

2. Suppressing means as defined in claim 1 in which the conductive line in which the energy waves exist is an ignition wire extending between a spark plug and a distributor and the coaxial stub packed with lossy material is connected adjacent the spark plug.

3. Suppressing means as defined in claim 1 in which the conductive line in which the energy waves exist is an ignition wire extending between a spark plug and a distributor and the coaxial stub packed with lossy material is connected adjacent the distributor.

4. Suppressing means as defined in claim 1 in which the conductive line in which the energy waves exist in an ignition wire extending between a spark plug and a distributor, and a plurality of coaxial stubs packed with lossy material are connected in the line between the spark plug and the distributor.

5. Suppressing means as defined by claim 4 in which the plurality of coaxial stubs are tuned to different center frequencies and part faced in opposite directions.

6. Suppressing means as defined in claim 1 in which the material packed in the coaxial stub cavity is a ferrite.

7. Suppressing means as defined in claim 1 in which the material packed in the coaxial stub cavity is a titinate.

8. Suppressing means as defined in claim 1 in which the material packed in the coaxial stub cavity is a graphite compound.

References Cited

UNITED STATES PATENTS

2,297,512	9/1942	Von Baeyer	333—12
3,041,498	6/1962	Fontaine	315—54
3,134,950	5/1964	Cook	333—79 XR
3,191,132	6/1965	Mayer	333—79
3,191,133	6/1965	Texsier	123—148

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