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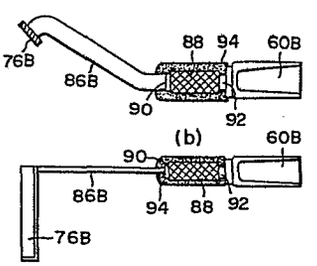
(54) **Distributor for an internal combustion engine.**

(57) A distributor for an internal combustion engine, especially of the type having a plurality of cylinders, each having a plurality of ignition plugs, has leads between discharge electrodes and cable connectors which are made of electrically-resistive material in order to attenuate electromagnetic noise generated during discharge. One type of lead includes a flat, electrically-resistive conductor mounted on a flat insulator, and is especially effective in attenuating low-frequency noise. Another type employs a graphite fiber core as an electrically-resistive conductor, and is especially effective in attenuating high-frequency noise.

*FIG.5*

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# DISTRIBUTOR FOR AN INTERNAL COMBUSTION ENGINE

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention relates generally to a distributor for an internal combustion engine, and more particularly to a distributor having means for reducing noise generated from the distributor.

### 2. Description of the Prior Art

An ignition system for an internal combustion engine generates electromagnetic noise (hereinafter, referred to simply "noise") which has wide frequency range and high intensity so that the noise will interfere with television and radio receiver over a broad area. In order to eliminate noise generation by the ignition system, there has been conventionally utilized a combination of a resistive ignition plug and a resistive high-voltage cable connecting the plug and the distributor which applies current at a high voltage to the plug. Such a conventional noise eliminator is effective only against noise generated by the plug. However, the noise is generated not only by the plug, rather, the distributor also generates noise sufficiently strong to cause interference.

Generally, an internal combustion engine comprises a plurality of cylinders. Accordingly, a conventionally-used distributor comprises a rotating electrode segment connected to an ignition coil and a

plurality of peripheral electrodes, each connected to an ignition plug provided with in a corresponding cylinder. The noise from the distributor is caused by discharging from the rotating conductor to the peripheral electrode.

In conventional distributor, a plurality of insulating conduits are integrally formed vertically in the top surface of a distributor cap in order to protect a connection member between each electrode and a high-voltage cable. On the other hand, the insulating conduits can be integrally formed on the side surface of the distributor cap so as to eliminate upward projections, thereby allowing the cap to be shortened. Further, such a structure also improves the ease of connecting or disconnecting the high-voltage cable to or from the cap. However, the latter structure allows more noise generation than the former.

## BRIEF SUMMARY OF THE INVENTION

With these problems in mind, therefore, it is an object of the present invention to provide a noise-preventive distributor for an internal combustion engine.

Another object of the present invention is to provide a distributor suitable for an internal combustion engine equipped with a complicated ignition system such as a plurality of cylinders each of which is equipped with a plurality of ignition plugs.

Another object of the present invention is to provide a distributor which has a compact construction.

To achieve the above-mentioned objects, a

distributor for an internal combustion engine according to the present invention comprises a first means for electrically connecting a central electrode which contacts a rotating conductor and a connector which can engage one end of a high-voltage cable connected to an ignition coil, at least a part of the first means being made of resistive material; and a second means for electrically connecting each peripheral electrode segment facing the rotating conductor to each connector engaging one end of the high-voltage cable connected to an ignition plug, at least a part of the second means being made of resistive material.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and advantages of the distributor according to the present invention will be more clearly appreciated from the following description taken in conjunction with the accompanying drawings in which like reference numerals designate corresponding elements, and in which:

Fig. 1 is a vertical cross-sectional view of an upper portion of a conventional distributor, the cap of which is formed with vertical insulating conduits;

Fig. 2 is a schematical perspective plane view of another conventional type of distributor cap which is constructed in such manner that insulating conduits are arranged horizontally on the side surface of the cap;

Fig. 3 is a schematical vertical cross-sectional view of the distributor cap according to Fig. 2;

Fig. 4 is a graph showing a comparison between the distributor according to Fig. 1 and the other according to Fig. 2 with respect to noise level;

Fig. 5(a) is a longitudinal-section view of first embodiment of the present invention;

Fig. 5(b) is a longitudinal-sectional side view of Fig. 5(a);

Fig. 6(a) is a longitudinal-section view of second embodiment of the present invention;

Fig. 6(b) is a longitudinal-sectional side view of Fig. 6(a);

Fig. 6(c) is a enlarged view of part of Fig. 6(b);

Fig. 7 is a longitudinal-section view of third embodiment of the present invention; and

Fig. 8 is a graph showing a comparison between the conventional distributor and the distributors according to the present invention with respect to noise level.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

To facilitate understanding the present invention, a brief reference will be made to conventional distributors. Referring to Fig. 1, there is shown a vertical cross-sectional view of one typical prior-art distributor which is formed with a plurality of vertical insulating conduits on the distributor housing in which a governor advancer or a vacuum advancer is housed and a

rotor shaft 12 is rotatably disposed at substantially the center thereof. A disc-shaped rotating member 14 is fixed to the free end of the shaft 12 so as to rotate therewith. The rotating member 14 is generally made of plastic resin such as polypropylene. Further, a rotating conductor 16 is integrally secured on the upper surface of the rotating member 14. On the top end of the housing 10 a distributor cap 18 is secured so as to cover the rotating member 14. The cap 18 is provided with a plurality of peripheral electrodes 20 in such manner that one end of the peripheral electrode 20 faces the free end of the rotating conductor 16 across a discharge gap 22. The other end of the peripheral electrode 20 is connected to an ignition plug (not shown) via a high-voltage cable 24. Further, the distributor cap 18 is provided with a carbon electrode 26 at the center of the cap 18. The upper end of the central electrode 26 is connected to an ignition coil (not shown) through an electrically conductive spring 28, a connector 30, and a high-voltage cable 32. The spring 28 urges the central electrode 26 into continuous contact with the rotating conductor 16 so that electric current flows from the central electrode 26 to the peripheral electrode 20 through the rotating conductor 16 and the discharge gap 22.

In such a distributor structure, when the rotating conductor 16 reaches a position such as is shown in Fig. 1; that is, the tip of the rotating conductor 16

faces a peripheral electrode 20 located at the left side in the figure, dielectric breakdown occurs in the discharge gap 22 due to the high voltage current applied via the carbon point 26, resulting in a spark discharge between the rotating conductor 16 and the peripheral electrode 20. In response to this discharge, the ignition plug also generates a spark discharge so that the volatilized fuel in the corresponding cylinder of the internal combustion engine can be ignited. In addition to the noise generated by the spark discharge of the ignition plug, the spark discharge between the rotating conductor 16 and the peripheral electrode 20 causes noise.

The distributor cap 18 of the distributor shown in Fig. 1 is integrally formed with a plurality of insulating conduits 34 and 36 to protect connection members between the high voltage cables 24 and 32 and the peripheral electorde 20 or the central electrode 26 in such manner that the conduits project upwards from the top surface of the cap 18.

Referring to Figs. 2 and 3, there is shown another type of conventional distributor, the cap of which is provided with a plurality of insulating conduits arranged horizontally on the side surface thereof. Such a structure is intended to decrease the height of the distributor cap so as to minimize projections from the engine, and improve ease of mounting or dismounting the high voltage cable onto or from the terminal of the

distributor.

Figs. 2 and 3 are respectively plan and side cross-sectional views in which solid lines represent the outlines of the resin molded parts of the distributor cap and electric members such as an electrodes, terminals, leads and so on, are designated by hatching. This type of distributor is designed so as to be used for a four-cylinder internal combustion engine, each cylinder of which is equipped with twin ignition plugs. The distributor comprises two central electrode elements connected to an ignition coil system which applies high-voltage current to them and a set of four peripheral electrodes corresponding to each central electrode element, i.e., a total of eight peripheral electrodes.

In Figs. 2 and 3, the reference numeral 40 denotes a distributor cap which is integrally formed with two insulating conduits 42A and 42B and eight insulating conduits 44A, 46A, 48A, 50A, 44B, 46B, 48B and 50B projecting horizontally from the side surface of the cap. The insulating conduit 42A houses a connector 52A which engages with one end of a high voltage cable (not shown) connected to an ignition coil system (not shown) in the same manner as described with reference to Fig. 1. The insulating conduit 42B also houses a connector 52B which engages with one end of a high voltage cable (not shown) connected to the ignition coil system (not shown). The insulating conduits 44A, 46A, 48A and 50A house connectors

54A, 56A, 58A and 60A, respectively. In the same manner as described above, the inksulating conduits 44B, 46B, 48B and 50B house connectors 54B, 56B, 58B and 60B, respectively. These connectors each engage with one end of high voltage cables (not shown) connected to corresponding ignition plugs (not shown), respectively.

The connectors 52A and 52B are respectively connected to central electrodes 62A and 62B through leads 64A and 64B and coil springs 66A and 66B, which are made of an electrically conductive material. In Fig. 2, the central electrode 62A and coil spring 66A cannot be seen since they are behind the central electrode 62B and coil spring 66B. The bottom points of each of the central electrodes 62A and 62B slidingly contact the upper surface of rotating electrode 68. The reference numerals 70A, 72A, 74A, 76A, 70B, 72B, 74B and 76B denote peripheral electrodes which are arranged in such a manner that they face the rotating electrode 68 through a discharge gap at the point of closest approach. The electrodes 70A, 72A, 74A, 76A, 70B, 72B, 74B, and 76B and the connectors 54A, 56A, 58A, 60A, 54B, 56B, 58B and 60B respectively are electrically connected by means of leads, made of electric conductive material, 80A, 82A, 84A, 86A, 80B, 82B, 84B and 86B, respectively.

However, as noted above, the conventional distributor having such a structure generates more noise than the first structure in which insulating conduits are

formed vertically on the distributor cap. That is, the leads are relatively long so that they act as antennae which radiate effectively the noise generated by the discharge between the rotating electrode and the side electrode. For instance, if the length of a lead increases 1 cm, the noise level will increase by about one decibel. Referring to Fig. 4, there is shown a graph which represents a comparison between the levels of noise generated by the structure of Fig. 1 (refer to the dotted line b) and that of Fig. 2 (refer to the solid line a). According to this graph, the solid line a is about 5 dB high than the dotted line b.

Fig. 5(a) is a schematic cross-sectional view of a first embodiment according to the present invention. This embodiment includes an electrically conductive element comprising connector 60B, lead 86B and electrode 76B and is shown in the state before assembly of the distributor cap. In the following figures, identical reference numerals denote corresponding elements or parts so that descriptions will not be repeated.

This first embodiment further comprises an electrically resistive member 88 inserted between the connector 60B and the lead 86B. The electrically resistive member 88 can be a carbonaceous-composition-type resistor, a carbon-coated resistor or a metal wire coil resistor. The resistive member 88 is electrically connected to the lead 86B and the connector 60B through solder joints 90 and

92. In order to protect the resistive member from pressure when the electrically conductive elements are molded in the distributor cap 40, the resistive member 88 is pre-molded in resin 94. Fig. 5(b) is a side view of the embodiment of Fig. 5(a).

Referring to Figs. 6(a), 6(b) and 6(c), there is shown a second embodiment of the present invention. Fig. 6(a) and Fig. 6(b) are a cross-sectional plan view and a cross-sectional side view, respectively. Fig. 6(c) is a partially-enlarged view of Fig. 6(b). In this second embodiment, the lead 86B is replaced by an electrically resistive member which comprises an insulating base plate 96 and a resistive layer 98 provided thereon. The resistive member is electrically connected to the connector 60B and the electrode 76B by means of solder joints 90 and 92 and clamps 100 and 102. The insulating base plate 96 is made of a ceramic or a heat-resistant resin. The resistive layer 98 is formed on the plate 96 by means of printing and calcination of a thermosetting resistive paste or vacuum evaporation or injection molding of resistive material. Further, the resistive member is covered by resin 94 in the same manner as the first embodiment.

Referring to Fig. 7, there is shown a third embodiment of the present invention. The resistive member 104 used for this embodiment is made of a core of graphite fiber coated with a resin 94 in a suitable shape, such as that of the lead 86B. The resistive member 104 is

electrically connected between the connector 60B and the elecrode 76B in such manner that the ends of graphite fiber core 104 overlapping the ends of connector 60B and the electrode 76B are secured by clamps 106 and 108, respectively. Further, if conductive needles 110 connected to the clamps are inserted into the ends of the graphite fiber core 104, the connections between the core 104 and the connector 60B and the electrode 76B will be further improved.

Though the shape of the lead member is changeable in accordance with number of cylinders or ignition plugs and the type of ignition system, any shape of the lead member can be replaced by a resistive member in the manner stated above. Thus, the electrically conductive element containing the resistance member can be arranged and molded into the distributor cap in the conventional manner.

Further, the electrically resistive member can also be an electrically conductive rubber of suitable resistivity or a resin containing densely dispersed metal powders.

Assuming that the total resistance value of the resistive member 88 in Fig. 5 is in the range of 1 KΩ to 10 KΩ the resistive member 88 will function as a localized resistor along the lead 86b. On the other hand, assuming that the resistance value per length of the resistive members in Figs. 6 and 7 is about 10 to 20 KΩ/m. substantially the same effects as with a resistive high-

voltage cable will be obtained. These resistive members will form a frequency filter in conjunction with the dispersed capacitance of the lead 86b so that high frequency noise will be attenuated, thereby decreasing the radiation of noise from the lead members.

Fig. 8 is a graph containing comparative data with respect to the noise levels radiated from a conventional distributor and the distributor of the present invention. In the figure, 0 decibels is equivalent to 1 μV/m/kHz. The curve (1) represents the result from the conventional distributor according to Fig. 2, in which the length of the longest lead member is about 10 cm. The curve (2) represents the result from the currently-disclosed distributor, which is of substantially the same structure except for replacement of the lead members by similarly-shaped lead members prepared as shown in Fig. 5 (the total resistance; 5 KΩ). The curve (3) represents the result from the disclosed distributor according to Fig. 6 (the average resistivity; 5 KΩ/10 cm). The measuring conditions are as follows:

The internal combustion engine speed ---1500 rpm

The distance between the vehicle provided with the engine acting as a test noise source and the antenna acting as a test noise receiver --- 10m

The height of the antenna --- 3m

The type of the antenna --- Log periodic antenna

The measurement was carried out under the

condition that the noise level from the ignition plugs and the high voltage cable was relatively weak, when compared to that of the distributor.

As can be understood from Fig. 8, the distributor according to Fig. 5 shows excellent noise preventive characteristics in the lower frequency range, and the distributor according to Fig. 6 shows excellent characteristics in the higher frequency range. Either distributor can reduce the noise level by about 5 to 15 decibels.

As stated above, according to the present invention, since the lead members, which are most likely to generate noise, are replaced by lead members having electrical resistance, the noise generated by electrical discharge can be reduced by the filtering effect of the resistance, thereby decreasing the radiation of noise from the distributor.

In addition to the above noise-reducing effect, which are common to all embodiments of the present invention, the structures according to Figs. 6 and 7 can be used for the distributor in which the lead members are closely packed since the resistive members can be formed into thin plates. Further, the resistive leads of the present invention have a less deleterious effect on the insulation between lead members. The resistance members according to Figs. 6 and 7 are relatively long so that they are less influenced by self-induced capacitance.

Accordingly, the distributor constructed according to Figs. 6 and 7 can effectively prevent the radiation of high frequency noise.

It will be understood by those skilled in the art that the foregoing description is in terms of preferred embodiments of the present invention wherein various changes and modifications may be made without departing from the spirit and scope of the invention, as set forth in the appended claims.

WHAT IS CLAIMED IS:

1. A distributor for an internal combustion engine, comprising;

first means for electrically connecting a central electrode and a connector which can engage with one end of high-voltage cable connected to an ignition coil, at least part of the first means being made of electrically resistive material; and

second means for electrically connecting a peripheral electrode and a connector which can engage with one end of high-voltage cable connected to an ignition plug, at least part of the second means being made of electrically resistive material.

2. A distributor according to claim 1, wherein said first and second means comprise in part a discrete resistor.

3. A distributor according to claim 1, wherein said first and second means comprise an electrically resistive member which comprises an insulating base plate and a resistive layer provided thereon.

4. A distributor according to claim 1, wherein said first and second means comprise an electrically resistive member comprising a graphite-fiber core.

5. A distributor according to claim 1, wherein said first and second means comprise an electrically resistive member made of an electrically conductive rubber.

6. A distributor according to claim 1, wherein said first and second means comprise an electrically resistive member comprising resin and metal powder densely dispersed therein.

7. A distributor according to claim 2, wherein the discrete resistor is a discrete resistor of carbonaceous composition.

8. A distributor according to claim 2, wherein the discrete resistor is a conductive-wire coil.

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**FIG.1** PRIOR ART

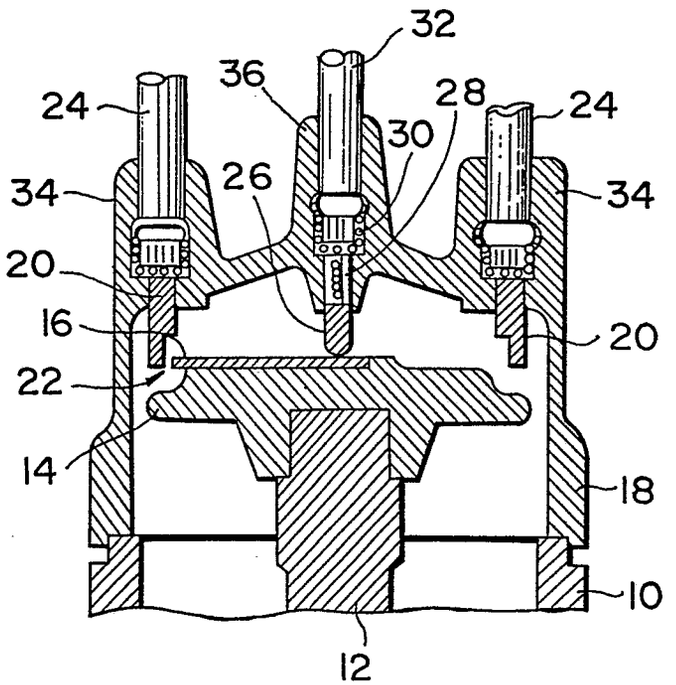


**FIG.4** PRIOR ART

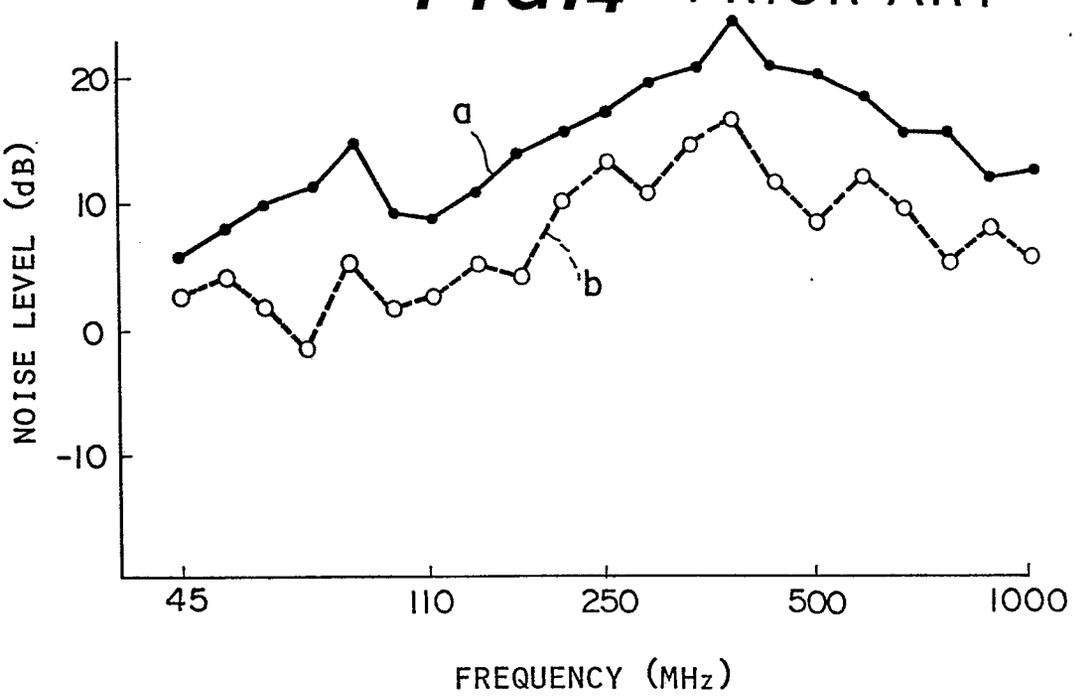

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FIG.2 PRIOR ART

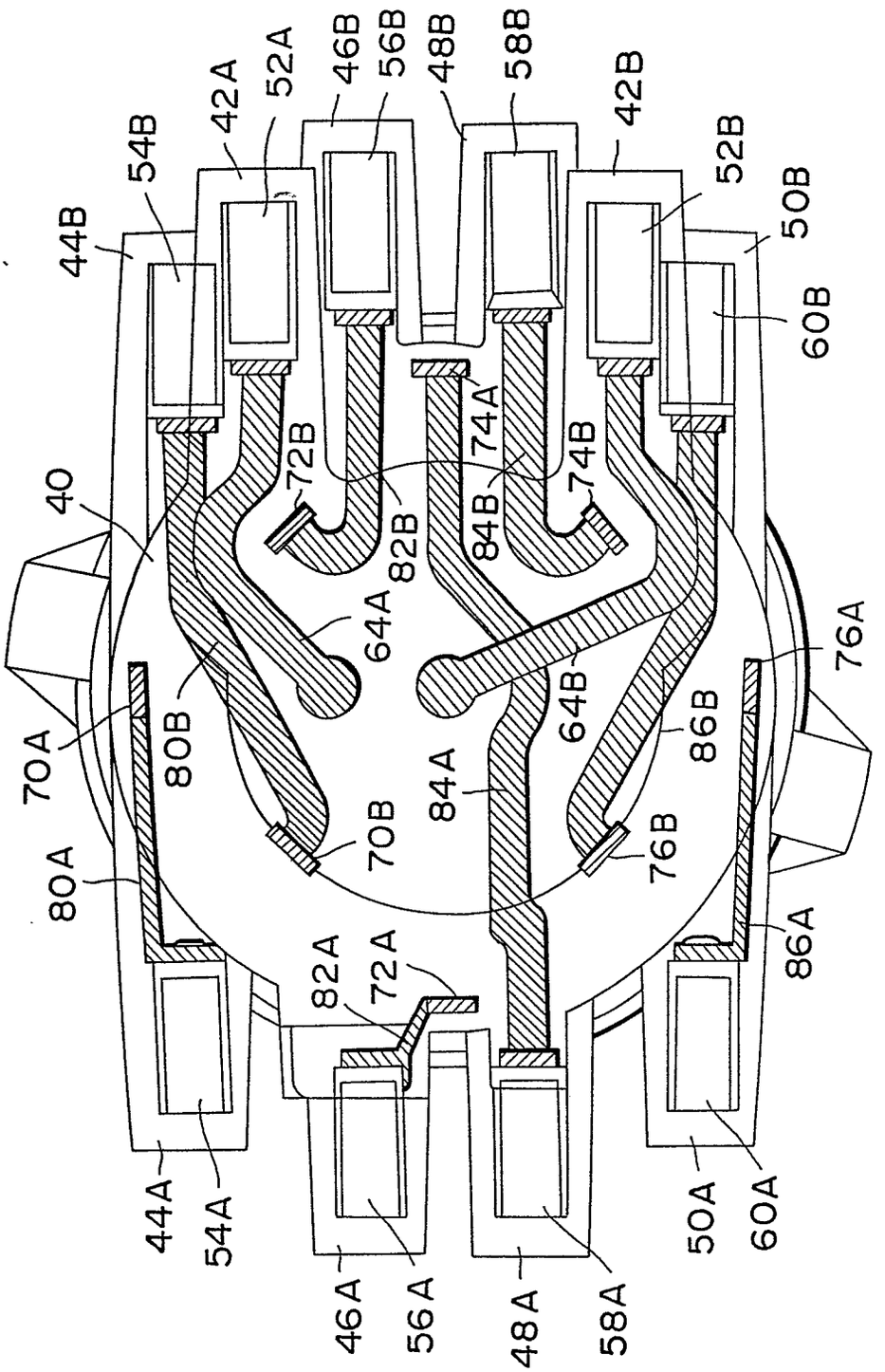


FIG.3 PRIOR ART

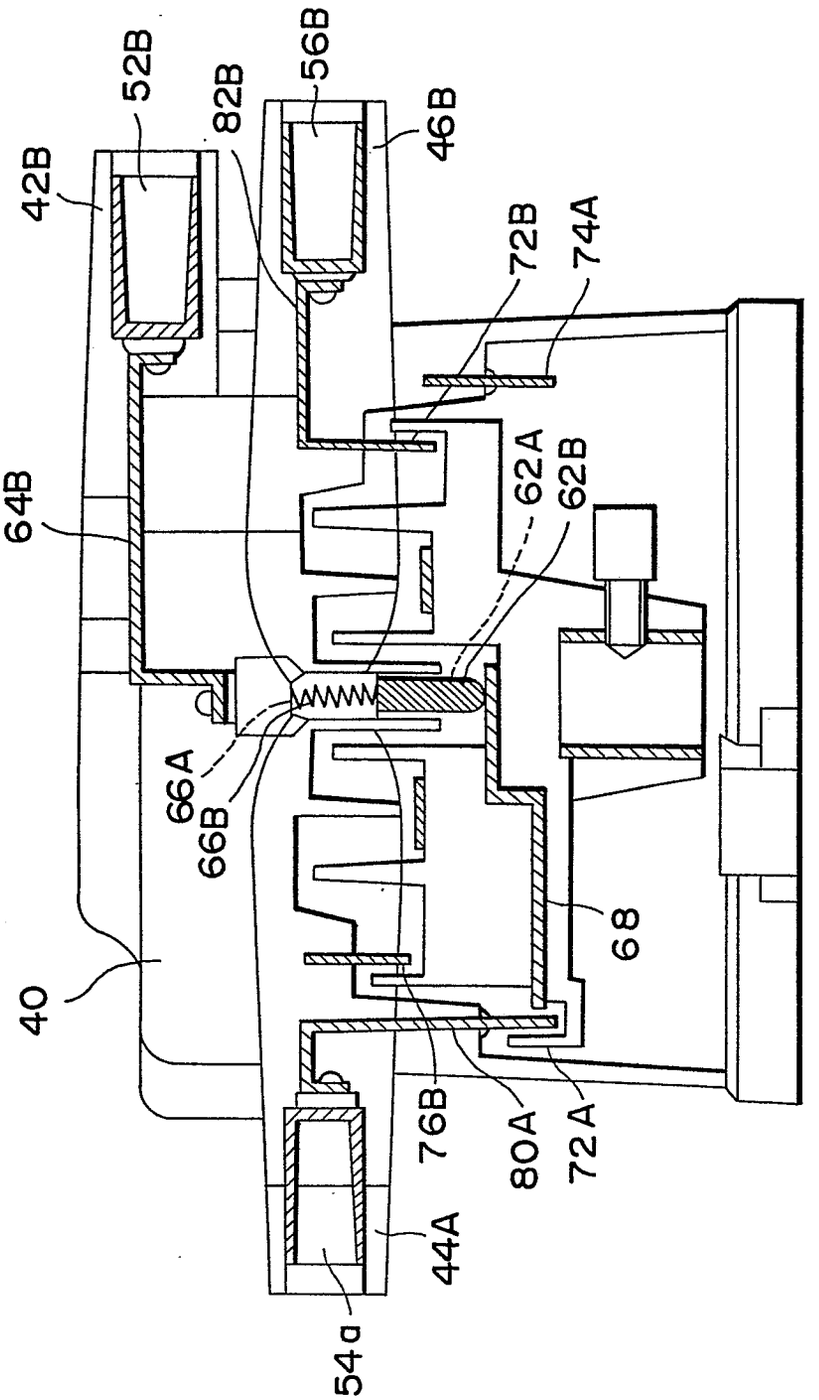
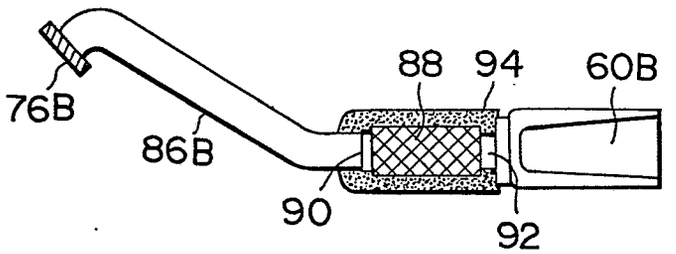


FIG. 5

(a)




(b)

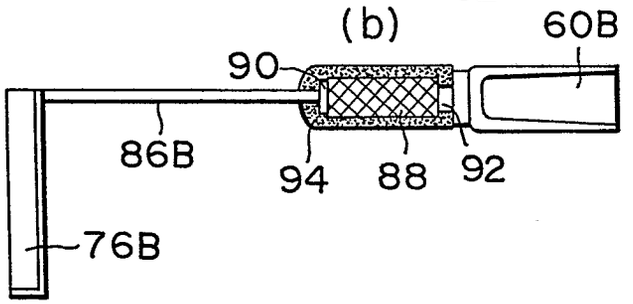
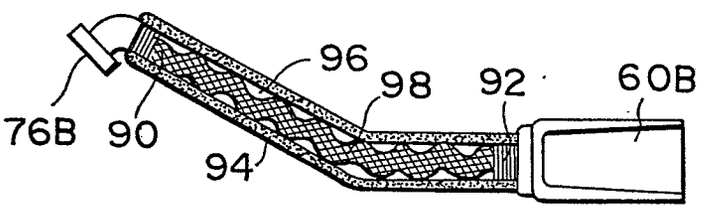
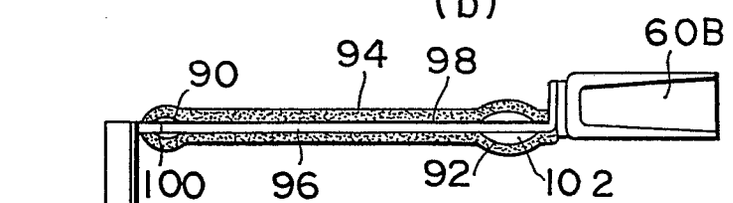



FIG. 6

(a)




(b)




(c)

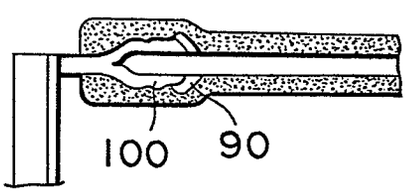


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FIG.7

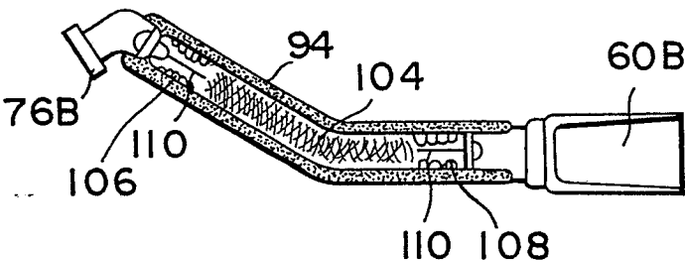
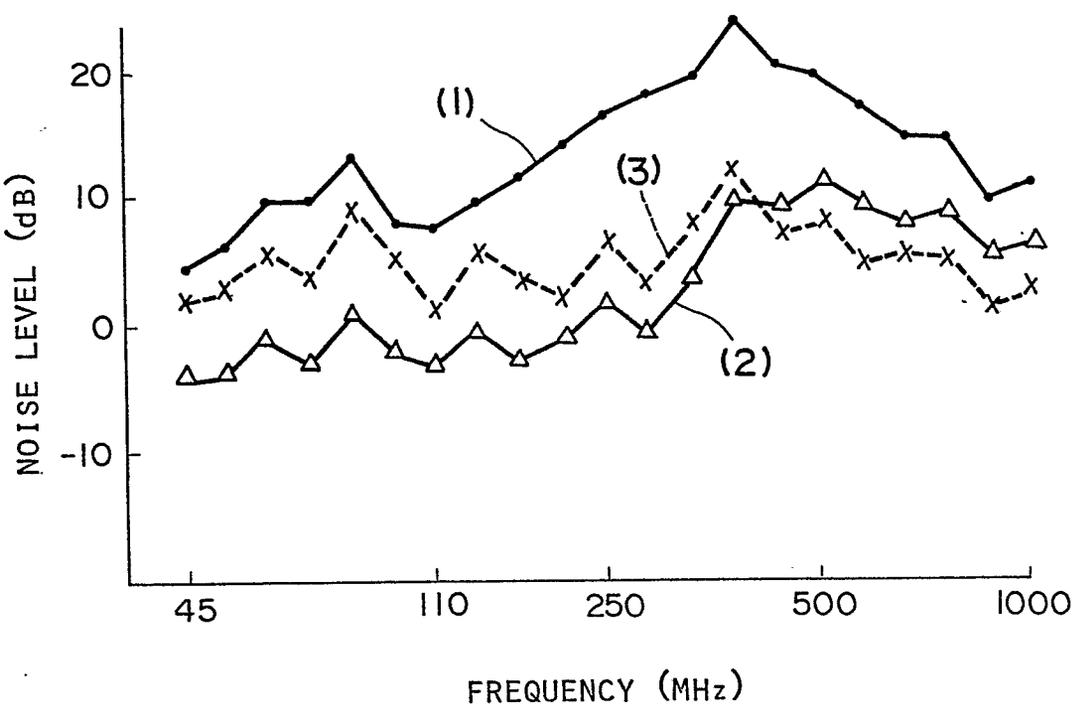



FIG.8



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# EUROPEAN SEARCH REPORT

Application number
EP 82 10 0244.1

| DOCUMENTS CONSIDERED TO BE RELEVANT | | | CLASSIFICATION OF THE APPLICATION (Int. Cl. 3) |
|---|---|---|---|
| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | |
| Y | DE - A - 2 005 195 (R. BOSCH GMBH)<br>* claim 1; fig. 1 *<br>& GB - A - 1 276 996<br>-- | 1,2 | F 02 P 7/02<br>H 01 R 39/60 |
| Y | US - A - 3 404 245 (E. KOHLER)<br>* column 2, lines 40 to 56; fig. 1 *<br>-- | 1,2 | |
| Y | FR - A - 886 175 (R. BOSCH GMBH)<br>* page 1, lines 5 to 29; fig. 1 *<br>-- | 1,2 | TECHNICAL FIELDS SEARCHED (Int.Cl. 3) |
| A | FR - A1 - 2 369 437 (R. BOSCH GMBH)<br>* page 1, lines 12 to 27; page 2, lines 9 to 40; page 5, lines 22 to 28; fig. 1, 2 *<br>& US - A - 4 217 470<br>-- | 2,3 | F 02 P 7/00<br>H 01 R 39/60 |
| A | FR - A1 - 2 361 548 (NISSAN MOTOR CO.)<br>* claim 1; page 2, lines 7 to 20; fig. 1, 2 *<br>& US - A - 4 146 759<br>---- | 3 | |

CATEGORY OF CITED DOCUMENTS

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X The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Berlin | 01-04-1982 | ROUSSEL |