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(54) **Ignition coil assembly**

(57) An ignition coil assembly (10) for an internal combustion engine comprises a plastic housing (14) in which a primary winding (20), a secondary winding (22) and a magnetic core (18) are accommodated. A high-tension terminal (28) connected to a first end of the secondary winding (22) is provided for connecting a spark plug (12) of the engine. The plastic housing (14) further comprises fixing means (44) for fixing the ignition coil assembly (10) to the engine. The fixing means (44) comprise an electrically conductive portion (48) that comes into contact with an electrically conductive part of the engine upon fixing thereto. The second end of the secondary winding (22) is connected to the electrically conductive portion (48) of the fixing means (44).

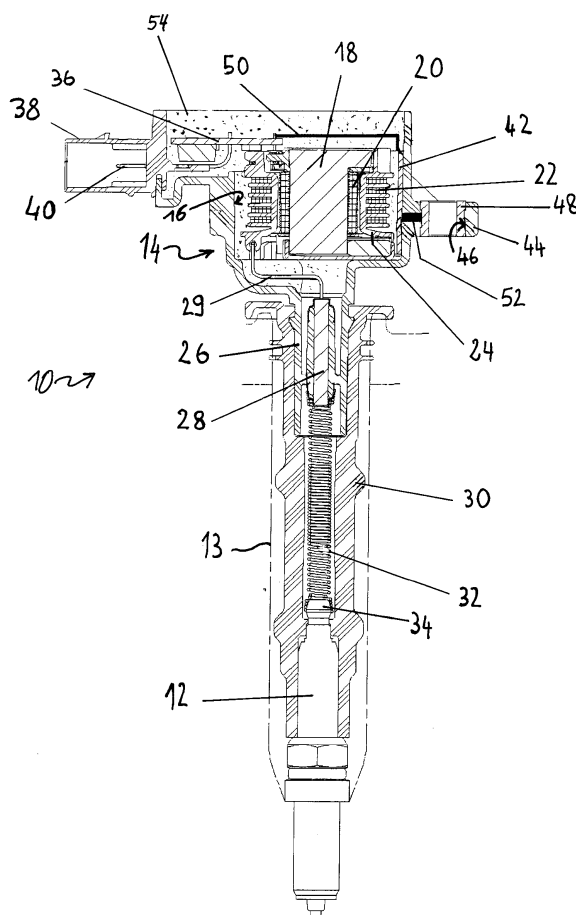


Fig. 1

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Description**FIELD OF THE INVENTION**

[0001] The present invention generally relates to an ignition coil assembly.

BACKGROUND OF THE INVENTION

[0002] Traditionally, gasoline engines have used ignition systems including one single coil to control all of the spark plugs, via e.g. a mechanical distributor, generally of the kind having a rotary distributor arm. Such a system has the drawback that it necessitates a bundle of high-tension cables which connect the secondary of the ignition coil to the distributor, and the distributor to each of the spark plugs. Such cables must be heavily insulated to contain the voltage and must also be coated with an outer jacket that can withstand high temperatures and chemical attack. Apart from the cost of the bundle of cables, the latter is subject to electrical losses, which give rise to substantial electromagnetic interference (EMI).

[0003] In order to overcome the above disadvantages, it has been proposed to associate one ignition coil per spark plug. In this technology, often referred to as "coil per cylinder ignition", "coil on plug" or "plug top coil", an ignition coil assembly is mounted on top of each spark plug in the engine. Such an ignition coil assembly generally comprises a central magnetic core around which two spools of plastic material are arranged coaxially. Primary and secondary windings are wound on these spools, and these components are integrated into a housing, into which they are encapsulated by moulding over with plastic material. The bottom of the housing normally has a connecting portion, in which a high-tension terminal is accommodated for connection to the spark-plug. In the housing, this high-tension terminal is connected to a first end of the secondary winding. The housing is further provided with fixing flanges for its mounting to the engine block.

[0004] Such an ignition coil assembly typically also includes a metallic shield enclosing the windings to close the magnetic circuit, as well as a driving circuit. The housing has a connector part for connection to an associated cable bundle, which delivers the power for exciting the primary winding. One pin of this connector is connected to the opposite, second end of the secondary wiring, so as to provide a ground connection.

[0005] Although such an ignition coil assembly of the "plug top coil" type allows to reduce the electromagnetic interference with regard to the conventional, single-coil ignition system, vehicle manufacturers are still demanding for a reduction in the radiated emissions to ensure disturbance-free operation between the various electrical devices in- and outside the vehicle.

OBJECT OF THE INVENTION

[0006] The object of the present invention is to provide an improved ignition coil assembly that causes less electromagnetic interference. This object is achieved by an ignition coil assembly as claimed in claim 1.

SUMMARY OF THE INVENTION

[0007] An ignition coil assembly in accordance with the invention comprises a primary winding, a secondary winding and a magnetic core. The primary and secondary windings are coaxially arranged around the magnetic core. The primary and secondary windings as well as the magnetic core are accommodated in a plastic housing, which further comprises a fixing means for fixing to an engine. A high-tension terminal is connected to a first end of the secondary winding for connecting a spark plug of the engine.

[0008] According to an important aspect of the invention, the fixing means comprises an electrically conductive portion, which permits an electric contact with the engine upon fixing thereto. The secondary winding has an opposite second end, which is connected to the electrically conductive portion of the fixing means.

[0009] Hence, upon fixing of the ignition coil assembly to the engine, the second end of the secondary winding is directly put to ground, via the fixing means. This eliminates the need for a special ground cable in the cable bundle that is typically associated with such an assembly of the "plug top coil" type. As a result, the secondary return path used in the ignition coil assembly of the invention is extremely short, thereby minimising the electromagnetic noise generated by the coil assembly. In addition, the present ignition coil assembly allows simplifying the connector structure and cable harness, by eliminating the need for the secondary winding ground cable, which also leads to cost savings.

[0010] The fixing means may comprise any portion of the plastic housing designed for fixing, e.g. with a hole, this fixing portion also preferably integrating a metallic element connected with the second end of the secondary winding and that comes into contact with the engine upon fixing thereto.

[0011] In a preferred embodiment, the fixing means comprises a plastic flange portion integrally formed with the plastic housing, the flange portion having a bore therein and a metallic mounting bushing integrated in the bore. The second end of the secondary winding is connected to the metallic mounting bushing. Hence, the metallic mounting bushing has a double function: firstly, to reinforce the fixing means by providing a robust portion of the housing and secondly, to provide a ground connection by contact with the engine block. A preferred metal for the mounting bushing is brass.

[0012] To close the magnetic circuit, a metallic shield advantageously surrounds the primary and secondary windings in the housing. In such a case, the second end

of the secondary winding may be connected to the shield and the latter may thus be connected to the electrically conductive portion of the fixing means.

[0013] The housing may further include a connector part for connection to an associated cable bundle, that provides the power for exciting the primary winding. A driving circuit for the primary winding is preferably also integrated in the plastic housing.

[0014] Advantageously, the housing further comprises a plug connecting portion in which the high-tension terminal is accommodated. This plug connecting portion may be adapted to be directly connected to the top of a spark-plug. However, the high-tension terminal of the present ignition coil assembly is preferably connected to the plug via a flexible rubber boot including a conductive spring. The flexible boot has one end attached to the plug connecting portion and the other end adapted for mounting over a spark-plug in the engine.

[0015] The various components accommodated in the housing are preferably encapsulated, to seal the high voltage, keep the components in place and insulate them from each other. This may be done by filling the housing with resin or other adequate synthetic material.

BRIEF DESCRIPTION OF THE DRAWING

[0016] The present invention will now be described, by way of example, with reference to the accompanying drawing, in which:

FIG. 1: is a longitudinal section view through a preferred embodiment of an ignition coil assembly in accordance with the invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0017] Fig.1 shows a preferred embodiment of an ignition coil assembly 10 mounted on top of a spark plug 12 in a plug well (indicated in phantom lines 13) of a gasoline engine. The ignition coil assembly 10 includes a plastic housing 14, which is moulded in such a way as to define a cavity 16, in which a magnetic core 18, a primary winding 20 and a secondary winding 22 are accommodated.

[0018] The primary and secondary winding 20, resp. 22, are preferably coaxially arranged around the magnetic core 18, the secondary winding 22 surrounding the primary winding 20. The primary winding 20 is herein directly wound on the magnetic core 18, but could also be supported by a spool. The secondary winding 22 is wound on a plastic spool 24 enclosing the primary winding 20. The magnetic core 18 is e.g. a plastic-coated sintered iron core with a central part of cylindrical cross-section.

[0019] The plastic housing 14 further includes a plug connecting portion 26, in which a high-tension terminal 28 is accommodated, the high-tension terminal 28 being

connected with a first end of the secondary winding 22 by means of a wire 29. The assembly 10 further comprises a flexible rubber boot 30 attached to the plug connecting portion 26 and fitted over the spark plug 12. Inside the boot 30, a metallic spring 32 is arranged so as to be compressed between the high-tension terminal 28 and the metallic head 34 of the spark plug, whereby electric contact is ensured.

[0020] Reference sign 36 indicates a printed circuit board with a driving circuit for driving the primary winding 20. Accordingly, both ends of the primary winding 20 are connected to the printed circuit board 36, which is e.g. so designed that one end of the primary winding is connected to the driving circuit and the other end to the battery voltage. The housing 14 also includes a connector part 38, with pins 40 (only one can be seen in Fig.1) that are connected to the printed circuit board 36. Connector part 38 is formed as a socket to receive a plug (not shown) from an associated cable bundle, which provides the power required for driving circuit and exciting the primary winding 20.

[0021] Reference sign 42 indicates a metallic shield that surrounds the secondary winding 22 on most of its periphery. The metallic shield is e.g. a cylindrically shaped foil of magnetic steel.

[0022] Fixing of the ignition coil assembly 10 to the engine is carried out by means of fixing means which preferably comprise a fixing flange 44 having a bore 46 therein and a metallic mounting bushing 48, e.g. of brass, integrated in the bore 46. It will be appreciated that the second end of the secondary winding 22—opposite the first end connected to the high-tension terminal 28—is connected to this mounting bushing 48. As a matter of fact, in the present embodiment, the second end of the secondary winding 22 is connected to the mounting bushing 48 via the metallic shield 42. A first wire 50 connects the second end of the secondary winding 22 to the shield 42 and a second wire 52, extending in the plastic flange 44, connects the shield 42 to the bushing 48. A metallic bolt (not shown) is inserted through the mounting bushing and screwed in a threaded bore in the cylinder head so as to firmly fix the assembly 10 to the engine block.

[0023] Upon fixing of the ignition coil assembly, the secondary winding 22 is put to ground. Indeed, the second end of the secondary winding 22 is in electrical contact with the engine block via the first wire 50, the metallic shield 42, the second wire 42, the metallic bushing 48 and the fixing bolt screwed in the cylinder head. Hence, a very short secondary return path is provided via the fixing means, which reduces electromagnetic interferences and further eliminates the need for a special ground cable in the associated cable bundle. It will be noted that this is achieved, although the housing 14 and flange 44 are made of plastic, i.e. non-conductive material.

[0024] It remains to be noted that the components accommodated in the cavity 16 are preferably encapsulat-

ed. This is done by filling the cavity 16—typically under vacuum—with a resin or other adequate synthetic material 54 (symbolised by dots in Fig.1). Although not used in the present embodiment, the cavity may be closed by a cover.

Claims

1. An ignition coil assembly (10) for an internal combustion engine comprising:

a primary winding (20);

a secondary winding (22);

a magnetic core (18), said primary and secondary windings (20; 22) being coaxially arranged around said magnetic core (18);

a plastic housing (14) in which said primary winding (20), said secondary winding (22) and said magnetic core (18) are accommodated, said plastic housing (14) comprising fixing means (44) for fixing said ignition coil assembly (10) to an engine;

a high-tension terminal (28) connected to a first end of said secondary winding (22) for connecting a spark plug (12) of said engine;

characterised in that

said fixing means (44) comprise an electrically conductive portion (48) that comes into contact with an electrically conductive part of said engine upon fixing thereto; and

said secondary winding (22) has an opposite, second end, which is connected to said electrically conductive portion (48) of said fixing means (44).

2. The ignition coil assembly according to claim 1, **characterised in that** said fixing means comprise a portion (44) of said housing designed for fixing, in which a metallic element (48) is integrated, said metallic element (48) being connected to said second end of said secondary winding (22).

3. The ignition coil assembly according to claim 1 or 2, **characterised in that**

said fixing means comprises a flange portion (44) integrally formed with the plastic housing (14), said flange portion (44) having a bore (46) therein and a metallic mounting bushing (48) integrated in said bore (46); and

said second end of said secondary winding (22) is connected to said metallic mounting bushing (48).

4. The ignition coil assembly according to claim 1, 2

or 3, **characterised by** a metallic shield (42) surrounding said primary and secondary windings (20; 22) in said housing (14).

5. The ignition coil assembly according to claim 4, **characterised in that** said second end of said secondary winding (22) is connected to said metallic shield (42) and said metallic shield (42) is connected to said electrically conductive portion (48) of said fixing means (44).

6. The ignition coil assembly according to any one of the preceding claims, **characterised by** a driving circuit in said housing for driving said primary winding (20).

7. The ignition coil assembly according to any one of the preceding claims, **characterised in that** said housing (14) includes a connector part (38) for connection to an associated cable bundle.

8. The ignition coil assembly according to any one of the preceding claims, **characterised in that** said housing (14) comprises a plug connecting portion (26) in which said high-tension terminal (28) is accommodated.

9. The ignition coil assembly according to the preceding claim, **characterised by** a flexible boot (30) having one end mounted to said plug connecting portion (28) and an other end for fitting over a spark plug (12) in said engine.

10. The ignition coil assembly according to any one of the preceding claims, **characterised in that** the components in said housing (14) are encapsulated.

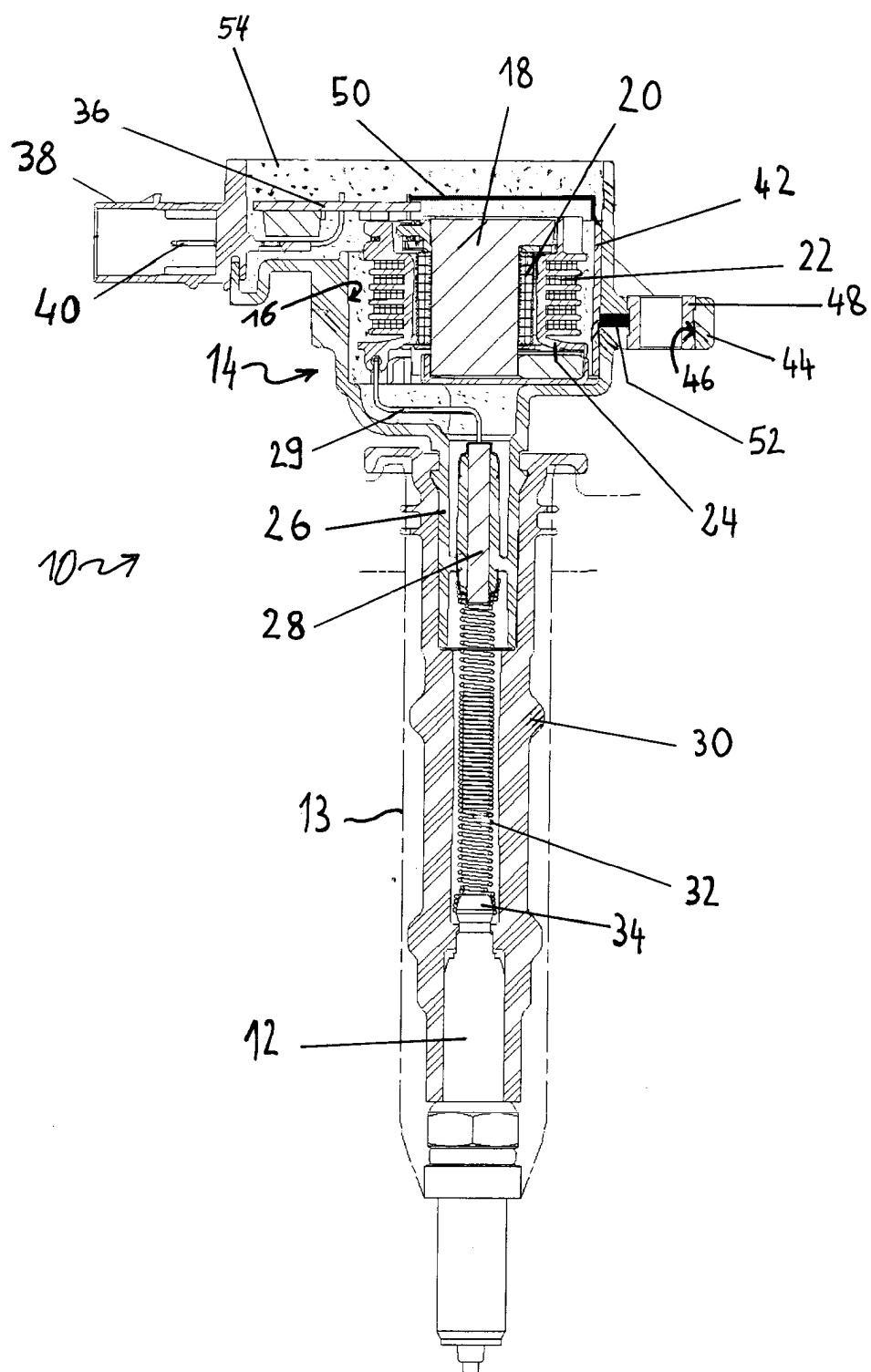


Fig. 1



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EUROPEAN SEARCH REPORT

Application Number
EP 03 10 0660

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 6 August 2003	Examiner Röttger, K
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82