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(54) Ignition Coil

(57) This invention relates to an ignition coil for the engine of a vehicle. The ignition coil comprises a core member (18) having a number of layers wrapped around it. The formation of these layers from the core member outward comprises a secondary support spool (22), a secondary coil (24), a primary support spool (28) and a primary coil (32). Resilient thermal expansion de-coupling means (30) is provided between at least one of the primary and secondary coils (32, 24) and its or their corresponding support spool or spools (28, 22). The thermal expansion de-coupling means (30) allows each layer to expand and contract substantially independently of one another. This reduces the stress exerted on each layer as it is heated/cooled which increases the overall lifetime of the ignition coil.

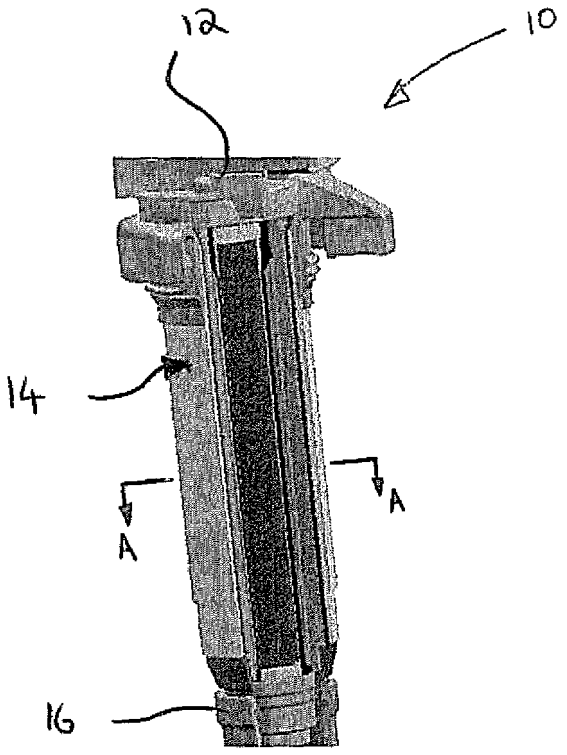

Fig. 1

EP 1 780 737 A1

Description

[0001] The present invention relates to ignition coils, particularly, but not exclusively, ignition coils which are directly attached to the spark plugs of internal combustion engines.

[0002] Independent ignition coils (also known as "pencil-type coils") are commonly mounted directly to the spark plugs of an internal combustion engine. Such coils typically include co-axially arranged secondary and primary coils which are wound around respective support spools. Each coil is typically attached to the support spool by way of a resin which holds them in place during assembly and operation.

[0003] Pencil-type coils are normally mounted very close to the engine combustion chambers and are therefore subjected to a continual heating/cooling cycle throughout their operational lifetime. The variation in the thermal expansion properties of the co-axially arranged materials in the ignition coil can cause stresses and strains within the coil which result in components breaking over time. This produces reliability problems.

[0004] According to the present invention there is provided an ignition coil comprising:

a core member;
a secondary support spool around the core member;
a secondary coil around the secondary support spool;
a primary support spool around the secondary coil; and
a primary coil around the primary support spool, wherein resilient thermal expansion de-coupling means is provided between at least one of the primary and secondary coils and its or their corresponding support spool or spools.

[0005] Preferably, the resilient thermal expansion de-coupling means is provided between the first coil and first support spool. Optionally, the resilient thermal expansion de-coupling means is provided between the second coil and second support spool.

[0006] Preferably, the resilient thermal expansion de-coupling means comprises a resilient sheath buffer capable of expanding and contracting in a radial direction i.e. normal to the co-axis. More preferably, the resilient sheath buffer is also capable of movement in an axial direction. Preferably, said movement in the axial direction is a result of relative axial movement between the primary coil and primary support spool.

[0007] Typically, the material comprising the resilient thermal expansion de-coupling means comprises a material having a Young's Modulus in the region of 10 to 100Mpa at approximately 170°C and typically has a wall thickness in the region of 0.1 to 0.5 mm.

[0008] Preferably, the resilient sheath buffer is provided with a radial protrusion adjacent at least one end of the resilient sheath buffer such that resilient axial movement of the primary coil relative to the primary support spool is possible.

[0009] Typically, the primary support spool comprises a tubular synthetic member around which the resilient thermal expansion de-coupling means and primary coil may be arranged.

[0010] Typically, the secondary support spool comprises a tubular synthetic member around which the secondary coil may be wound.

[0011] Preferably, a shrink tube is provided around the core member.

[0012] Embodiments of the present invention will now be described, with reference to the following figures, in which:-

Fig. 1 is a isometric partial cut-away view of an ignition coil according to the present invention;
Fig. 2 is a cross section of the co-axial layers of the apparatus of Fig. 1 taken along the view A-A;
Fig. 3 is a more detailed view of the lower portion of the ignition coil shown in Fig. 1; and
Fig. 4 is a isometric view showing a section of the co-axial layers shown in Fig. 2.

[0013] An ignition coil unit 10 comprises an ignition circuit case 12 which houses the coil circuitry (not shown), a core housing 14 and a boot 16 which allows connection to a spark plug (not shown).

[0014] Referring to Fig. 2, co-axial layers within the core housing 14 comprise a core member 18, shrink tube 37, epoxy resin layer 20, secondary support spool 22, secondary coil 24, epoxy insulation layer 26, primary support spool 28, resilient thermal expansion de-coupling buffer 30, primary coil 32 and casing 34. An outer protective sheath 36 (Fig. 3) is also provided around the mid-section of ignition coil 10.

[0015] The core member 18 is typically formed from an elongate silicon steel member.

[0016] The secondary support spool 22 is typically a tube formed from a synthetic resin and houses the core member 18 therein via a shrink tube 37 and a layer of epoxy resin 20. In addition to its securing properties, the layer of resin 20 also provides electrical insulation between the core member 18 and the outer coils 24, 32.

[0017] Secondary coil 24 is formed from a wire wound around the secondary support spool 22 thousands of times. In the present embodiment the wire has approximately 1500 turns.

[0018] The epoxy insulation layer 26 and shrink tube 37 act as electrical insulators between the primary and secondary coils.

[0019] Primary support spool 28 is positioned around the epoxy insulation layer 26 and may be held to some extent thereby. The primary support spool 28 is similar in construction to the secondary support spool 22 with appropriate dimensional modifications; however, a lip L also projects radially outward from the outer circumference of the primary support 28. This lip L allows secure

abutment against a shoulder 35 of the casing 34 and provides a gap A between the shoulder 35 and the coil 32 / buffer 30 as discussed subsequently.

[0020] The resilient thermal expansion de-coupling buffer 30 comprises any material (such as silicon rubber) which is capable of withstanding the heating conditions of the surrounding environment and which is capable of expanding and contracting to accommodate the differential expansion and contraction of the components surrounding it. In this regard, the buffer may typically comprise a sleeve having a wall thickness of between 0.1mm and 0.5mm and a Young's Modulus of 10 to 100 MPa at 170°C.

[0021] A radially extending protrusion P is provided around the lower circumference of the buffer 30 as shown in Fig. 3. This sits against the upper surface of lip L and resiliently supports coil 32 as discussed subsequently.

[0022] Primary coil 32 is formed by a wire wound around the buffer 30 and primary support spool 28 many hundreds of times. In the present embodiment, the wire is provided with approximately 200 turns. Primary coil 32 typically has a lower co-efficient of thermal expansion than the rest of the components in the ignition coil 10 and the effects of this will be discussed subsequently.

[0023] In use, as the ignition coil 10 heats up from an initial cold state, each of the co-axial layers described will expand in the axial direction (Ax in Fig. 3) and radial direction (Ra in Fig. 3) according to their respective co-efficient of thermal expansion. The primary wire may be regarded as a composite material since it comprises copper wire combined with an epoxy. This results in a composite material which has a co-efficient of thermal expansion that is significantly less than that of the other layers. However, the buffer 32 is able to accommodate these differences in expansion of the layers by radially expanding or contracting as required. In addition, the protrusion P of the buffer in conjunction with the support provided by lip L allows resilient relative axial movement between the primary coil 32 and primary spool 28 to occur. Such a protrusion P may be provided at either or both of the high voltage and low voltage ends of the ignition coil 10.

[0024] The expansion and compression of the buffer 30 therefore allows stresses between the primary coil 32 and primary support 28 (which would otherwise occur during heating and cooling of the ignition coil 10) to be alleviated. This de-coupling of stresses increases the longevity and reliability of the ignition coil 10.

[0025] Modifications and improvement may be made to the foregoing without departing from the scope of the invention, for example:

[0026] Although, the embodiment described only has a buffer 30 between the primary coil 32 and the primary support spool 28 it would be possible to have a buffer between the secondary coil and the secondary support if desired. In addition, it would be possible to arrange the primary coil inside of the secondary coil.

Claims

1. An ignition coil comprising:

a core member (18);
a secondary support spool (22) around the core member (18);
a secondary coil (24) around the secondary support spool (22);
a primary support spool (28) around the secondary coil (24); and
a primary coil (32) around the primary support spool (28), wherein resilient thermal expansion de-coupling means (30) is provided between at least one of the primary and secondary coils (32, 24) and its or their corresponding support spool or spools (28, 22).

2. An ignition coil according to claim 1, wherein the resilient thermal expansion de-coupling means (30) is provided between the primary coil (32) and primary support spool (28).

3. An ignition coil according to either of claims 1 and 2, wherein the resilient thermal expansion de-coupling means (30) is provided between the secondary coil (24) and secondary support spool (22).

4. An ignition coil according to any preceding claim, wherein the resilient thermal expansion de-coupling means comprises a resilient sheath buffer (30) capable of expanding and contracting in a radial direction.

5. An ignition coil according to claim 4, wherein the resilient sheath buffer (30) is also capable of movement in an axial direction where said movement in the axial direction is a result of relative axial movement between the primary coil (32) and primary support spool (28).

6. An ignition coil according to any preceding claim, wherein the material comprising the resilient thermal expansion de-coupling means (30) comprises a material having a Young's Modulus in the region of 10 to 100Mpa at approximately 170°C.

7. An ignition coil according to claim 6, wherein the material comprising the resilient thermal expansion de-coupling means (30) further has a wall thickness in the region of 0.1 to 0.5 mm.

8. An ignition coil according to any of claims 4 to 7, wherein the resilient sheath buffer (30) is provided with a radial protrusion (P) adjacent at least one end of the resilient sheath buffer (30) such that resilient axial movement of the primary coil (32) relative to the primary support spool (28) is possible.

9. An ignition coil according to any preceding claim, wherein the primary support spool (28) comprises a tubular synthetic member around which the resilient thermal expansion de-coupling means (30) and primary coil (32) may be arranged.

10. An ignition coil according to any preceding claim, wherein the secondary support spool (22) comprises a tubular synthetic member around which the secondary coil (24) may be wound.

11. An ignition coil according to any preceding claim, wherein a shrink tube (37) is provided around the core member (18).

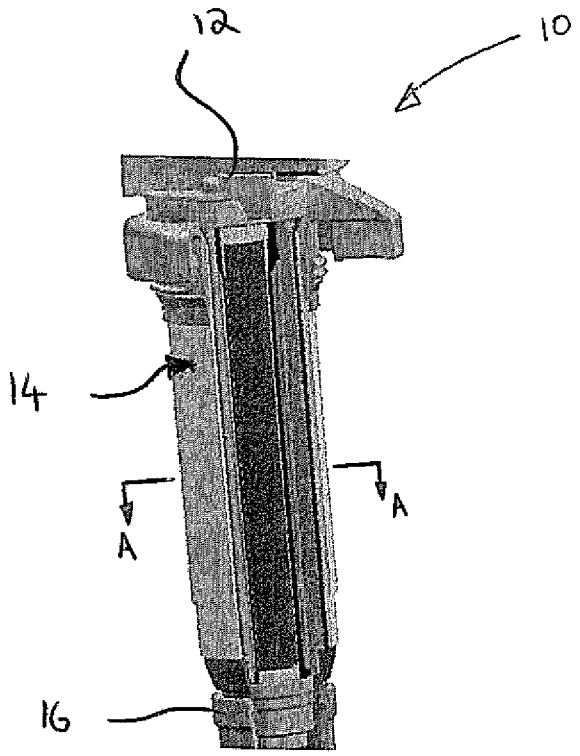

Fig. 1

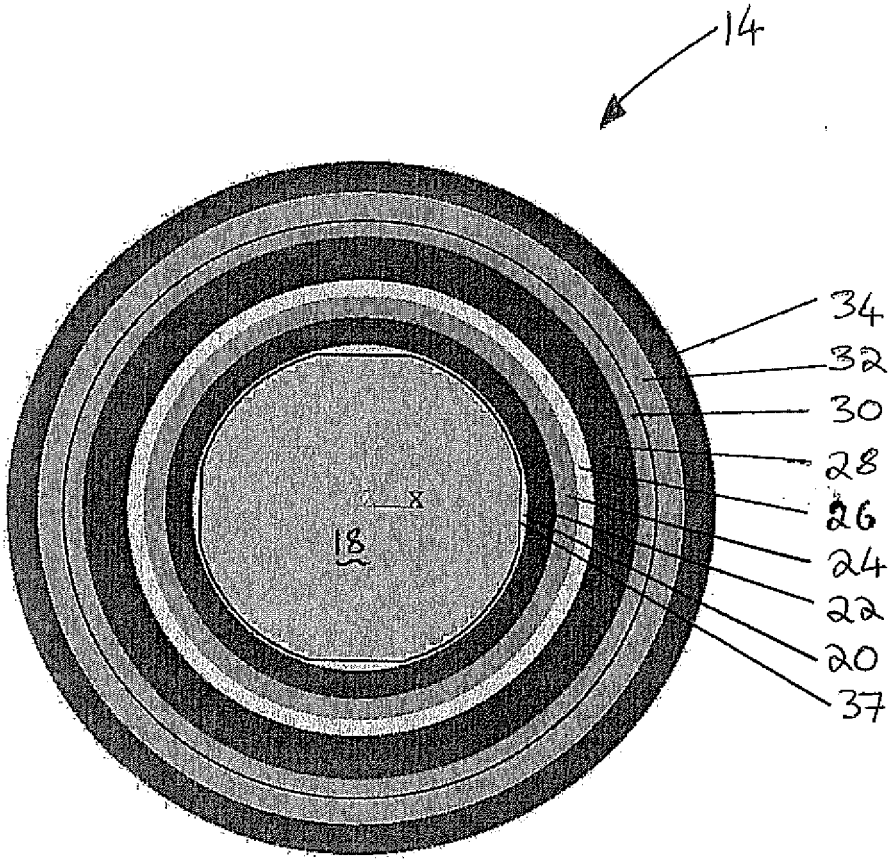

Fig. 2

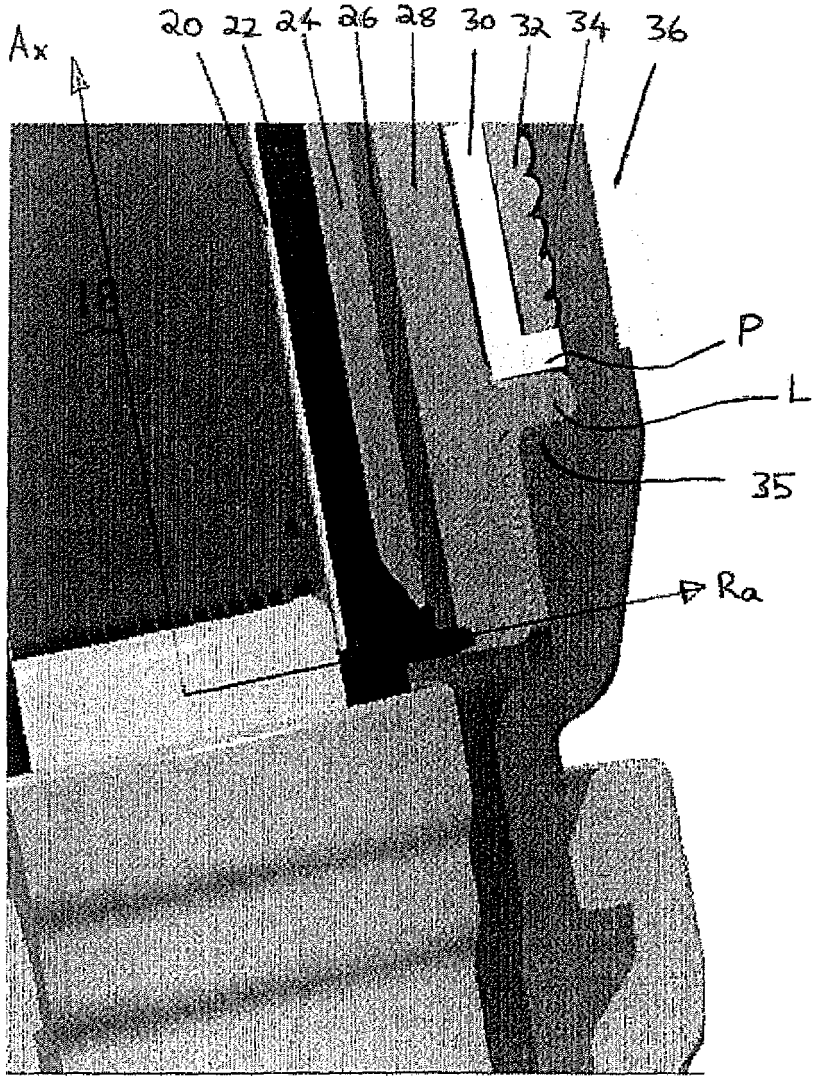

Fig. 3

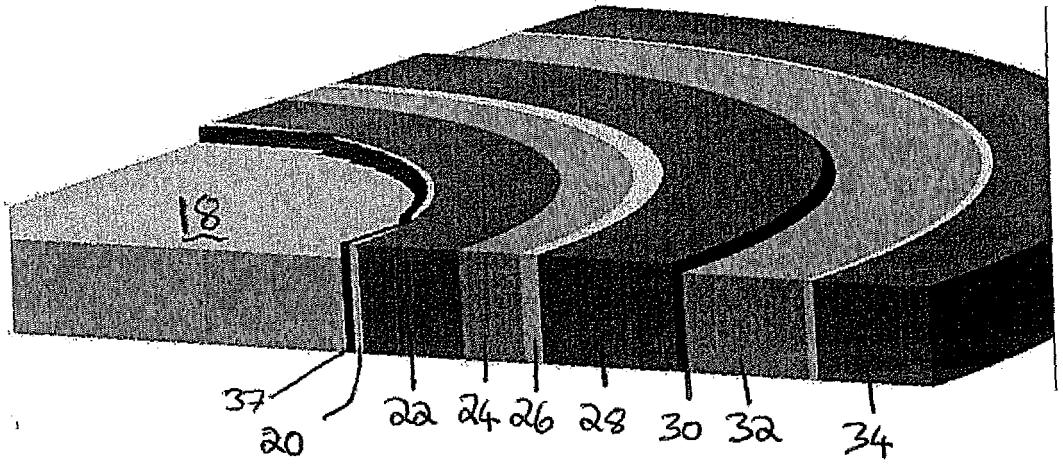

Fig. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 27 0043

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 March 2007	Ulivieri, Enrico

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X : particularly relevant if taken alone
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