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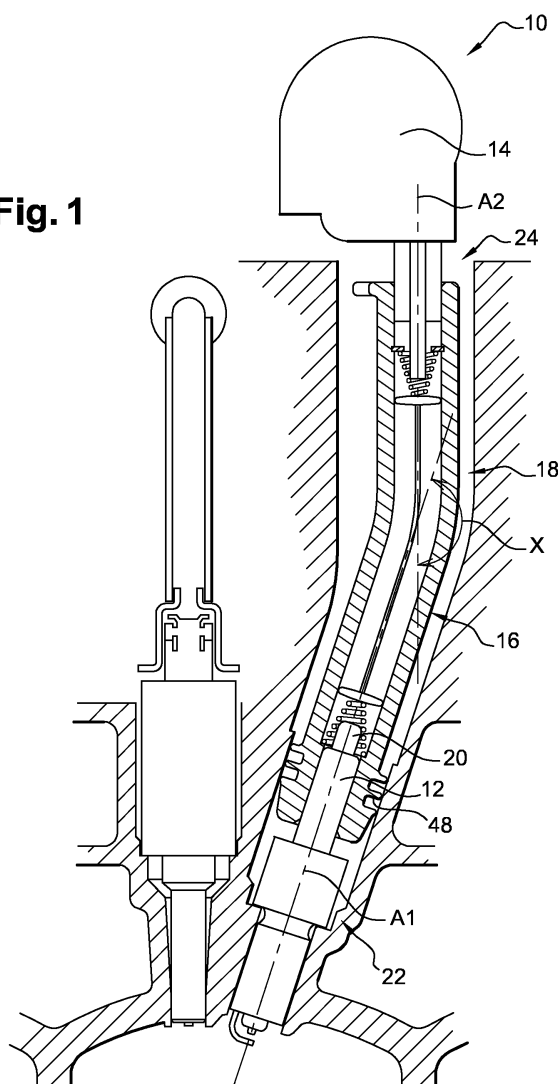
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(54) **Spark plug connector**

(57) Spark Plug Electrical Connector for connecting an ignition coil to a spark plug especially for use with an engine in which a spark plug is located within a deep and bent well while the ignition coil is outside the well, the connector comprising an electrically insulating tubular boot inside of which is an electrically conductive means connecting the coil to the spark plug. To accommodate the bent well the electrically conductive means is bent accordingly and serves as a strengthening member extending from the spark plug end to the coil end.

Fig. 1



Description

TECHNICAL FIELD

[0001] This invention relates to a spark plug connector for an internal combustion engine.

BACKGROUND OF THE INVENTION

[0002] Spark plugs are known to have a male terminal protruding from a ceramic portion. A high voltage ignition wire terminal is press fitted and thereby sits onto the male terminal of the spark plug. This high voltage electrical connection is surrounded by an elastomeric, electrically insulating boot which is integral to the ignition wire protruding from the spark plug and fits snugly around the upper ceramic portion of the spark plug. In addition to the boot's insulating characteristics, the boot also assures that the high voltage electrical connection remains clean and free of moisture thereby providing a strong and efficient spark within the combustion chamber.

[0003] In today's complex engines, the spark plug is often positioned into a deep well typically surrounded by an electrically grounded and heat dissipating engine block. After insertion into the well the spark plug is threadably engaged to the engine block.

[0004] The latest's engines have an even more complex and compact design resulting in a non straight spark plug well, the well presenting a small bend. To accommodate the bent well, the spark plug connectors are bent accordingly. To properly assemble the connector onto the spark plug, one common solution is an external handle that enables the operator to firmly engage the soft boot onto the spark plug terminal ensuring a correct electrical connection. As a consequence, the state of the art product is complex, costly and requires space to accommodate for the connector and for the external handle.

SUMMARY OF THE INVENTION

[0005] The object of the present invention is to resolve these problems by proposing a connector simple in design, cheaper and more compact. More specifically, the invention proposes a spark plug electrical connector for connecting an ignition coil to a spark plug of an engine in which a spark plug is located within a well, the connector comprising an electrically insulating tubular boot having a spark plug open end and a coil open end and inside of which are an electrically conductive means connecting the coil to the spark plug and a strengthening member extending substantially from the spark plug open end to the coil open end.

[0006] Additional advantageous features of the inventions are that:

the strengthening member is an element of the electrically conductive means. The strengthening member is an elongated rod having a first end oriented

toward the spark plug and a second end oriented toward the coil:

the connector makes at least one bend between the spark plug open end (36) and the coil open end, this in order to accommodate the bend of the well;

the rod is bent;

the electrically conductive means comprises a first spring connected to the spark plug and a second spring connected to the ignition coil; the rod is provided with a first plate at its first end, the first plate being in contact with the first spring and a second plate at its second end, the second plate being in contact with the second spring, both plates being substantially flat and orthogonal to the rod,

the electrically conductive means comprising the first spring, the first plate, the rod, the second plate and the second spring is maintained inside the boot thanks to a retaining means comprising an internal shoulder provided with the boot and located in the vicinity of the first open end and against which the first spring is in abutment and an elastic ring positioned in a groove located inside the boot in the vicinity of the second open end and against which the second spring is in abutment;

the boot is made of soft material such as silicone; all surfaces of the electrically conductive means are smooth without sharp angle so that during assembly when the electrically conductive means is inserted into the boot, and during service, the boot is not damaged.

[0007] Additionally the present invention teaches a process to manufacture the spark plug connector comprising the steps of:

- molding a bent boot in soft material such as silicone,
- manufacturing a bent rod to the same angle as the bent boot,
- inserting the first spring and locating it in abutment against the shoulder,
- partially straightening the boot while the bent rod, provided with the two plates, is forced in the boot.
- inserting the second spring and locating it in contact with the second plate,
- positioning the elastic ring inside the groove.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Other advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying figures wherein:

Figure 1 is a section of an internal combustion engine in the area of the spark plug;

Figure 2 is a section of the connector object of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0009] Figure 1 represents a portion of an engine block 10 with a spark plug 12 an ignition coil 14 and a spark plug connector 16.

[0010] To ease the description, and without any intention to limit it, the orientation "bottom to top" is, as per Figure 1, "from the spark plug to the ignition coil".

[0011] The spark plug 12 is threaded in the engine block 10 at the bottom of a well 18. The spark plug 12 as an electrodes end, located in the combustion chamber of the engine, and a ceramic portion from which is protruding a male terminal 20 emerging at the bottom 22 of the well 18.

[0012] The ignition coil 14 is fixed (fixation mean not represented) onto the engine block 10 at the top end 24 of the well 18. The well 16 is bent with the bottom end 22 extending along a lower axis A1, and the top end 24 extending along an upper axis A2. The lower axis A1 and the upper axis A2 make an angle X. The angle X is preferably between 160° and 180°, but could go to 135°.

[0013] The spark plug connector 16 extends inside the well 18 from the spark plug 12, where it is connected onto it, to the ignition coil 14, whereto it is also connected. The connector 16 is bent by the angle X, as is the well 18.

[0014] Figure 2 details the elements of the spark plug connector 16. The connector 16 comprises a tubular boot 30 having an internal surface 32 and an external surface 34, the boot 30 having an annular circular section. The boot 30 extends, along axis A1, from a spark plug end 36, to a coil end 38 along axis A2, the boot 30 being open at both ends 32, 34. The tubular boot 30 is bent by the angle X. Preferably, the boot 30 is made of one single piece.

[0015] In the vicinity of the spark plug end 36, the internal surface 32 of the boot 30 is provided with a shoulder 42 restricting, toward the spark plug end 36, the internal section of the boot 30.

[0016] In the vicinity of the coil end 38, the internal surface 32 of the boot 30 is provided with an annular groove 44 where an internal elastic ring 46 is located.

[0017] The shoulder 42 and the elastic ring 46 are retaining means for the internal elements of the connector 16.

[0018] In the vicinity of the spark plug end 36, the external surface 34 of the boot 30 is provided with a set of radially extending discs forming lips 48 that, as shown on figure 1, are in sealing contact with the well 18 so that, no dust nor other particles can accumulate around the spark plug 12.

[0019] The boot 30 is made of soft and electrically isolating material such as silicone.

[0020] Inside the boot, the connector 16 comprises a

first conical spring 50 with large end on abutment against the shoulder 42 and small end oriented upward.

[0021] The connector 16 comprises a second conical spring 52 with large end on abutment against the elastic ring 44 and small end oriented toward downward.

[0022] Between the two conical springs 50, 52 is positioned a rod 54 having a spark plug extremity 56 extending along axis A1 and a coil extremity 58 extending along axis A2. The rod 54 is bent as per the angle X. The rod 54 is metallic and constitutes a strengthening member for the connector 16.

[0023] The rod 54 extremities 56, 58 are integrally provided with flat heads 60 62 forming plates. The spark plug extremity 56 is provided with the first plate 60 radially extending from axis A1. Similarly, the coil extremity 58 is integrally provided with the second plate 62 radially extending from axis A2.

[0024] The first conical spring 50 is on abutment against the first plate 60 by its small end. Similarly, the second conical spring 52 is on abutment against the second plate 62 by its small end.

[0025] The two conical springs 50, 52, the two plates 60, 62 and the rod 54 are of electrically conductive material.

[0026] To avoid damaging the internal surface 32 of the boot 30, either during assembly of the connector or in operation, the surfaces of the electrically conductive elements are smooth without any sharp angle.

[0027] The distance from the shoulder 42 to the internal groove 44 is slightly smaller than the cumulated free length of the two conical springs 50, 52 added to the thickness of the two plates 60, 62 and the length of the rod 54. Therefore when assembled the two conical springs 50, 52, the two plates 60, 62 and the rod 54 are in slight compression ensuring a tight contact between the various elements and, when plugged onto the spark plug 12 and onto the ignition coil 14, providing electrical continuity from the spark plug 12 to the ignition coil 14.

[0028] When assembled, the bent of the boot 30 and the bent of the rod 54 are centered on a same point O.

[0029] The manufacturing and assembly process of the connector 16 comprise the following steps:

The bent tubular boot 30 is molded of soft material such as silicone.

[0030] The rod 54 is manufactured and equipped with the integral heads 60, 62 forming plates.

[0031] The rod 54 is bent to make the angle X.

[0032] The first spring 50 is inserted inside the tubular boot 30 and positioned on abutment against the shoulder 42.

[0033] The boot 30 is partially straightened and the rod 54 is inserted inside and positioned so that the first plate 60 comes in contact against the first spring 50.

[0034] The second spring 52 is positioned inside with small end in contact against the second plate 62.

[0035] The electrically conductive elements being in

place, the assembly is slightly axially compressed so that the elastic ring 46 can be positioned inside the groove 44.

[0036] This description is not intended to limit the teaching of the present invention. A number of variants are possible such as, the elastic ring 46 being replaced by a second shoulder similar to the shoulder 42; the heads 60 62 of the rod having a different shape still ensuring an abutment for the springs 50 52 and a good electrical continuity; in fact the springs 50 52, here described conical could be different as they adapt on a variety of spark plugs and coils; the electrically conductive elements, here described as five components - two springs, one rod, two plates - could be integral into one piece. Also the process could optionally include the direct manufacture of a rod 54 having the angle X (e.g. a molded rod) instead of a rod manufactured straight then being bent.

Claims

1. Spark Plug Electrical Connector (16) for connecting an ignition coil (14) to a spark plug (12) especially for use with an engine (10) in which a spark plug (12) is located within a deep well (18) while the ignition coil (14) is outside the well (18), the connector (16) comprising an electrically insulating tubular boot (30) having a spark plug open end (36) and a coil open end (38) and inside of which is an electrically conductive means (50, 60, 54, 62, 52) connecting the coil (14) to the spark plug (12) **characterized in that** the connector (16) comprises a strengthening member (54) positioned inside the boot (30), the strengthening member (54) extending substantially from the spark plug open end (36) to the coil open end (38).
2. Connector (16) as set forth in claim 1 **characterized in that** the strengthening member (54) is an element of the electrically conductive means (50, 60, 54, 62, 52).
3. Connector (16) as set forth in any of the preceding claim **characterized in that** the strengthening member (54) is an elongated rod (54) having a first end (56) oriented toward the spark plug (12) and a second end (58) oriented toward the coil (14).
4. Connector (16) as set forth in any of the preceding claim **characterized in that** the connector (16) makes at least one bend (X) between the spark plug open end (36) and the coil open end (38).
5. Connector (16) as set forth in claim 3 and 4 **characterized in that** the rod (54) is bent (X).
6. Connector (16) as set forth in any of the preceding claim **characterized in that** the electrically conductive means (50, 60, 54, 62, 52) comprises a first

spring (50) that is connected to the spark plug (12).

7. Connector (16) as set forth in any of the preceding claim **characterized in that** the electrically conductive means (50, 60, 54, 62, 52) comprises a second spring (52) that is connected to the ignition coil (14).
8. Connector (16) as set forth in claims 3 and 6 in combination with any other claim **characterized in that** the rod (54) is provided with a first plate (60) at its first end (56), the first plate (60) being substantially flat and orthogonal to the rod (54), the first plate (60) being in contact with the first spring (50).
9. Connector (16) as set forth in claims 3 and 7 in combination with any other claim **characterized in that** the rod (54) is provided with a second plate (62) at its second end (58), the second plate (62) being substantially flat and orthogonal to the rod (54), the second plate (62) being in contact with the second spring (52).
10. Connector (16) as set forth in claims 3, 6, 7, 8 and 9 **characterized in that** the electrically conductive means (50, 60, 54, 62, 52) comprising the first spring (50), the first plate (60), the rod (54), the second plate (62) and the second spring (52) is maintained inside the boot (30) thanks to a retaining means (42, 44, 46).
11. Connector (16) as set forth in claim 10 **characterized in that** the retaining means (42, 44, 46) comprises an internal shoulder (42) provided with the boot (30) and located in the vicinity of the first open end (36) and against which the first spring (50) is in abutment and an elastic ring (46) positioned in a groove (44) located inside the boot (30) in the vicinity of the second open end (38) and against which the second spring (52) is in abutment.
12. Connector (16) as set forth in any of the preceding claim **characterized in that** the boot (30) is made of soft material such as silicone.
13. Connector (16) as set forth in claim 12 **characterized in that** all surfaces of the electrically conductive means (50, 60, 54, 62, 52) are smooth without sharp angle so that during assembly when the electrically conductive means (50, 60, 54, 62, 52) is inserted into the boot (30), and during service, the boot (30) is not damaged.
14. Process to manufacture a Spark plug connector (16) comprising a bent boot (30) and a bent rod (54) as described in the claims 5, 8, 9, 11 and 12 the manufacturing process comprising the steps of:
 - molding a bent boot (30) in soft material such as silicone,

- manufacturing a bent rod (54) to the same angle (X) as the bent boot (30),
- inserting the first spring (50) and locating it in abutment against the shoulder (42),
- partially straightening the boot (30) while the bent rod (54), provided with the two plates (60, 62), is forced in the boot (30). 5
- inserting the second spring (52) and locating it in contact with the second plate (62),
- positioning the elastic ring (46) inside the groove (44). 10

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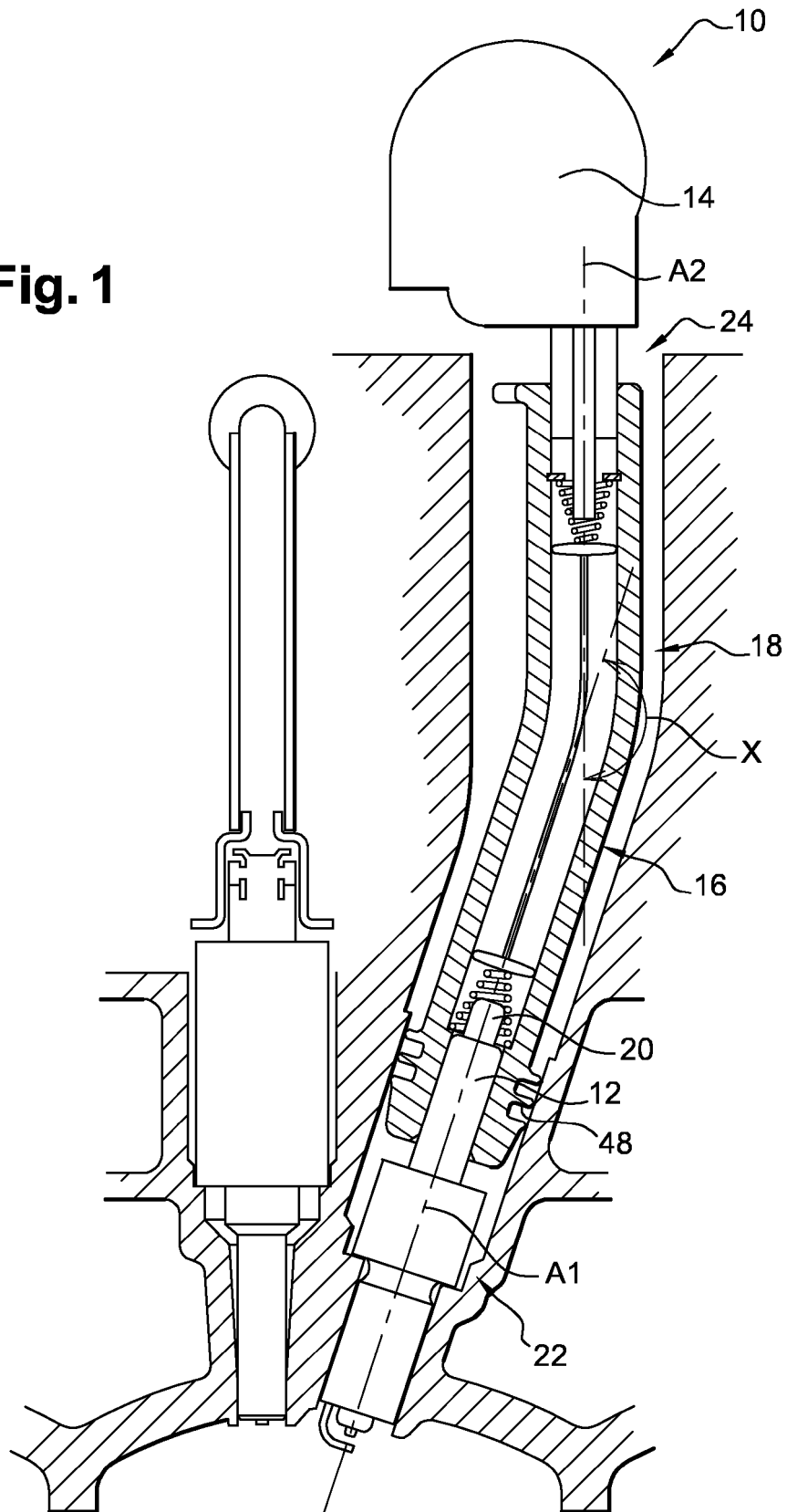
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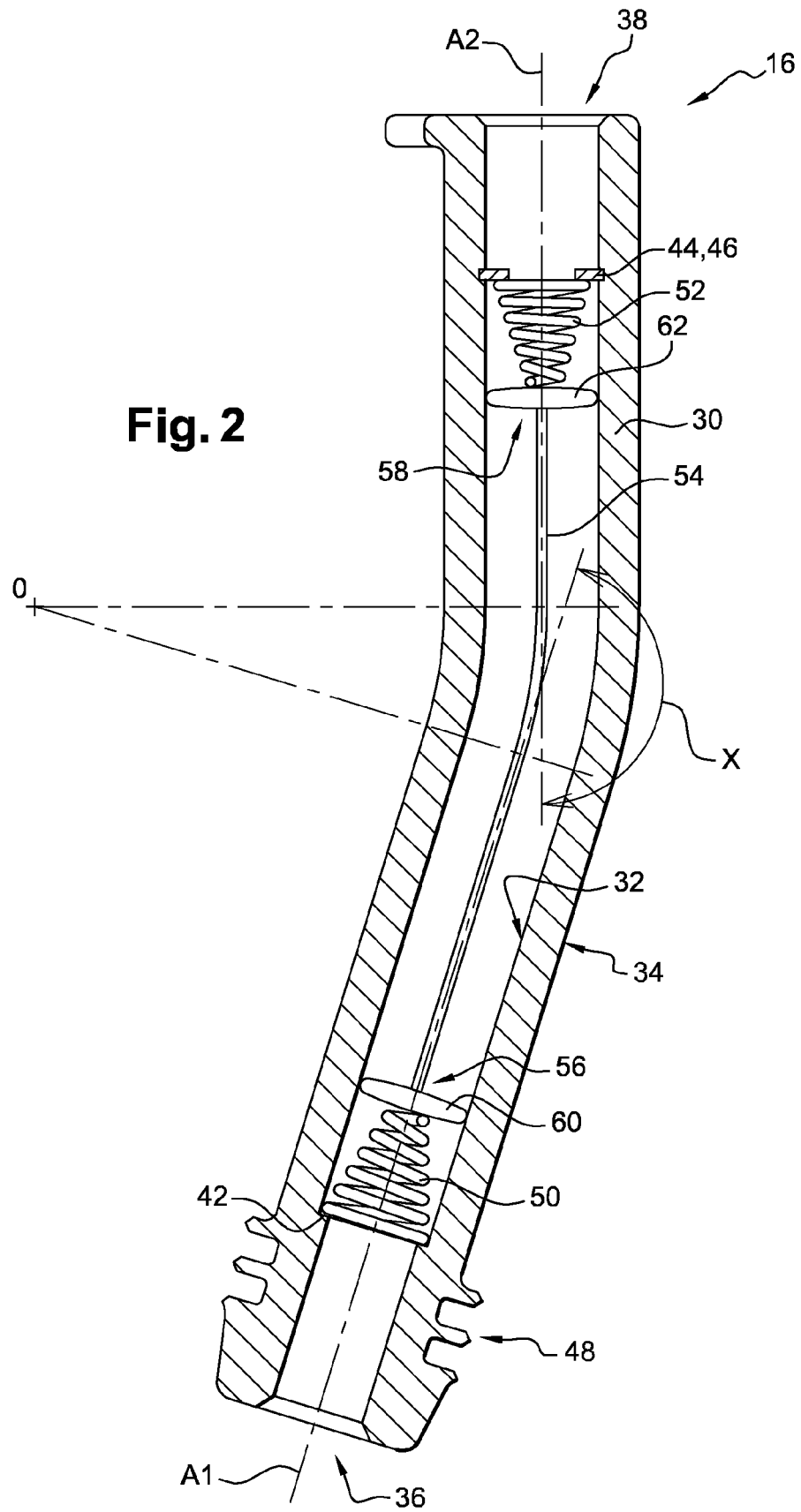
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Fig. 1







EUROPEAN SEARCH REPORT

Application Number
EP 09 15 6347

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2008/271724 A1 (IDOGAWA TAKASHI [JP] ET AL) 6 November 2008 (2008-11-06) * page 2, paragraph 26 - paragraph 29; figure 3 *	1,2,4, 12,13	INV. H01T13/04
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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 5 August 2009	Examiner Bijn, Eric
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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EPO FORM 1503.03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 09 15 6347

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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