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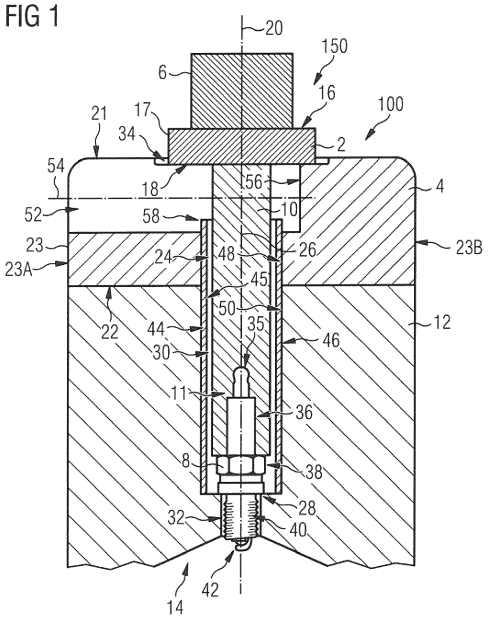
(54) MOUNTING ASSEMBLY FOR AN IGNITION DEVICE OF AN INTERNAL COMBUSTION ENGINE

(57) The present disclosure relates to a mounting assembly (100) for mounting an ignition device (150) to a cylinder head (12) of an internal combustion engine. The internal combustion engine includes at least one combustion chamber (14). The mounting assembly (100) comprises a cylinder head cover (4) configured to be mounted to the cylinder head (12). The cylinder head cover (4) includes a bore (24) extending along a bore axis (26). The bore (24) is fluidly connected to the at least one combustion chamber (14) via the cylinder head (12). The mounting assembly (100) further comprises a mounting flange (2) mounted to the cylinder head cover (4). The mounting flange (2) is configured to seal the bore (24) and to mount the ignition device (150). In the mounting assembly (100) at least one of the cylinder head cover (4) and the mounting flange (2) includes a venting passage (52) configured to fluidly connect the bore (24) to the atmosphere.

FIG 1



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Description

Technical Field

[0001] The present disclosure generally relates to a spark ignited internal combustion engine. More particularly, the present disclosure relates to a mounting assembly for mounting an ignition device to an internal combustion engine.

Background

[0002] Ignition devices for internal combustion engines usually include an ignition coil configured to produce a high voltage, and a spark plug connected to the ignition coil and configured to generate an electric spark. The ignition coil can be connected to the spark plug in various ways. In a so-called coil-on-plug configuration, the ignition coil is arranged close to the spark plug, preferably directly on top of the spark plug, and electrically connected to the spark plug by a spark plug extender.

[0003] In the coil-on-plug configuration, the spark plug extender and the spark plug are usually disposed at least partially within a bore provided in a cylinder head and a cylinder head cover of the internal combustion engine. The bore is part of a spark plug well which provides access to a combustion chamber of the cylinder. The ignition coil is placed on top of the bore and mounted to the cylinder head or cylinder head cover via a mounting flange. By disposing both the spark plug extender and the spark plug within the spark plug well, the high-voltage part of the ignition device is shielded by the cylinder head and the cylinder head cover. As a consequence, an electromagnetic interference between the various ignition devices may be reduced and an electromagnetic compatibility of the engine may be increased.

[0004] The present disclosure is directed, at least in part, to improving or overcoming one or more aspects of prior systems.

Summary of the Disclosure

[0005] According to one aspect of the present disclosure, a mounting assembly for mounting an ignition device to a cylinder head of an internal combustion engine is disclosed. The internal combustion engine includes at least one combustion chamber. The mounting assembly comprises a cylinder head cover configured to be mounted to the cylinder head. The cylinder head cover includes a bore extending along a bore axis. The bore is fluidly connected to the at least one combustion chamber via the cylinder head. The mounting assembly further comprises a mounting flange mounted to the cylinder head cover. The mounting flange is configured to seal the bore and to mount the ignition device, wherein at least one of the cylinder head cover and the mounting flange includes a venting passage configured to fluidly connect the bore to the atmosphere.

[0006] According to another aspect of the present disclosure, a cylinder head cover is disclosed. The cylinder head cover is configured to be used in a mounting assembly as exemplary disclosed herein. The cylinder head cover comprises a circumferential cylinder head cover face, a bottom cylinder head cover face, a top cylinder head cover face, and a bore extending along a bore axis from the bottom cylinder head cover face to the top cylinder head cover face. The bore is fluidly connected to the at least one combustion chamber via the cylinder head. The cylinder head cover further includes a venting passage configured to fluidly connect the bore to the atmosphere. The venting passage extends in axial direction with respect to the bore axis from the top cylinder head cover face towards the bottom cylinder head cover face, and extends in radial direction with respect to the bore axis from the circumferential cylinder head cover face towards the bore axis.

[0007] According to another aspect of the present disclosure, an internal combustion engine is disclosed. The internal combustion engine comprises at least one combustion chamber, a cylinder head associated with the at least one combustion chamber, and at least one ignition device. The at least one ignition device includes an ignition coil configured to produce a high voltage, a spark plug configured to generate an electric spark, and a spark plug extender configured to connect the ignition coil to the spark plug. The internal combustion engine further comprises a mounting assembly as exemplary disclosed herein.

[0008] Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

Brief Description of the Drawings

[0009] The accompanying drawings, which are incorporated herein and constitute a part of the specification, illustrate exemplary embodiments of the disclosure and, together with the description, serve to explain the principles of the disclosure. In the drawings:

Fig. 1 shows a partial cross-sectional view of an exemplary embodiment of a mounting assembly for mounting an ignition device to a cylinder head of the internal combustion engine;

Fig. 2 shows a top view of the mounting assembly of Fig. 1;

Fig. 3 shows a partial cross-sectional view of another exemplary embodiment of a mounting assembly for mounting an ignition device to a cylinder head of the internal combustion engine; and

Fig. 4 shows a cross-sectional view of an exemplary embodiment of a mounting assembly taken along line I-I of Fig. 3.

Detailed Description

[0010] The following is a detailed description of exemplary embodiments of the present disclosure. The exemplary embodiments described therein and illustrated in the drawings are intended to teach the principles of the present disclosure, enabling those of ordinary skill in the art to implement and use the present disclosure in many different environments and for many different applications. Therefore, the exemplary embodiments are not intended to be, and should not be considered as, a limiting description of the scope of patent protection. Rather, the scope of patent protection shall be defined by the appended claims.

[0011] The present disclosure is based in part on the realization that by covering the spark plug well, e.g. the bore fluidly connecting the combustion chamber of the internal combustion engine and accommodating the spark plug, with a mounting flange, the spark plug well may be sealed and venting of the spark plug well may be obstructed.

[0012] The present disclosure is further based in part on the realization that, when the spark plug well is sealed, the spark plug is subject to a higher thermal load during operation of the internal combustion engine. Moreover, as an exchange of air between the spark plug well and the atmosphere is reduced, the air trapped inside the spark plug well may become moist. Also, an amount of ions present in the air due to an electric discharge caused by generating the electric spark may increase. Both factors, potentially cause short circuits, which may result in ignition failures and potentially promote unnecessary replacements of the spark plug. Furthermore, when the spark plug well is sealed by the mounting flange, a pressure within the spark plug well may increase, for example, in case of a leakage between the spark plug and the combustion chamber. Thus, during operation of the internal combustion engine, in particular during a compression stroke of the internal combustion engine, the pressure increase within the spark plug well may be such that the mounting flange may no longer withstand the pressure and, as a result, the mounting flange, the ignition coil and also the cylinder head cover may be detached from the cylinder head and may potentially cause damage to an operator or parts of the internal combustion engine.

[0013] Thus, the present disclosure is further based in part on the realization that the potential health and safety hazard of a covered and sealed spark plug well may be minimized or at least reduced by providing a venting passage. The venting passage is configured to fluidly connect the spark plug well, e.g. the bore, to the atmosphere, providing venting of the spark plug well, and, therewith also a venting of the combustion chamber in case a leakage between the cylinder head and the spark plug occurs. By including a venting passage, humidity may escape, the amount of ions may be reduced and short circuits may be prevented. Moreover, the pressure increase may be reduced, thereby allowing the mounting flange, the ignition coil and the cylinder head cover to remain intact in case of a burst or a crack of the spark plug.

[0014] The present disclosure is further based in part on the realization that the venting passage is disposed at least partially in at least one of the mounting flange and the cylinder head cover. In cases where the cylinder head cover is integrally formed with the cylinder head, the venting passage may also at least partially be formed within the cylinder head. The venting passage may further at least partially be disposed at an interface between the mounting flange and the cylinder head cover and/or between the cylinder head cover and the cylinder head. The venting passage may further include a first venting passage portion disposed in the cylinder head cover and a second venting passage portion fluidly disposed in the mounting flange and fluidly connected to the first venting passage portion.

[0015] The present disclosure is further based in part on the realization that the venting passage is disposed in the mounting flange and/or the cylinder head cover such that in case of a burst or a damage of the spark plug, debris which is thrown out of the spark plug well may be deflected by the mounting flange, may brake due to the impact caused by the mounting flange, and may then be directed to the atmosphere, preferably at a direction substantially perpendicular to a direction of the spark plug well.

[0016] The present disclosure is further based in part on the realization that in embodiments where the internal combustion engine is a V-shape internal combustion engine with a first and a second cylinder bank, the venting passage is disposed in the mounting flange and/or the cylinder head cover such that loose debris is directed towards a V-shaped space defined between the first and the second cylinder bank. By directing debris in such a manner, the potential health and safety hazard of loose debris being thrown out of the spark plug well may be reduced and injuires to an operator of the internal combustion engine may be minimized.

[0017] Referring now to the drawings, Fig. 1 shows a partial cross-sectional view of a first embodiment of a mounting assembly 100 for mounting an ignition device 150 to a cylinder head of the internal combustion engine. The internal combustion engine may be of any size, with any number of cylinders, and in any configuration. For example, the internal combustion engine may be a V-shaped internal combustion engine including a first cylinder bank and a second cylinder bank. The first and the second cylinder banks are arranged at an angle of, for example, 60° or 90° to each other, thereby forming the typical "V". The first and the second cylinder banks further define a V-shaped space between them.

[0018] Mounting assembly 100 includes a mounting flange 2 and a cylinder head cover 4. Ignition device 150 includes an ignition coil 6 and a spark plug 8 connected to ignition coil 6 via a spark plug extender 10.

[0019] Mounting flange 2 is configured to receive igni-

tion coil 6 and mounted to cylinder head cover 4. Cylinder head cover 4 is configured to be mounted to a cylinder head 12 of the internal combustion engine. Cylinder head 12 is associated with at least one combustion chamber 14 of the internal combustion engine, the at least one combustion chamber 14 being defined by a cylinder (not shown) of the internal combustion engine. In embodiments where the internal combustion engine is a V-shaped internal combustion engine, each cylinder bank may include its own cylinder head 12 and cylinder head cover 4.

[0020] Mounting flange 2 includes a top flange face 16 and bottom flange face 18 opposite top flange face 16. Top flange face 16 and bottom flange face 18 define a central flange axis 20 extending in longitudinal direction from bottom flange face 18 to top flange face 16. Mounting flange 2 further includes a circumferential flange face 17 extending between top flange face 16 and bottom flange face 18. In embodiments where the internal combustion engine is a V-shaped internal combustion engine, circumferential flange face 17 further includes a first flange side face 17A (shown in Fig. 4) facing the V-shaped space, and a second flange side face 17B (shown in Fig. 4) not facing the V-shaped space.

[0021] Cylinder head cover 4 includes a top cylinder head cover face 21 and a bottom cylinder head cover face 22 opposite top cylinder head cover face 21. Cylinder head cover 4 further includes a circumferential cylinder head cover face 23 extending between top cylinder head cover face 21 and bottom cylinder head cover face 22. In embodiments where the internal combustion engine is a V-shaped internal combustion engine, circumferential cylinder head cover face 23 further includes a first cylinder head cover side face 23A facing the V-shaped space, and a second cylinder head cover side face 23B not facing the V-shaped space. Circumferential cylinder head cover face 23 further includes a front cylinder head cover face 23C (shown in Fig. 2), and a back cylinder head cover face 23D (shown in Fig. 2).

[0022] Cylinder head cover 4 further includes a bore 24 extending along a bore axis 26 from bottom cylinder head cover face 22 to top cylinder head cover face 21. Bore 24 is fluidly connected to combustion chamber 14 via cylinder head 12. Bore 24 may be disposed centrally within cylinder head cover 4, as shown in Fig. 1, or may be disposed non-centrally within cylinder head cover 4. In embodiments where the internal combustion engine includes more than one cylinders, cylinder head cover 4 may include a plurality of bores 24, and each bore 24 is associated with the respective cylinder of the internal combustion engine.

[0023] Cylinder head 12 includes a stepped bore 28 with a first bore portion 30 and a second bore portion 32. First bore portion 30 is configured to fluidly connect bore 24 to second bore portion 32, and second bore portion 32 is configured to fluidly connect first bore portion 30 to combustion chamber 14. First bore portion 30 and bore 24 effectively have the same diameter. In some embodiments, first bore portion 30 and bore 24 may have different diameters. Bore 24, first bore portion 30 and second bore portion 32 together form a so-called spark plug well. Cylinder head 12 may further include passages not shown in Fig. 1, for example, inlet passages for admitting air and fuel to combustion chamber 14 and exhaust gas passages for discharging exhaust gas from combustion chamber 14.

[0024] Top cylinder head cover face 21 includes a mounting portion 34 configured to receive mounting flange 2. Mounting flange 2 is detachably mounted to cylinder head cover 4, for example, via screws, bolts, studs, or the like. For this, mounting flange 2 may include holes or bores, as schematically illustrated in Fig. 2 and 4. In some embodiments, a seal may be disposed between mounting flange 2 and top cylinder head cover face 21 to sealingly connect mounting flange 2 to cylinder head cover 4.

[0025] Cylinder head cover 4 is detachably mounted to cylinder head 12, for example, via screws, bolts, studs, threads, or the like, or is non-detachably mounted to cylinder head 12, for example, via glueing, welding, soldering, riveting, or the like. Cylinder head cover 4 may be made from any suitable material such as plastics. In some embodiments, cylinder head cover 4 may also be integrally formed with cylinder head 12, for example, via casting or milling, such that cylinder head 12 and cylinder head cover 4 together form a unit.

[0026] Top flange face 16 is configured to receive ignition coil 6. Ignition coil 6 is detachably or non-detachably mounted to top flange face 16 using any suitable connection means known to the skilled person.

[0027] Ignition coil 6 includes a connector (not shown) for connecting to a power source and is configured to produce a high voltage from power provided by the power source. Ignition coil 6 may be any type of ignition coil known to the skilled person. For example, ignition coil 6 may include one or more coils made, for example, from copper wire and arranged around a magnetic core for producing the high voltage.

[0028] Bottom flange face 18 is configured to connect to spark plug extender 10. Connection between bottom flange face 18 and spark plug extender 10 may be detachable, for example, via screws and bolts, or may be non-detachable. Bottom flange face 18 is configured to electrically connect (not shown) to top flange face 16 for transmitting the high voltage produced by ignition coil 6 to spark plug extender 10.

[0029] Spark plug extender 10 is any type of spark plug extender known to the skilled person. Spark plug extender 10 is configured to connect to spark plug 8 for transmitting the high voltage produced by ignition coil 6 to spark plug 8. Spark plug extender 10 may include an electrically conductive core (not shown) and an insulating sleeve (not shown) arranged around the core. The insulating material may be made from any suitable material, such as teflon, ceramic, porcelain, bekalite, or the like. Spark plug extender 10 may further include a receiving

portion 11 configured to receive spark plug 8.

[0030] Spark plug 8 may be any type of spark plug known to the skilled person. Spark plug 8 is configured to generate an electric spark based on the high voltage transmitted from ignition coil 6 to spark plug 8 via spark plug extender 10. Spark plug 8 may include various components known to the skilled person, such as a connector 35 for connecting spark plug 8 to spark plug extender 10, an intermediate part 36 for insulating spark plug 8, a tool engaging part 38 for mounting and dismounting spark plug 8, a threaded part 40 for screwing spark plug 8 into a corresponding thread of second bore portion 32, and an electrode part 42 for generating an electric spark in combustion chamber 14. Spark plug 8 may further include a seal face disposed between tool engaging part 38 and threaded part 40, the seal face being configured to fluidly seal bore 24 and first bore portion 30 against combustion chamber 14.

[0031] A spark plug sleeve 44 is inserted into bore 24 and first bore portion 30. Spark plug sleeve 44 essentially includes a hollow cylindrical body with an inner sleeve side 45 and an outer sleeve side 46. Outer sleeve side 46 includes a thread (not shown) for screwing spark plug sleeve 44 into a corresponding thread (not shown) formed in cylinder head cover 4 or cylinder head 12. In some embodiments, spark plug sleeve 44 may be press-fitted into bore 24 and first bore portion 30. Spark plug sleeve 44 may be made from any suitable material such as steel, brass, aluminum, or the like.

[0032] Spark plug sleeve 44 is sized to fit into bore 24 and first bore portion 30 such that outer sleeve side 46 abuts an inner bore side 48 of bore 24 and an inner bore portion side 50 of first bore portion 30. In embodiments, where first bore portion 30 has a diameter different from the bore diameter of bore 24, spark plug sleeve 44 may further include a protrusion or recess configured to account for that difference in diameter. Moreover, spark plug sleeve 44 is sized such that inner sleeve side 45 does not abut an outer circumferential side of spark plug extender 10, but provides an annular gap between spark plug sleeve 44 and spark plug extender 10. The annular gap shall provide for a certain amount of venting between the spark plug well and the atmosphere.

[0033] However, as mentioned earlier, when mounting flange 2 is mounted to cylinder head cover 4 from on top, as exemplarily shown in Fig. 1, bore 24 and first bore portion 30 are covered by mounting flange 2. Thus, the annular gap is effectively sealed by mounting flange 2, and a venting of bore 24 and the first bore portion 30 to the atmosphere, generally a venting of the spark plug well to the atmosphere, is obstructed. As a consequence, in the embodiment shown in Fig. 1, cylinder head cover 4 further includes a venting passage 52. Venting passage 52 is configured to fluidly connect bore 24 to the atmosphere, thereby enabling a venting of the spark plug well to the atmosphere, or in other words, enabling a venting of air inside the annular gap to the atmosphere.

[0034] Venting passage 52 extends in axial direction with respect to bore axis 26 from top cylinder head cover face 21 towards bottom cylinder head cover face 22. Venting passage 52 further extends in radial direction with respect to bore axis 26 from circumferential cylinder head cover face 23 towards bore axis 26. Moreover, venting passage 52 extends in radial direction with respect to bore axis 26 along a venting passage axis 54 that lies in a plane extending perpendicularly to bore axis 26. Thus, venting passage 52 extends in radial direction essentially perpendicularly to bore axis 26. In some embodiments, however, venting passage axis 54 may lie in a plane extending at an oblique angle to bore axis 26. In those embodiments, venting passage 52, may extend non-perpendicularly to bore axis 26.

[0035] Furthermore, venting passage 52 extends in radial direction with respect to bore axis 26 such that a radial end face 56 of the venting passage 52 protrudes further in radial direction than inner bore portion side 50. As a consequence, an entire ring-space of the annular gap between spark plug extender 10 and spark plug sleeve 44 is fluidly connected to venting passage 52, and the entire ring-space of the annular gap may effectively be vented to the atmosphere. Of course, in embodiments where no spark plug sleeve 44 is used, the entire ring-space of the annular gap between inner bore portion side 50 and spark plug extender 10 is fluidly connected to venting passage 52, thereby ensuring a venting of bore 24 to the atmosphere. In some embodiments, radial end face 56 may, however, not protrude further in radial direction than inner bore portion side 50.

[0036] Also, venting passage 52 extends in axial direction with respect to bore axis 26 such that a distal end 58 of spark plug sleeve 44 protrudes into venting passage 52. As a consequence, in case of, for example, a burst or a crack of spark plug 8, distal end 58 may guide loose debris towards mounting flange 2. Mounting flange 2 then deflects the loose debris and eventually guides the loose debris to the atmosphere at a direction substantially perpendicular to bore axis 26. In some embodiments, distal end 58 may not protrude into venting passage 52.

[0037] Venting passage 52 may include a semicircular cross-section, an oval cross-section, a rectangular cross-section, or any other cross-sectional shape suitably for fluidly connecting bore 24 to the atmosphere. For example, venting passage 52 may be a bore drilled in circumferential cylinder head cover face 23. In some embodiments, venting passage 52 may be milled at an interface between mounting flange 2 and cylinder head cover 4. In some embodiments, venting passage 52 may at least partially be formed at the interface between mounting flange 2 and cylinder head cover 4.

[0038] Fig. 2 shows a top view of mounting assembly 100 shown in Fig. 1. Elements already explained in connection with Fig. 1 such as mounting flange 2, cylinder head cover 4 and venting passage 52 have the same reference numerals.

[0039] As can be seen, venting passage 52 extends in radial direction with respect to bore axis 26 from circum-

ferential cylinder head cover face 23 towards bore axis 26.

[0040] In embodiments where the internal combustion engine is a V-shaped internal combustion engine, venting passage 52 extends in radial direction with respect to bore axis 26 from first cylinder head cover side face 23A towards bore axis 26. Thus, venting passage 52 extends in radial direction such that venting passage 52 fluidly connects the V-shaped space between the first and the second cylinder banks with bore 24. As a consequence, in case of a burst or a crack of spark plug 8, loose debris being thrown out of the spark plug well is directed to the V-shaped space, where the loose debris collides with other parts of the internal combustion engine, thereby minimizing a potential health and safety hazard for an operator or a bystander of the internal combustion engine.

[0041] Moreover, venting passage 52 extends in circumferential direction with respect to bore axis 26 from front cylinder head cover face 23C to back cylinder head cover face 23D. In the embodiment shown, venting passage axis 54 extends parallel to front and back cylinder head cover faces 23C, 23D. In some embodiments, venting passage axis 54 may extend at an angle towards front and back cylinder head cover faces 23C, 23D. Moreover, venting passage 52 extends centrally between front and back cylinder head cover faces 23C, 23D. In some embodiments, venting passage 52 may extend non-centrally between front and back cylinder head cover faces 23C, 23D. Furthermore, venting passage 52 includes a first circumferential end face 64 and a second circumferential end face 66 opposite first circumferential end face 64. Both first and second circumferential end faces 64, 66 extend along venting passage axis 54 and are parallel to each other. In some embodiments, first and second circumferential end faces 64, 66 may extend obliquely one to another, such that a distance between first and second circumferential end faces 64, 66 increases from bore axis 26 to circumferential cylinder head cover face 23. As a consequence, in those embodiments, a cross-sectional area of venting passage 52 increases in radial direction from bore axis 26 to circumferential cylinder head cover face 23, which, in turn, may result in a reduction in fluid flow velocity, and, thus, in a reduction in an exit velocity of loose debris being thrown out of the spark plug well.

[0042] First and second circumferential end faces 64, 66 further include rounded edges 68. Rounded edges 68 may be formed, for example, as chamfers, and are configured to further guide the flow of fluid. In some embodiments, first and second circumferential end faces 64, 66 may not include rounded edges 68.

[0043] Fig. 3 shows a partial cross-sectional view of another exemplary embodiment of mounting assembly 100. Again, elements already explained in connection with the previous figures have the same reference numerals.

[0044] Venting passage 52 includes a first venting passage portion 52A and a second venting passage portion 52B. First venting passage portion 52A is disposed in cylinder head cover 4, and second venting passage portion 52B is disposed in mounting flange 2. First venting passage portion 52A is fluidly connected to second venting passage portion 52B. First venting passage portion 52A further extends along a first venting passage portion axis 54A that extends coaxially to bore axis 26. First venting passage portion 52A further includes a first venting passage portion diameter that is larger than a bore diameter of bore 24. Or in other words: First venting passage portion 52A includes a radial end face 56A that has a larger radial distance from bore axis 26 than inner bore portion side 50. As a result, the entire ring-space of the annular gap between spark plug extender 10 and spark plug sleeve 44 is fluidly connected to first venting passage portion 52A. Moreover, as the first venting passage portion diameter is larger than the bore diameter of bore 24, a flow velocity of fluid exiting bore 24 is reduced, and, thus an exit velocity of loose debris being thrown out of bore 24 may be reduced as well. In some embodiments, however, the first venting passage portion may be equal to the bore diameter of bore 24. Thus, in those embodiments, a radial distance between radial end face 56A an bore axis 26 is equal to a radial distance between inner bore portion side 50 and bore axis 26. First venting passage portion 52A may, for example, be a drilled bore formed in top cylinder head cover face 21.

[0045] Second venting passage portion 52B extends in axial direction from bottom flange face 18 towards top flange face 16, and in radial direction from circumferential flange face 17 towards bore axis 26. Moreover, second venting passage portion 52B extends in radial direction along a second venting passage portion axis 54B that lies in a plane extending perpendicularly to bore axis 26. Thus, second venting passage portion 52B extends in radial direction essentially perpendicularly to bore axis 26. In some embodiments, however, second venting passage portion axis 54B may lie in a plane extending at an oblique angle to bore axis 26. In those embodiments, second venting passage portion 52B, may extend non-perpendicularly to bore axis 26.

[0046] As shown in Fig. 3, second venting passage portion 52B extends in axial direction with respect to bore axis 26 such that an axial distance between bottom flange face 18 and an axial end face 70 of second venting passage portion 52B is smaller than an axial dimension of mounting flange 2. As a consequence, in case of, for example, a burst or a crack of spark plug 8, loose debris may be deflected by axial end face 70 and directed to the atmosphere at a direction substantially perpendicular to bore axis 26.

[0047] Moreover, second venting passage portion 52B extends in radial direction with respect to bore axis 26 such that a radial distance between a radial end face 56B of second venting passage portion 52B and bore axis 26 is smaller than a radial distance between inner sleeve side 45 and bore axis 26. Or in other words: Radial end

face 56B protrudes further in radial direction than inner sleeve side 45. When the radial distance between radial end face 56B and bore axis 26 is smaller than the radial distance between inner sleeve side 45 and bore axis 26, it is ensured that a maximized portion of the annular gap between spark plug sleeve 44 and spark plug extender 10 is fluidly connected to second venting passage portion 52B. Of course, as mentioned earlier, in embodiments where no spark plug sleeve 44 is used, second venting passage portion 52B may extend in radial direction such that the radial distance between radial end face 56B and bore axis 26 is smaller than the radial distance between inner bore portion side 50 and bore axis 26.

[0048] To illustrate the fluid connection between the annular gap and second venting passage portion 52B even clearer, Fig. 4 shows a cross-sectional view taken along line I-I of Fig. 3. As can be seen, radial end face 56B has a distance from bore axis 26 which is smaller than an inner radius 72 of spark plug sleeve 44. As a consequence, the annular gap between spark plug sleeve 44 and spark plug extender 10 is fluidly connected to second venting passage portion 52B. Thus, a venting of the spark plug well via first venting passage portion 52A and second venting passage portion 52B is ensured.

[0049] Moreover, second venting passage portion 52B extends at least partially circumferentially about bore axis 26. Similar to the embodiment shown in Fig. 1, second venting passage portion 52B includes a first circumferential end face 64B and a second circumferential end face 66B opposite first circumferential end face 64B. Both first and second circumferential end faces 64B, 66B extend along second venting passage portion axis 54B and are parallel to each other. In some embodiments, first and second circumferential end faces 64B, 66B may extend obliquely one to another, such that a distance between first and second circumferential end faces 64B, 66B increases in radial direction from bore axis 26 to circumferential flange face 17. In those embodiments, a cross-sectional area of second venting passage portion 52B increases from bore axis 26 to circumferential flange face 17. As a consequence, a reduction in fluid flow velocity may occur, and, thus, a reduction in an exit velocity of debris being thrown out of the spark plug well.

[0050] In some embodiments, first and second circumferential end faces 64B, 66B may further include rounded edges (not shown) connecting circumferential flange face 17 to first and second circumferential end faces 64B, 66B. Similar to Fig. 2, those rounded edges may be configured to further guide the flow of fluid.

[0051] Second venting passage portion 52B may include a semicircular cross-section, an oval cross-section, a rectangular cross-section, or any other cross-sectional shape. For example, second venting passage portion 52B may be a bore drilled in circumferential flange face 17. In some embodiments, second venting passage portion 52B may be milled at bottom flange face 18.

[0052] In embodiments where the internal combustion engine is a V-shaped internal combustion engine, second venting passage portion 52B extends in radial direction from first flange side face 17A towards bore axis 26. Thus, second venting passage portion 52B fluidly connects the V-shaped space between the first and the second cylinder banks with bore 24. As a consequence, in case of a burst or a crack of spark plug 8, loose debris being thrown out of the spark plug well is directed to the V-shaped space, where the loose debris collides with other parts of the internal combustion engine, thereby minimizing a potential health and safety hazard for an operator or a bystander of the internal combustion engine.

Industrial Applicability

[0053] The disclosed mounting assembly 100 may be applicable to any spark ignited internal combustion engine. For example, mounting assembly 100 may be applicable to geaseous fuel internal combustion engines manufactured by Caterpillar Energy Solutions GmbH, Germany. The skilled person will, however, appreciate that other internal combustion engines may be applicable as well.

[0054] Once components of ignition device 150 are connected to mounting flange 2 - e.g. ignition coil 6 is mounted to top flange face 16, spark plug extender 10 is mounted to bottom flange face 18 and spark plug 8 is connected to spark plug extender 10 - mounting flange 2 is mounted to cylinder head cover 4. Cylinder head cover 4 may already be mounted to cylinder head 12. Once mounting flange 2 is mounted to cylinder head cover 4, bore 24 and first bore portion 30 are covered by mounting flange 2. Thus, a venting of bore 24 and first bore portion 30, generally a venting of the spark plug well, is obstructed by mounting flange 2. As a consequence, during operation of the internal combustion engine, air trapped inside the spark plug well may become moist. Also, an amount of ions in the air may increase during operation of the internal combustion engine. Both factors may cause short circuits potentially resulting in ignition failures of ignition device 150.

[0055] However, as venting passage 52 is disposed in a least one of mounting flange 2 and cylinder head cover 4, bore 24 and generally the entire spark plug well, are fluidly connected to the atmosphere. The fluid connection between bore 24 and the atmosphere provides for a venting of bore 24, first bore portion 30 and generally the entire spark plug well. As a consequence, humidity may escape from the spark plug well, the amount of ions may be reduced and short circuits may be prevented. Moreover, in case of, for example, a burst or a crack of spark plug 8, distal end 58 of spark plug sleeve 44 may guide loose debris towards mounting flange 2 where the debris is deflected and directed to the atmosphere at a substantially axial direction to bore axis 26. Furthermore, in embodiments where the internal combustion engine is a V-shaped internal combustion engine, venting passage 52 extends in radial direction with respect to bore axis 26 such that the V-shaped space between the first and the

second cylinder banks is fluidly connected to bore 24. As a result, loose debris may be guided towards the V-shaped space and a potential health and safety hazard of debris being thrown out of the spark plug well may be minimized and injuries to an operator or a bystander of the internal combustion engine may be reduced as well.

[0056] Generally, venting passage 52 may also be disposed at least partially within cylinder head 12. Moreover, venting passage 52 may be disposed at least partially at an interface between cylinder head cover 4 and cylinder head 12.

[0057] Moreover, in embodiments where the internal combustion engine includes a plurality of cylinders, cylinder head 12 may include a plurality of stepped bores 28, wherein each stepped bore 28 is associated with the respective combustion chamber 14 of the internal combustion engine. Likewise, cylinder head cover 4 may include a plurality of bores 24 for fluid connection with the plurality of stepped bores 28, and cylinder head cover 4 may further include a plurality of venting passages 52, wherein each venting passage 52 is configured to fluidly connect to the respective bore 24 to the atmosphere.

[0058] The term "radial direction" as used herein refers to a radial direction with respect to bore axis 26. Likewise, the term "axial direction" as used herein refers to an axial direction with respect to bore axis 26, and the term "circumferential direction" as used herein refers to a circumferential direction with respect to bore 24. Similarly, the terms "radial", "axial" or "circumferential" direction, distance and dimension are referenced to with respect to bore axis 26.

[0059] Although the preferred embodiments of this invention have been described herein, improvements and modifications may be incorporated without departing from the scope of the following claims.

Claims

1. A mounting assembly (100) for mounting an ignition device (150) to a cylinder head (12) of an internal combustion engine, the internal combustion engine including at least one combustion chamber (14), the mounting assembly (100) comprising:

   a cylinder head cover (4) configured to be mounted to the cylinder head (12), the cylinder head cover (4) including a bore (24) extending along a bore axis (26), the bore (24) being fluidly connected to the at least one combustion chamber (14) via the cylinder head (12); and
   a mounting flange (2) mounted to the cylinder head cover (4), the mounting flange (2) being configured to seal the bore (24) and to mount the ignition device (150), wherein at least one of the cylinder head cover (4) and the mounting flange (2) includes a venting passage (52) configured to fluidly connect the bore (24) to the atmosphere.

2. The mounting assembly (100) according to claim 1, wherein the venting passage (52) is disposed at least partially at an interface between the mounting flange (2) and the cylinder head cover (4).

3. The mounting assembly (100) according to any one of claims 1 and 2, wherein the venting passage (52) extends at least partially circumferentially about the bore axis (26).

4. The mounting assembly (100) according to any one of the preceding claims, wherein the venting passage (52) at least partially extends along a venting passage axis (54) lying in a plane extending perpendicularly to the bore axis (26).

5. The mounting assembly (100) according to any one of the preceding claims, wherein the internal combustion engine is configured as a V-shaped internal combustion engine including a first cylinder bank and a second cylinder bank, the first cylinder bank and the second cylinder bank defining a V-shaped space between them, wherein the venting passage (52) extends in radial direction with respect to the bore axis (26) such that the venting passage (52) fluidly connects the V-shaped space to the bore (24).

6. The mounting assembly (100) according to any one of the preceding claims, wherein the venting passage (52) includes a first venting passage portion (52A) disposed in the cylinder head cover (4), and a second venting passage portion (52B) disposed in the mounting flange (2), wherein the first venting passage portion (52A) is fluidly connected to the second venting passage portion (52B).

7. The mounting assembly (100) according to claim 6, wherein the first venting passage portion (52A) extends along a first venting passage portion axis (54A) coaxially extending along the bore axis (26), and wherein the first venting passage portion (52A) includes a first venting passage portion diameter equal to or larger than a bore diameter of the bore (24).

8. The mounting assembly (100) according to any one of claims 6 and 7, wherein the mounting flange (2) includes a bottom flange face (18), a top flange face (16), and a circumferential flange face (17), and the second venting passage portion (52B) extends in axial direction with respect to the bore axis (26) from the bottom flange face (18) towards the top flange face (16), and extends in radial direction with respect to the bore axis (26) from the circumferential flange face (17) towards the bore axis (26).

9. The mounting assembly (100) according to claim 8,

wherein the second venting passage portion (52B) incudes an axial extension between the bottom flange face (18) and the top flange face (16), wherein the axial extension is smaller than an axial dimension of the mounting flange (2).

10. The mounting assembly (100) according to any one of the preceding claims, wherein the cylinder head cover (4) includes a mounting portion (34) configured to receive the mounting flange (2).

11. The mounting assembly (100) according to any one of the preceding claims, wherein the mounting flange (2) includes a top flange face (16) configured to connect to an ignition coil (6) configured to produce a high voltage.

12. The mounting assembly (100) according to claim 11, wherein the mounting flange (2) includes a bottom flange face (18) configured to connect to a spark plug extender (10), the spark plug extender (10) connecting the ignition coil (6) to a spark plug (8).

13. The mounting assembly (100) according to any one of the preceding claims, wherein the bore (24) includes a spark plug sleeve (44), the spark plug sleeve (44) including an outer sleeve side (46) configured to abut an inner bore side (48) of the bore (24).

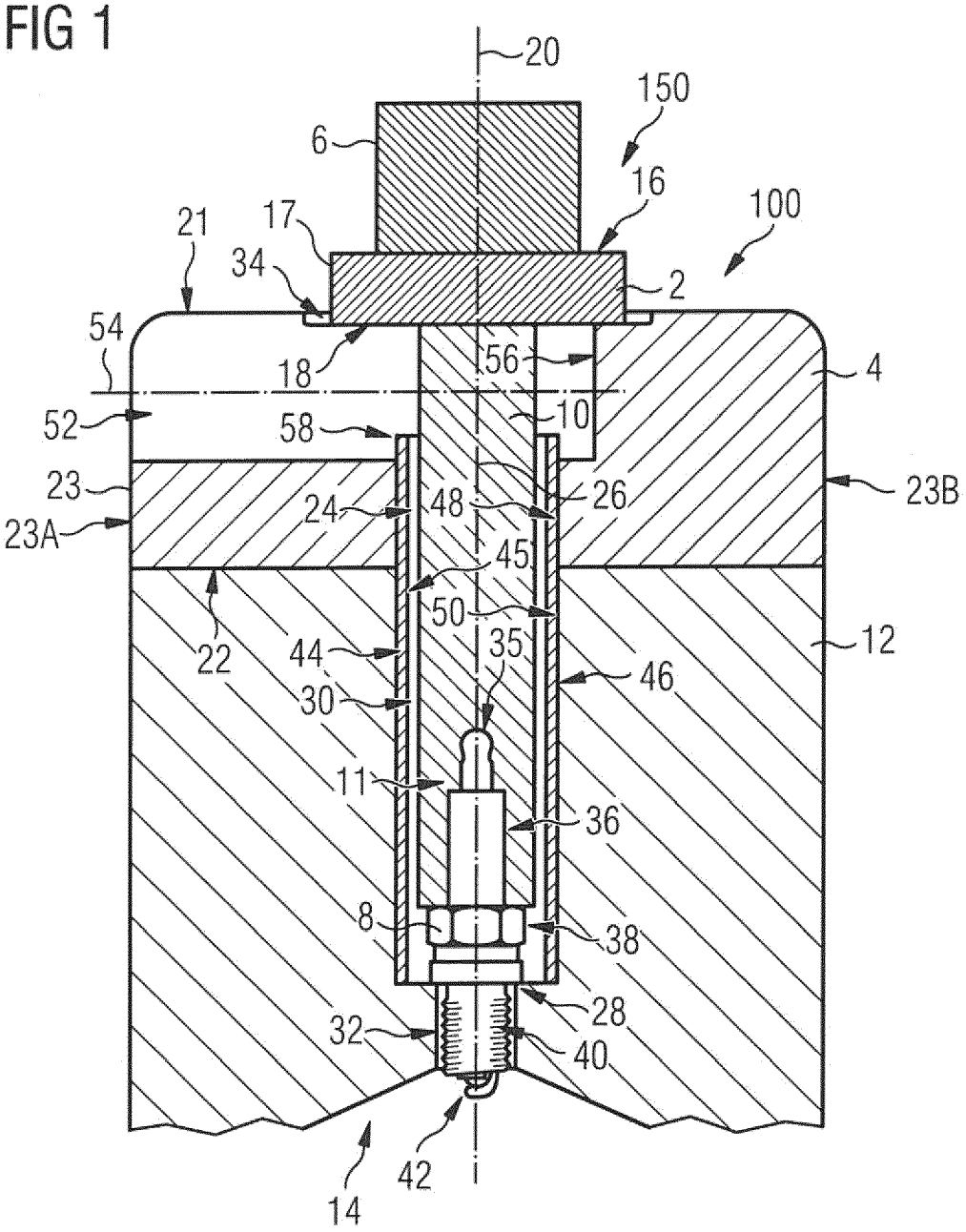
14. A cylinder head cover (4) configured to be used in a mounting assembly (100) according to any one of the preceding claims, the cylinder head cover (4) comprising:

a circumferential cylinder head cover face (23);
a bottom cylinder head cover face (22);
a top cylinder head cover face (21);
a bore (24) extending along a bore axis (26) from the bottom cylinder head cover face (22) to the top cylinder head cover face (21), the bore (24) being fluidly connected to the at least one combustion chamber (14) via the cylinder head (12); and
a venting passage (52) configured to fluidly connect the bore (24) to the atmosphere, the venting passage (52) extending in axial direction with respect to the bore axis (26) from the top cylinder head cover face (21) towards the bottom cylinder head cover face (22), and extending in radial direction with respect to the bore axis (26) from the circumferential cylinder head cover face (23) towards the bore axis (26).

15. An internal combustion engine, comprising:

at least one combustion chamber (14);
a cylinder head (12) associated with the at least one combustion chamber (14);
at least one ignition device (150) including an ignition coil (6) configured to produce a high voltage, a spark plug (8) configured to generate an electric spark, and a spark plug extender (10) configured to connect the ignition coil (6) to the spark plug (8); and
a mounting assembly (100) according to anyone of claims 1 to 13.

FIG 1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150
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26
23B
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FIG 2

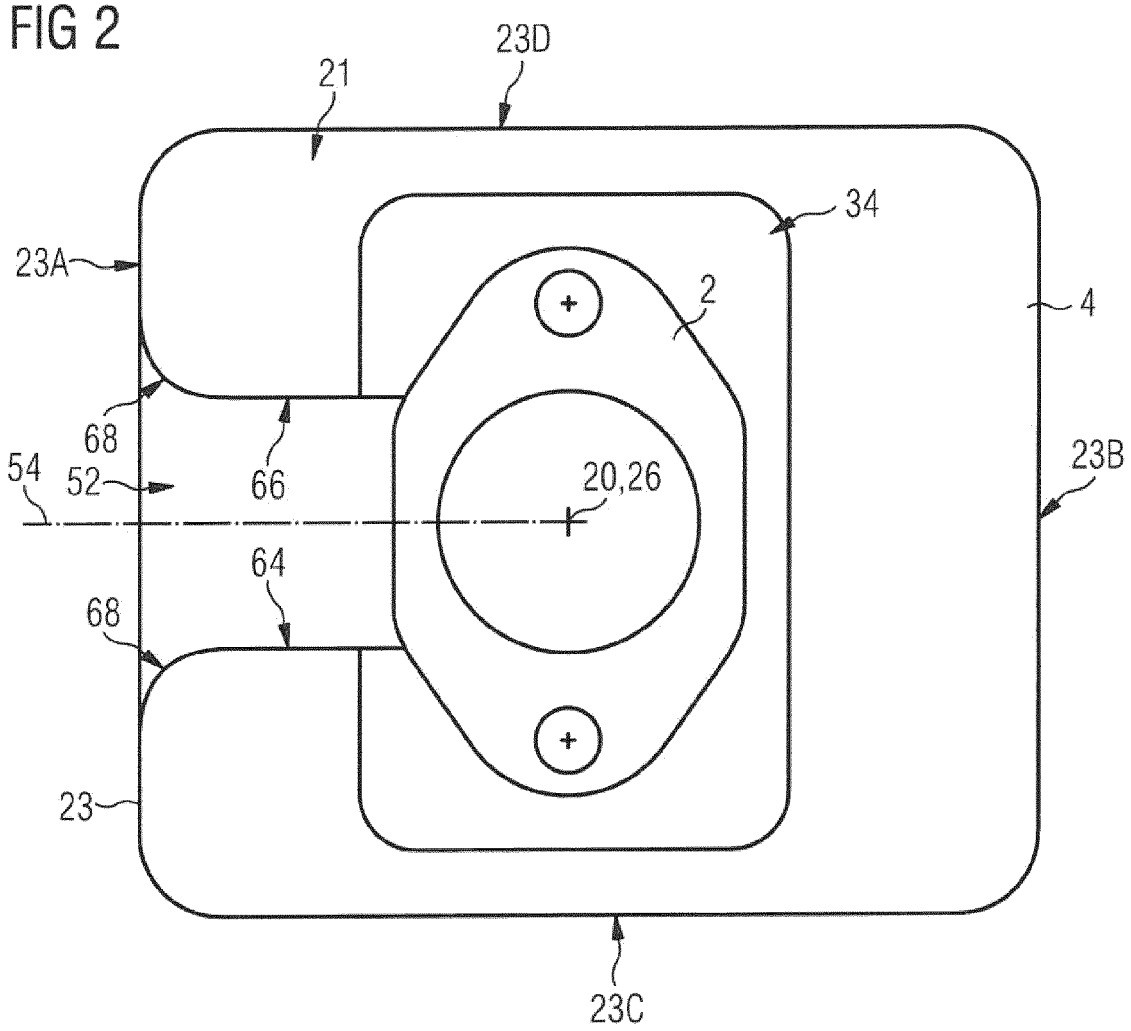

FIG 3

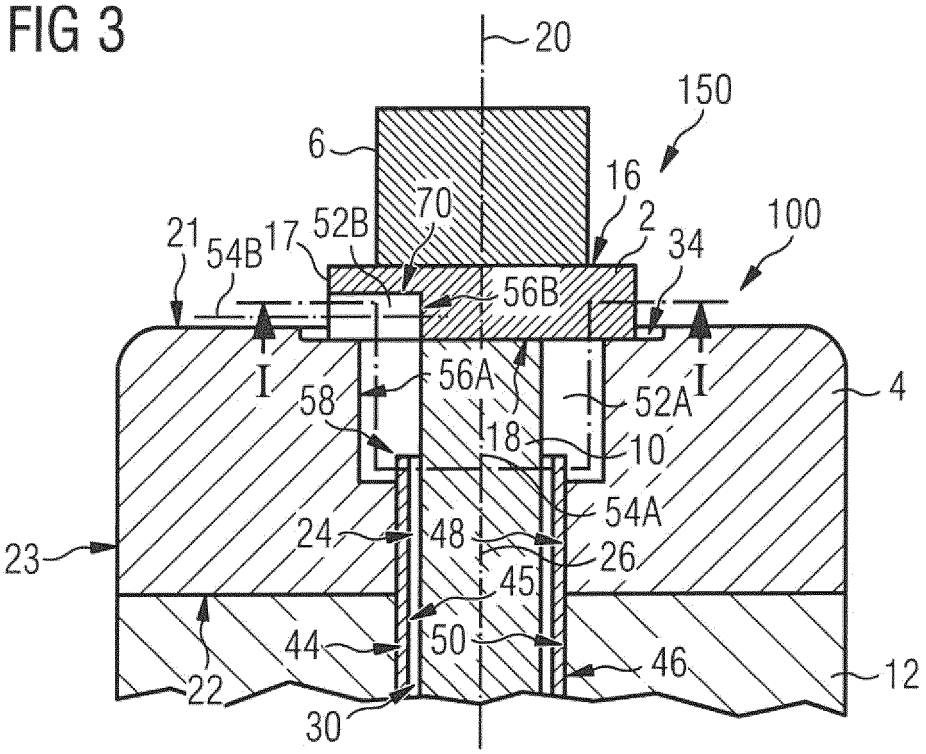
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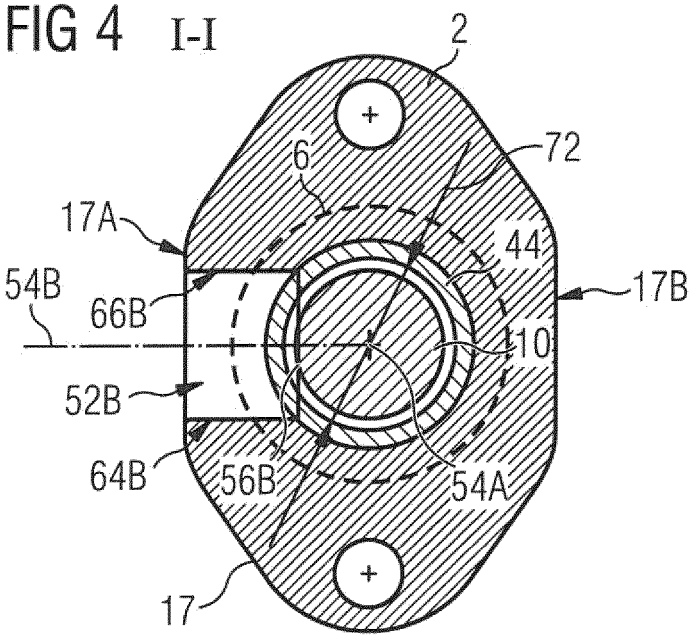
FIG 4 I-I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17A
44
54B
66B
17B
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52B
64B
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EUROPEAN SEARCH REPORT

Application Number
EP 15 15 9011

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Place of search	Date of completion of the search	Examiner
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