Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).
Description

[0001] The present invention relates to a spark plug and to a method for manufacturing a spark plug to be mounted on an internal-combustion engine so as to ignite an air-fuel mixture, and to a spark plug manufactured by the method.

[0002] Conventionally, a spark plug for ignition is used for an internal-combustion engine. A conventional spark plug is comprised of: a center electrode in which a front end thereof serves as an electrode for spark discharge; an insulator having an axial bore and accommodating the center electrode in a front end of the axial bore; and a metal shell surrounding and holding the insulator in a radial direction thereof. A fitting thread portion shaped as a male screw is formed on a front end side outer circumference face of the metal shell so as to engage with a fitting thread hole of an internal-combustion engine. Then, a spark is discharged in the internal-combustion engine to thereby ignite an air-fuel mixture.

[0003] The metal shell of such a spark plug includes a seal portion, the perimeter thereof being radially outwardly disposed towards a rear end side with respect to the fitting thread portion. An annular-shaped hollow gasket is disposed on a locating portion formed between the seal portion and the fitting thread portion. The hollow gasket is sandwiched between an opening peripheral portion of the fitting threaded hole and the seal portion of the metal shell when the spark plug is mounted on an internal-combustion engine, and deformed to thereby improve its sealing properties and prevent the air leakage of the combustion chamber through the fitting threaded hole. Such a hollow gasket is produced by, for example, radially bending a ring-like plate member into an "S" shape or a "C" shape in the cross section. As a result, the gasket is easily deformed when mounting the spark plug and its sealing properties may be maintained after being deformed.

[0004] In the manufacturing process of the spark plug, the hollow gasket is inserted from the front end side of the metal shell having a thread ridge in the fitting thread portion, which is subjected to a cutting process, and is disposed on the locating portion. At this time, plural parts of an inner edge of the hollow gasket are compressed in an axial direction so as to form a nail-like portion, which radially inwardly projects with respect to a portion serving as the maximum outer diameter of the fitting thread portion. As a result, the gasket is retained and prevented from falling out from the metal shell through the fitting thread portion (e.g., refer to Japanese Patent Application Laid-Open (kokai) No. 2000-133410).

[0005] In recent years, the improvement in an output of an automobile engine and fuel efficiency are highly in demand, and further improvement in spark plug components is also required. Regarding a gasket, a flat solid gasket assuming a thick disc shape and comprised of an alloy, which is mainly made of copper or the like, is considered. One of the advantages of using such a flat solid gasket is that after being mounted on the engine, the spark plug is unlikely to loosen. Further, because such a gasket is a flat solid member, it is unlikely to be crushed. Furthermore, a position of a front end of a center electrode, which projects to a combustion chamber, with respect to an axis of the fitting threaded hole is unlikely to vary, thereby stabilizing an igniting position.

[0006] In the manufacturing process of the spark plug using the flat solid gasket, in order to prevent the flat solid gasket from falling out from the metal shell, for example, a pipe shaped, pressing member having an inner diameter slightly larger than the maximum outer diameter of the thread ridge is provided from the front end side of the metal shell in a state that the flat solid gasket is disposed on the locating portion of the metal shell in which the fitting thread portion has already been formed. Further, a front end opening of the pressing member being in contact with the flat solid gasket is pressed against the seal portion. As a result, the inner edge of the flat solid gasket radially inwardly projects from a portion serving as the maximum outer diameter of the fitting thread portion.

[0007] However, in the manufacturing process of a spark plug, since there is no large difference in diameters between an inner circumference of a pressing member and a thread ridge of a fitting thread portion of the metal shell when disposing a gasket on a locating portion of a metal shell after a thread rolling and processing for preventing a falling out of a gasket, and there is a tendency of producing a chip of the thread ridge. In order to prevent a loosening of a spark plug, the hardness of the gasket is necessary to be raised. However, when such a gasket is used, a dressing force against the gasket using a pressing member during a process of preventing the falling out of the gasket needs to be increased. As a result, a durability of a pressing member decrease, thereby causing a rise of a production cost.

[0008] US 2 941 105-describes a spark plug which includes a gasket which is screwed onto a threaded portion to prevent disengagement of the gasket.

[0009] The present invention at least partially resolves the foregoing problems, and an object of the present invention is to provide a method for manufacturing a spark plug in which a gasket used for securing the air tightness when mounting the spark plug on an internal-combustion engine is prevented from falling out from the metal shell with a simple step.

[0010] In view of the above, there is provided a method for manufacturing a spark plug according to a first aspect of the invention comprising: a center electrode; an insulator having an axial bore which extends in an axial direction and holding the center electrode in a front end side of the axial bore; and a metal shell surrounding and holding a radial circumference of the insulator and having a male-screw-shaped fitting thread portion formed on a front end side outer circumference face of the metal shell, a seal portion formed so as to radially outwardly project at a rear end side with respect to the fitting thread portion,
and a locating portion formed between the seal portion and the fitting thread portion, where an annular gasket is disposed so as to seal between an opening peripheral portion of a fitting threaded hole of an internal-combustion engine and the seal portion when screwing the fitting thread portion into the fitting threaded hole, wherein the method for manufacturing a spark plug comprising the steps of: a cylindrical member formation step for forming a cylindrical member which serves as an original form of the metal shell and where the seal portion and the locating portion are formed but no fitting thread portion is formed; a gasket locating step for disposing the gasket on an outer circumference face of the cylindrical member after the cylindrical member formation step; and a fitting thread portion formation step for forming a fitting thread portion with a thread rolling on a thread forming portion of the cylindrical member after the gasket locating step.

[0011] According to a second aspect, there is provided a method for manufacturing a spark plug as described above, wherein the gasket disposed on the outer circumference face of the cylindrical member is pressed towards the seal portion with a die for thread rolling so as to be disposed on the locating portion prior to the fitting thread portion formation step.

[0012] In addition or alternatively to the above aspects, a method for manufacturing a spark plug according to a third aspect is provided, wherein an inner diameter of the gasket is larger than an outer diameter of the thread forming portion, and wherein a maximum outer diameter of the thread ridge after the fitting thread portion formation step is larger than the inner diameter of the gasket.

[0013] Additionally to the above, the method for manufacturing a spark plug may further include that the gasket is an annular plate.

[0014] A spark plug according to a further aspect is manufactured by a method according to any one of the above aspects.

[0015] In the method for manufacturing a spark plug according to the first aspect, in producing the metal shell, the thread ridge is formed in the thread forming portion after disposing the gasket on the outer circumference face of the cylindrical member, which serves as the original form of the metal shell. Thus, an inner edge of the gasket is caught or held by the thread ridge after the thread rolling process so that the gasket is retrained by the fitting thread portion, thereby preventing the gasket from falling out from the metal shell. That is, since any additional process to secure the gasket is not necessary after disposing the gasket on the locating portion of the metal shell, reduction in the production cost along with simplifying the manufacturing process of the spark plug can be achieved. As a result, the spark plug can be manufactured cost-effective.

[0016] When the gasket is disposed before forming the thread ridge in the thread forming portion of the metal shell, as described above, the die or dies for threading the thread ridge is/are also used to press the gasket and to keep it on the locating portion. The gasket locating step and the fitting thread portion formation step can be therefore performed in series. Thus, reduction in the production cost along with simplifying the manufacturing process of the spark plug can be achieved. As a result, the spark plug can be cost-effective manufactured. Further, since the gasket is disposed on the locating portion using the die, it can save any extra labor to dispose the gasket on the locating portion in the gasket locating step.

[0017] Further, as in some aspects of the present invention, the gasket goes through or is slide over the thread forming portion from a front end side of a cut body and is located on the locating portion before forming the thread ridge. After threading the thread ridge, the edge portion of the inner circumference of the gasket is caught or captured by the formed thread ridge whereby the gasket cannot fall out from the locating portion.

[0018] Further, as in certain aspects of the present invention, since the gasket does not require any separate process to prevent it from falling out, it is easy to secure the gasket even if a flat solid gasket made of an intrac-table plate material is used for the spark plug. Furthermore, when mounting the spark plug that uses such a flat solid gasket on an internal-combustion engine, loosening of the spark plug as a result of vibration of the internal-combustion engine can be prevented. Moreover, since the gasket only slightly deforms, the position of the front end of the center electrode, which projects to a combustion chamber, with respect to an axis of the fitting threaded hole is unlikely to vary, thereby stabilizing an igniting position.

[0019] With respect to the spark plug as described above, when manufacturing a spark plug by the method according to any one of above aspects, the gasket is unlikely to separate, i.e. fall from the metal shell.

[0020] Hereafter, an embodiment of a method for manufacturing a spark plug and a spark plug manufactured by the method which carries out the present invention will be described with reference to the drawings. Therein:

Fig. 1 is a partial cross sectional view of a spark plug 100.
Fig. 2 is a perspective view of a gasket 5.
Fig. 3 is an enlarged sectional view of a vicinity of a locating portion 59 of a metal shell 50.
Fig. 4 shows a forging step of a manufacturing process of the spark plug 100.
Fig. 5 shows a cutting step of the manufacturing process of the spark plug 100.
Fig. 6 shows a gasket locating step of the manufacturing step of the spark plug 100.
Fig. 7 is a partial cross sectional view of a cut body 220 for explaining the gasket locating step.
Fig. 8 shows a first thread rolling step of the manufacturing process of the spark plug 100.
Fig. 9 shows a second thread rolling step of the manufacturing process of the spark plug 100.
Fig. 10 is a partial cross sectional view of a cut body 220 for explaining the second thread rolling step.
First, referring to Fig. 1, a composition of a spark plug 100 will be explained as an example of the spark plug produced by the method according to the present invention. Fig. 1 is a partial cross sectional view of a spark plug 100. In addition, in Fig. 1, the direction of axis “O” of the spark plug 100 is regarded as the top-to-bottom direction in the drawing. A lower side of the drawing is regarded as a front end side of the spark plug 100 and an upper side of the drawing is regarded as a rear end side of the spark plug 100.

As shown in Fig. 1, the spark plug 100 is generally comprised of an insulator 10, a metal shell 50 holding the insulator 10 therein, a center electrode 20 being held in the insulator 10 in an axis “O” direction, a ground electrode 30 having a base end portion 32 welded to a front end face 57 of the metal shell 50 and a front end portion 31 where a side face thereof faces a front end portion 22 of the center electrode 20; and a metal terminal fitting 40 provided at a rear end portion of the insulator 10.

First, the insulator 10 constituting an insulator of the spark plug 100 will be explained. The cylindrical insulator 10 includes an axial bore 12 extending along an axis “O” direction. The insulator 10 is made of sintering alumina or the like as is commonly known. A flange portion 19 having the largest outer diameter is formed generally at a central area along axis “O”. A rear end side body portion 18 is formed at the rear end side (upper side in Fig. 1) with respect to the flange portion 19. A front end side body portion 17 having a smaller outer diameter than that of the rear end side body portion 18 is formed at the front end side (lower side in Fig. 1) with respect to the flange portion 19. A long or elongated leg portion 13 having a smaller outer diameter than that of the front end side body portion 17 is formed at the front end side with respect to the front end side body portion 17. The diameter of the long leg portion 13 is gradually tapered towards the front end side. The long leg portion 13 is exposed to a combustion chamber 208 when the spark plug 100 is mounted to an engine head 200. A step portion 15 is formed between the long leg portion 13 and the front end side body portion 17.

Next, the center electrode 20 is made of nickel-system alloys or the like for example such as INCONEL (trade name) 600 or 601 in which a metal core 23 comprised of copper or the like with excellent thermal conductivity is provided. The front end portion 22 of the center electrode 20 projects from the front end face of the insulator 10 and is tapered towards the front end side. A noble metal tip 91 is welded to a front end face of the front end portion 22 so as to improve resistance to spark erosion. Further, the center electrode 20 is electrically connected to the metal terminal fitting 40 at the rear end side through a conductive seal material 4 and a ceramic resistance 3 both provided inside the axial bore 12. A high-tension cable (not shown) is connected to the metal terminal fitting 40 through a plug cap (not shown), to which high voltage is applied.

Next, the ground electrode 30 will be described. The ground electrode 30 is comprised of a metal having an excellent corrosion resistance. As one of the examples, a nickel-system alloy such as INCONEL (trade name) 600 or 601 is used. The ground electrode 30 has a generally rectangular shape as seen from the cross-section in the longitudinal direction. The base end portion of ground 32 is welded to the front end face 57 of the metal shell 50. The front end portion 31 of the ground electrode 30 is bent so that the side face thereof faces the front end portion 22 of the center electrode 20.

Next, the metal shell 50 will be described. The metal shell 50 is a tubular metal fitting for fixing the spark plug 100 to the engine head 200 of the internal-combustion engine. The metal shell 50 holds therein the insulator 10 so as to surround an area from a part of the rear end side body portion 18 to the long leg portion 13. The metal shell 50 is comprised of a low carbon steel material and includes a tool engagement portion 51 arranged to engage with a spark plug wrench (not shown) and a fitting thread portion 52 having a thread ridge 521 for engaging with a fitting threaded hole 201 of the engine head 200 provided in an upper part of the internal-combustion engine.

A flange-like seal portion 54 is formed between the tool engagement portion 51 and the fitting thread portion 52 of the metal shell 50. A locating portion 59 where a gasket 5, which will be mentioned later, is to be disposed is provided between a formation starting position 155, which is formed in a rear end of the fitting thread portion 52 (i.e., the rear end of the thread ridge 521 formed in the fitting thread portion 52), and a seat face 55 (a face facing the front end side) of the seal portion 54. A thin caulking portion 53 is formed at the rear end side with respect to the tool engagement portion 51 of the metal shell 50. Similar to the caulking portion 53, a thin buckling portion 58 is formed between the seal portion 54 and the tool engagement portion 51. Annular ring members 6, 7 lie between an inner circumference face of the metal shell 50 where the tool engagement portion 51 and the caulking portion 53 are formed and an outer circumference face of the rear end side body portions 18 of the insulator 10. Further, talc powder 9 is filled between both ring members 6, 7. The insulator 10 is pressed towards the front end side of the metal shell 50 through the ring members 6, 7 and the talc 9 by inwardly caulking an end portion 60 of the caulking portion 53. Thus, in the screw portion 52, a step portion 56 of metal shell 50 projects inwardly and supports the step portion 15 of the insulator 10 through an annular packing 8, thereby integrating the metal shell 50 and the insulator 10. At this time, the air tightness between the metal shell 50 and the insulator 10 is maintained by the packing 8, thereby preventing combustion gas from flowing out. The buckling portion 58 is formed so as to outwardly deform with...
an application of compression force at the time of a caulking process.

[0028] Next, the assembly of the gasket 5 will be described with reference to Figs. 1 to 3. Fig. 2 is a perspective view of the gasket 5. Fig. 3 is an enlarged sectional view of a vicinity of the locating portion 59 of the metal shell 50.

[0029] The gasket 5 shown in Fig. 2 is an annular flat solid packing, and can be formed by punching a platelike material made of copper or an alloy comprised mainly of copper. As shown in Fig. 3, the gasket 5 is disposed on the locating portion 59 of the metal shell 50. As shown in Fig. 1, when the spark plug 100 is mounted on the engine head 200, the gasket 5 interposes between the seat face 55 of the seal portion 54 and the outer peripheral portion 205 of the fitting threaded hole 201 of the engine head 200 where the fitting thread portion 52 is engaged. As shown in Fig. 3, the gasket 5 is retained and cannot fall out from the locating portion 59 of the metal shell 50, thereby preventing the gasket 5 from falling out from the metal shell 50 by retaining it between thread ridge 521 and seal portion 54.

[0030] As shown in Fig. 3, the annular-shaped gasket 5 has an inner diameter A which is smaller than an outer diameter of a portion B (hereinafter referred to as a "crest diameter") serving as the maximum outer diameter of the fitting thread portion 52 (i.e., the crest of the thread ridge 521) and which is larger than an outer diameter C (hereinafter referred to as a "core diameter") of a portion serving as the minimum outer diameter of the fitting thread portion 52 (i.e., a bottom portion between the thread ridges 521). In the manufacturing process of the metal shell 50 of the spark plug 100, which will be mentioned later, the thread ridge 521 of the fitting thread portion 52 is formed by a thread rolling process. Before threading the thread ridge 521, the metal shell 50 (a cut body 521 of the thread rolling portion 152 using the thread rolling cylindrical dies 300,310 has an outer diameter D of the thread forming portion 152) is formed. As a result, the gasket 5 adheres to the seat face 55 and the outer peripheral portion 205, forms a seal and thereby preventing an air leak from the engine through the fitting threaded hole 201.

[0031] In the manufacturing process of the spark plug 100 having such a composition, in this embodiment, the thread ridge 521 is formed in the thread forming portion 152 after disposing the gasket 5 on the locating portion 59 of the metal shell 50. In this respect, the metal shell 50 is processed so as to satisfy the aforementioned size requirement (crest diameter B of the fitting thread portion 52 > inner diameter A of the gasket 5). Thus, the gasket 5 is retained in, and prevented from falling out from the metal shell 50. Although the thread ridge 521 is formed in a second thread rolling step of the manufacturing process of the spark plug 100, which will be mentioned later, the composition of the thread rolling cylindrical dies 300,310 used for threading the thread ridge 521 in the thread forming portion 152 of the metal shell 50 will be briefly described with reference to Fig. 9. Fig. 9 shows the second thread rolling step of the manufacturing process of the spark plug 100.

[0032] As shown in Fig. 9, the thread rolling cylindrical dies 300,310 are provided so that an axis line P of a rotation shaft 302 and an axis line Q of a rotation shaft 312 are parallel with the axis O of the cut body 220. The rotation shafts 302,312 can slide towards each other (or are moveable in) a direction where the axis P and the axis Q can tie together (i.e., a horizontal direction in Fig. 9) and also can slide towards (or are movable in) a direction along each axis P and Q (up-and-down or vertical direction in Fig. 9). The thread rolling cylindrical dies 300,310 have processing faces 301,311, respectively, with a thread-shaped processing tooth being formed on their whole outer circumference face. Dies 300,310 are rotated in the same direction by a rotation means (not illustrated) at a predetermined speed. End faces 305,315 facing towards the rear end side of the cut body 220, which is disposed between the thread rolling cylindrical dies 300,310, are formed at one end of the thread rolling cylindrical dies 300,310 in the axis P and Q direction. End faces are formed planar in shape and are perpendicular to each axis P and Q.

[0033] In the manufacturing process for forming the spark plug 100, when producing the metal shell 50, the thread ridge 521 is formed in the thread forming portion 152 using the thread rolling cylindrical dies 300,310 hav-
ing a composition as described above. Hereafter, the method for manufacturing the spark plug 100 will be described with reference to Figs. 4 to 11. Fig. 4 shows a forging step of the manufacturing process of the spark plug 100. Fig. 5 shows a cutting step of the manufacturing process of the spark plug 100. Fig. 6 shows a gasket locating step of the manufacturing process of the spark plug 100. Fig. 7 is a partial cross sectional view of the cut body 220 for explaining the gasket locating step. Fig. 8 shows a first thread rolling step of the manufacturing process of the spark plug 100. Fig. 10 is a partial cross sectional view of the cut body 220 for explaining the second thread rolling step.

[0034] [Forging Step]

[0035] In manufacturing the metal shell 50, as shown in Fig. 4, a rod-like steel material made of low-carbon-steel material (e.g., low-carbon-steel material of 6C to 35C, such as S10C or S15C) is set to a cold forging machine (not illustrated). A forging operation, such as an extrusion molding is conducted, so as to form a forged body 210 serving later as the manufactured metal shell 50. The cylindrical forged body 210 has a through hole 215 used for accommodating the insulator 10. Further, a rear end side cylindrical portion 211 serving later as the caulking portion 53, the tool engagement portion 51 and the buckling portion 58, an intermediate cylindrical portion 212 serving later as the seal portion 54, and a front end side cylindrical portion 213 later serving as the seal portion 54.

[0036] [Cutting Step]

[0037] Next, the forged body 210 is set to a cutting machine (not illustrated) so that the outer circumference face thereof and the inside of the through hole 215 are cut into the respective shape of the metal shell 50. That is, in the through hole 215, the front end side with respect to the step portion 56 is cut, and a clearance (refer to Fig. 1) is formed which will be arranged between an inner wall of the through hole 215 and the long leg portion 13 when accommodating the insulator 10 in the through hole 215 in the assembly of the spark plug 100. Further, the caulking portion 53 having an annular outer circumference face and the buckling portion 58 is formed in the rear end side cylindrical portion 211, and the tool engagement portion 51 is formed in the remainder. The tool engagement portion 51 is not necessarily a hexagonal shape, but may be other shape, such as a BI-HEX shape.

[0038] The seal portion 54 is formed in the intermediate cylindrical portion 212, and the thread forming portion 152 which has not yet had the thread ridge 521 is formed in the front end side cylindrical portion 213. As mentioned above, the blank diameter D of the thread forming portion 152 is cut so as to be smaller than the inner diameter A (refer to Fig. 3) of the gasket 5 produced in a separate step. Further, the groove-like locating portion 59 is formed between the seal portion 54 and the thread forming portion 152.

[0039] [Gasket Locating Step]

[0040] Subsequently, as shown in Fig. 6, the base end portion 32 of the ground electrode 30 produced in a separate step is inserted from the front end side of the cut body 220. The cut body 220 is oriented so that the front end face 57 faces upwards or sideways, and the gasket 5 produced in a separate step is inserted from the front end side of the cut body 220 so as to go through or pass over the thread forming portion 152. As shown in Fig. 7, since the blank diameter D of the thread forming portion 152 of the cut body 220 is smaller than the inner diameter A of the gasket 5, the gasket 5 can slide past the thread forming portion 152 and reaches the locating portion 59. Thus, the gasket 5 can be in contact with the seat face 55 of the seal portion 54.

[0041] [First Thread Rolling Step]

[0042] Next, the thread ridge 521 is formed in the thread forming portion 152 of the cut body 220 with the thread rolling. As shown in Fig. 8, in this embodiment, the cut body 220 is supported pivotally with a holding jig (not illustrated) so as to rotate about its axis O. Cut body 220 is radially sandwiched between and pressed by the thread rolling cylindrical dies 300,310 to thereby form the thread ridge 521. First, the rotation shafts 302,312 of the thread rolling cylindrical dies 300,310 are moved by a driving means (not illustrated) to a position where each processing face 301,311 does not touch the cut body 220 and an edge portion of each end face 305,315 contacts the gasket 5 disposed on the locating portion 59 of the cut body 220. The gasket 5 is supported by the seal portion 54 which prevents further movement towards the rear end side in the axis O direction. Further, the gasket 5 is pressed by each end face 305,315 of the thread rolling cylindrical dies 300,310 so as to be located on the locating portion 59. The end faces 305,315 prevents gasket 5 from moving towards the front end side in the axis O direction.

[0043] [Second Thread Rolling Step]

[0044] With the gasket 5 maintained and disposed on the locating portion 59, as shown in Fig. 9, each rotation shaft or axis 302,312 slides towards each other in a direction where the axis P and the axis Q can join so that the cut body 220 is sandwiched between the thread rolling cylindrical dies 300,310. Then, the thread forming portion 152 of the cut body 220 is pressed by the processing face 301,311 of the thread rolling cylindrical dies 300,310 to thereby form, i.e. thread, the thread ridge 521. As mentioned above, the thread rolling cylindrical
dies 300,310 rotate in the same direction, and the cut body 220 sandwiched therebetween follows and rotates in the opposite direction to that of the thread rolling cylindrical dies 300, 310.

[0045] As shown in Fig. 10, an outer circumference face of the thread forming portion 152 of the metal shell 50 is plastically deformed due to the pressure from the processing tooth of the processing face 301,311 of the thread rolling cylindrical dies 300,310 to thereby form the thread ridge 521 with the crest diameter B and the core diameter C, which differ from each other. As mentioned above, in this embodiment, the material of the metal shell 50, the specification of the thread rolling cylindrical dies 300,310, the pressing conditions at the time of the thread rolling or the like are selected so that the crest diameter B of the thus-formed thread ridge 521 is larger than the inner diameter A of the gasket 5. After the thread rolling, since an edge portion of the inner circumference of the cut body 220 was formed so that the gasket 5 is caught by the thread ridge 521, the gasket 5 does not fall out from the locating portion 59, thereby preventing the gasket 5 from falling out from the metal shell 5. Thereafter, each part such as the insulator 10 integrated with the center electrode 20 is assembled by a known technique in the metal shell 50 where the thread ridge 521 has been formed. As a result, the spark plug 100 shown in Fig. 1 is completed.

[0046] It goes without saying that kinds of various modifications are possible in the present invention. For example, although the thread rolling dies 300,310 for threading the thread ridge 521 are cylindrical a rolling die with a flat type or a rotary type can be used as long as it has a face for pressing the gasket 5 so that the gasket 5 is maintained in the locating portion 59 during the thread rolling step. Further, the cut body 220 is disposed between the thread rolling dies and allowed to slide towards an axis of the rolling dies to form the thread ridge 521 of the thread forming portion 152. In this case, the gasket 5 is controlled not to move towards the front end side of the cut body 220 by the end face of the rotating dies. Further, along with the movement of the cut body 220, the gasket 5 may be disposed in the locating portion 59 after the thread rolling. Furthermore, when pivotally supporting the cut body 220 with a holding jig during the thread rolling, the axis O of the cut body 220 may be supported perpendicularly or horizontally.

[0047] In the embodiment described above, the gasket 5 is an annular flat solid packing. As shown in Fig. 11, a spark plug may use a conventional gasket 105 assuming an S-shape or C-shape in the cross section formed by radially bending a ring-like plate material. Similar to the above embodiment, if the thread ridge 521 of the thread forming portion 152 of the cut body 220 is formed so that the blank diameter D is smaller than the inner diameter E of the gasket 105 before the thread rolling process, and the crest diameter B of the thread ridge 521 is larger than the inner diameter E of the gasket 105 after the thread rolling, the gasket 105 does not fall out from the locating portion 59. Furthermore, any process is not neccessary to an inner edge of the gasket 105 for preventing it from falling out whereby the manufacturing process of the spark plug may be simplified.

[0048] Although the gasket 5 is disposed on the locating portion 59 in the gasket locating step, the gasket 5 may be disposed on a front end side outer circumference face with respect to the locating portion 59, such as the thread forming portion 152. In this case, the gasket 5 may be pressed by the end face 305,315 of the thread rolling cylindrical dies 300,310 in the first thread rolling step to allow the gasket to be positioned in the locating portion 59.

[0049] The present invention may be applicable to one, such as a spark plug, a temperature sensor or a gas sensor, having a gasket for preventing a gas leaking through a mounting bore where a metal shell is fitted.

Description of Reference Numerals

5: gasket
10: insulator
12: axial bore
20: center electrode
50: metal shell
52: fitting thread portion
54: seal portion
59: locating portion
100: spark plug
152: thread forming portion
201: fitting threaded hole
205: opening peripheral portion
220: cut body
300,310: thread rolling cylindrical dies
521: thread ridge

Claims

1. A method for manufacturing a spark plug (100) comprising:

a center electrode (20);
an insulator (10) having an axial bore (12) which extends in an axial direction and holds the center electrode (20) in a front end side of the axial bore (12); and
a metal shell (50) surrounding and holding a radial circumference of the insulator (10) and having a male-screw-shaped fitting thread portion (52) formed on a front end side outer circumference face of the metal shell (50), a seal portion (54) formed so as to project radially outwardly at a rear end side with respect to the fitting thread portion (52), and a locating portion (59) formed between the seal portion (54) and the fitting thread portion (52), where an annular gasket (5)
Verfahren zur Herstellung einer Zündkerze (100)

1. Patentansprüche

4. A method for manufacturing a spark plug (100) according to any one of claims 1 to 3, wherein the gas-

text portion formation step is larger than the inner diam-

3. The method for manufacturing a spark plug (100) according to claim 1, wherein the gasket (5) disposed

2. The method for manufacturing a spark plug (100) according to claim 1, wherein the gasket (5) disposed

1. Verfahren zur Herstellung einer Zündkerze (100) aufweisend:

   eine Mittelelektrode (20);
   einen Isolator (10) mit einer axialen Bohrung
   (12), welche sich in eine axiale Richtung er-
   streckt und die Mittelelektrode (20) in einer vor-
   deren Stirnseite der axialen Bohrung (12) fasst; und

   wobei das Verfahren zur Herstellung einer Zündker-
   ze (100) die Schritte umfasst:

   einen Zylinderteil-Bildungs-Schritt zum Bilden
   eines Zylinderteils (220), welches als Grund-
   form für die Metallhülse (50) dient und wo der
   Dichtabschnitt (54) und der Positionierabschnitt
   (59) gebildet werden, jedoch kein Passgewin-
   deabschnitt (52) gebildet wird;
   einen Dichtungs-Positionier-Schritt zum Anord-
   nen der Dichtung (5) auf einer äußeren Um-
   fangsfläche des Zylinderteils (220) nach dem
   Zylinderteil-Bildungs-Schritt; und
   einen Passgewindeabschnitt-Bildungs-Schritt
   zum Bilden eines Passgewindeabschnitts (52),
   mit einem Gewinde, welches auf einem Gewin-
   deformationsabschnitt (152) des Zylinderteils
   (220) rollt, nach dem Dichtungs-Positionier-
   Schritt.

2. Verfahren zur Herstellung einer Zündkerze (100) ge-

mäß Anspruch 1, wobei die Dichtung (5), die auf der

äußeren Umfangsfläche des Zylinderteils (220) an-

geordnet ist, mit einem Werkzeug (300, 310) zum

Gewindewalzen zu dem Dichtabschnitt (54) hin ge-

drückt wird, um vor dem Passgewindeabschnitt-Bil-

dungs-Schritt auf dem Positionierabschnitt (59) an-

geordnet zu sein.

3. Verfahren zur Herstellung einer Zündkerze (100) ge-

mäß Anspruch 1 oder 2, wobei ein Innendurchmes-

ser (A) der Dichtung (5) größer als ein Außendurch-

messer (Rohteildurchmesser: D) des Gewindefo-

rungsabschnitts (152) ist, und wobei ein maximaler

Außendurchmesser (Spitzendurchmesser: B) des

Gewindegrats (521) nach dem Passgewindeab-

schnitt-Bildungs-Schritt größer als der Innendurch-

messer (A) der Dichtung (5) ist.

Patentansprüche

1. Verfahren zur Herstellung einer Zündkerze (100) aufweisend:

   eine Mittelelektrode (20);
   einen Isolator (10) mit einer axialen Bohrung
   (12), welche sich in eine axiale Richtung er-
   streckt und die Mittelelektrode (20) in einer vor-
   deren Stirnseite der axialen Bohrung (12) fasst; und

   eine Metallhülse (50), welche einen radialen
   Umfang des Isolators (10) umgibt und fasst und
   einen Passgewindeabschnitt (52) in Außenge-
   windeform, welcher auf einer äußeren Um-
   fangsfläche der vorderen Stirnseite der Metall-
   hülse (50) gebildet ist, einen Dichtabschnitt (54),
   welcher so gebildet ist, dass er an einer hinteren
   Stirnseite hinsichtlich des Passgewindeab-
   schnitts (52) radial nach außen hervorsteht, und
   einen Positionierabschnitt (59), welcher zwi-
   schen dem Dichtabschnitt (54) und dem Pass-
   gewindeabschnitt (52) gebildet ist, wo eine ring-
   förmige Dichtung (5) so angeordnet ist, dass sie
   zwischen einem Öffnungsumfangsbereich
   (205) eines Passgewindelochs (201) eines Verb-
   rennungsmotors und dem Dichtabschnitt (54)
   zu dichten, wenn der Passgewindeabschnitt
   (52) in das Passgewindeloch (201) geschaubt
   wird, aufweist,

   wo ein Zylinderteil-Bildungs-Schritt zum Bilden
   eines Zylinderteils (220), welches als Grund-
   form für die Metallhülse (50) dient und wo der
   Dichtabschnitt (54) und der Positionierabschnitt
   (59) gebildet werden, jedoch kein Passgewin-
   deabschnitt (52) gebildet wird;
   einen Dichtungs-Positionier-Schritt zum Anord-
   nen der Dichtung (5) auf einer äußeren Um-
   fangsfläche des Zylinderteils (220) nach dem
   Zylinderteil-Bildungs-Schritt; und
   einen Passgewindeabschnitt-Bildungs-Schritt
   zum Bilden eines Passgewindeabschnitts (52),
   mit einem Gewinde, welches auf einem Gewin-
   deformationsabschnitt (152) des Zylinderteils
   (220) rollt, nach dem Dichtungs-Positionier-
   Schritt.

2. Verfahren zur Herstellung einer Zündkerze (100) ge-

mäß Anspruch 1, wobei die Dichtung (5), die auf der

äußeren Umfangsfläche des Zylinderteils (220) an-

geordnet ist, mit einem Werkzeug (300, 310) zum

Gewindewalzen zu dem Dichtabschnitt (54) hin ge-

drückt wird, um vor dem Passgewindeabschnitt-Bil-

dungs-Schritt auf dem Positionierabschnitt (59) an-

geordnet zu sein.

3. Verfahren zur Herstellung einer Zündkerze (100) ge-

mäß Anspruch 1 oder 2, wobei ein Innendurchmes-

ser (A) der Dichtung (5) größer als ein Außendurch-

messer (Rohteildurchmesser: D) des Gewindefo-

rungsabschnitts (152) ist, und wobei ein maximaler

Außendurchmesser (Spitzendurchmesser: B) des

Gewindegrats (521) nach dem Passgewindeab-

schnitt-Bildungs-Schritt größer als der Innendurch-

messer (A) der Dichtung (5) ist.

   wo ein Zylinderteil-Bildungs-Schritt zum Bilden
   eines Zylinderteils (220), welches als Grund-
   form für die Metallhülse (50) dient und wo der
   Dichtabschnitt (54) und der Positionierabschnitt
   (59) gebildet werden, jedoch kein Passgewinne-
   deabschnitt (52) gebildet wird;
   einen Dichtungs-Positionier-Schritt zum Anord-
   nen der Dichtung (5) auf einer äußeren Um-
   fangsfläche des Zylinderteils (220) nach dem
   Zylinderteil-Bildungs-Schritt; und
   einen Passgewindeabschnitt-Bildungs-Schritt
   zum Bilden eines Passgewindeabschnitts (52),
   mit einem Gewinde, welches auf einem Gewin-
   deformationsabschnitt (152) des Zylinderteils
   (220) rollt, nach dem Dichtungs-Positionier-
   Schritt.

2. Verfahren zur Herstellung einer Zündkerze (100) ge-

mäß Anspruch 1, wobei die Dichtung (5), die auf der

äußeren Umfangsfläche des Zylinderteils (220) an-

geordnet ist, mit einem Werkzeug (300, 310) zum

Gewindewalzen zu dem Dichtabschnitt (54) hin ge-

drückt wird, um vor dem Passgewindeabschnitt-Bil-

dungs-Schritt auf dem Positionierabschnitt (59) an-

geordnet zu sein.

3. Verfahren zur Herstellung einer Zündkerze (100) ge-

mäß Anspruch 1 oder 2, wobei ein Innendurchmes-

ser (A) der Dichtung (5) größer als ein Außendurch-

messer (Rohteildurchmesser: D) des Gewindefo-

rungsabschnitts (152) ist, und wobei ein maximaler

Außendurchmesser (Spitzendurchmesser: B) des

Gewindegrats (521) nach dem Passgewindeab-

schnitt-Bildungs-Schritt größer als der Innendurch-

messer (A) der Dichtung (5) ist.
4. Verfahren zur Herstellung einer Zündkerze (100) gemäß einem der Ansprüche 1 bis 3, wobei die Dich-
tung (5) eine ringförmige Platte ist.

Revendications

1. Procédé de fabrication d’une bougie d’allumage (100) comprenant :
   une électrode centrale (20) ;
   un isolant (10) ayant un alésage axial (12) qui s’étend selon une direction axiale et maintient l’électrode centrale (20) dans un côté d’extrémité frontale de l’alésage axial (12) ; et
   une coquille métallique (50) entourant l’isolant (10) et lui conservant une circonférence radiale, la coquille métallique (50) ayant une portion filetée d’adaptation (52) à filetage mâle formée sur une face de circonférence extérieure de côté d’extrémité frontale de la coquille métallique (50), une portion d’étanchéité (54) formée de façon à se projeter radialement vers l’extérieur au niveau d’un côté d’extrémité arrière par rapport à la portion filetée d’adaptation (52), et une portion de positionnement (59) formée entre la portion d’étanchéité (54) et la portion filetée d’adaptation (52), où un joint plat annulaire (5) est disposé de façon à assurer l’étanchéité entre une portion périphérique d’ouverture (205) d’un trou d’adaptation fileté (201) d’un moteur à combustion interne et la portion d’étanchéité (54) lorsque l’on visse la portion filetée d’adaptation (52) dans le trou d’adaptation fileté (201), le procédé de fabrication d’une bougie d’allumage (100) comprenant les étapes de :
   une étape de formation d’un élément cylindrique pour former un élément cylindrique (220) qui sert de forme originale pour la coquille métallique (50) et au cours de laquelle sont formées la portion d’étanchéité (54) et la portion de positionnement (59), mais aucune portion filetée d’adaptation (52) ;
   une étape de mise en place d’un joint plat pour disposer le joint plat (5) sur une face de circonférence extérieure de l’élément cylindrique (220), après l’étape de formation de l’élément cylindrique ; et
   une étape de formation d’une portion filetée d’adaptation pour former une portion filetée d’adaptation (52) avec un roulage des filets sur une portion de formation de filet (152) de l’élément cylindrique (220), après l’étape de mise en place du joint plat.

2. Procédé de fabrication d’une bougie d’allumage (100) selon la revendication 1, dans lequel le joint plat (5) est une plaque annulaire.

3. Procédé de fabrication d’une bougie d’allumage (100) selon la revendication 1 ou 2, dans lequel un diamètre intérieur (A) du joint (5) est supérieur à un diamètre extérieur (diamètre d’ébauche : D) de la portion de formation de filet (152), et dans lequel un diamètre extérieur maximal (diamètre de crête : B) de la nervure de filet (521), après l’étape de formation de la portion filetée d’adaptation, est supérieur au diamètre intérieur (A) du joint plat (5).

4. Procédé de fabrication d’une bougie d’allumage (100) selon l’une quelconque des revendications 1 à 3, dans lequel le joint plat (5) est une plaque annulaire.
Fig. 6
REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader’s convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2000133410 A [0004]
- US 2941105 A [0008]