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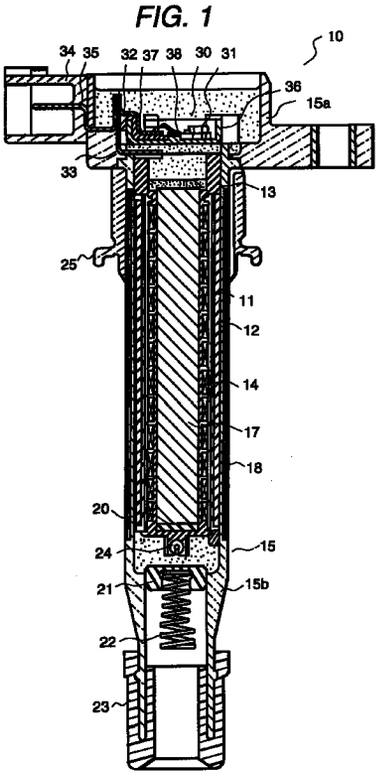
(54) Ignition apparatus for use in internal combustion engine

(57) An ignition apparatus is received in a plug hole (43a) which is formed by a cylinder head (41a) and a cylinder head cover (42a) of an internal combustion engine. A side core (18) has a slit between two horizontally extending side wall ends. The side core (18) comprises one selected from a laminated sheet structure comprised of two grain oriented silicon steel sheets, each having a slit between two horizontally extending side wall ends, and the plural slits align at a substantially same position. The slit prevents an one-turn short of a magnetic flux of the side core (18), thereby a predetermined secondary voltage more than an engine requirement secondary voltage is obtained. An ignitor reception portion comprises an independent and individual ignitor reception portion and an independent and individual coil reception portion, and the ignitor reception portion and the coil reception portion are combined.

FIG. 1



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Description

Background of the Invention:

The present invention relates to an ignition apparatus for use in an internal combustion engine and more particularly relates to a cylindrical form ignition apparatus for use in an internal combustion engine which is received in a plug hole portion of the internal combustion engine.

The present invention relates to a cylindrical form ignition apparatus for use in an internal combustion engine comprising a cylindrical form side core having a slit between vertical side wall ends, and this side core having the slit is constituted by selected one from a single grain oriented silicon steel sheet, a single grain non-oriented silicon steel sheet, a laminated structure of at least two comprised of a grain oriented silicon steel sheet and a grain non-oriented silicon steel sheet, and a laminated structure of at least two grain oriented silicon steel sheets.

The present invention relates to a cylindrical form ignition apparatus for use in an internal combustion engine having a reception body comprised of an ignitor case part and a coil case part, and the reception body comprises an independent and individual ignitor reception portion for receiving the ignitor case part having a connector and an independent and individual coil reception portion for receiving the coil case part.

The present invention relates to an ignition apparatus for use in an internal combustion engine and in particularly to a sealing structure of a cylindrical form ignition apparatus which is received in a plug hole portion of the internal combustion engine.

In a conventional ignition apparatus for use in an internal combustion engine, for example, as shown in Japanese laid-open patent publication No. 228,011/1990, a side core of the ignition apparatus is formed in a spiral form by multiplex winding and laminating with a single grain non-oriented silicon steel sheet to an outer case of the ignition apparatus. The side core includes the grain non-oriented silicon steel sheet of having silicon of 6.5 wt% degree and the grain non-oriented silicon steel sheet has a sheet thickness of 0.1 mm.

However, in the above stated conventional ignition apparatus, the ignition apparatus requires much time for manufacturing the side core in the spiral form and it invites a high cost ignition apparatus for use in the internal combustion engine.

Further, the side core structure in the above stated conventional ignition apparatus overlaps multiplex and completely a whole outside periphery portion of the outer case, in other words, the side core structure forms no gap or no space on the outside periphery portion of the outer case toward an outside periphery horizontal direction of the outer case.

As a result, the conventional ignition apparatus has a low secondary voltage and according to the circumferences the conventional ignition apparatus cannot obtain a necessary secondary voltage and then the ignition apparatus cannot spark surely to the internal combustion engine.

In the above stated conventional ignition apparatus, regardless of a material or a length of a cylinder head or a cylinder head cover of the internal combustion engine in which a plug hole portion for receiving the ignition apparatus is formed, the side core is wound round to have a substantially same cross-sectional area of a center core.

Further, in the above stated Japanese laid-open patent publication No. 228,011/1990, the ignition apparatus has two magnets provided on both ends of the center core. These magnets generate in a magnetic path an opposite side direction magnetic flux against a magnetic flux generated by a primary coil. As a result, it invites a high cost ignition apparatus for use in the internal combustion engine.

In a conventional cylindrical form ignition apparatus for use in an internal combustion engine, the ignition apparatus has an outer case and an ignitor case part (IC package type unit) and a cylindrical form ignition apparatus main body are embodied as an integral body, and a connector is integrally formed to the ignitor case part and is adjacently arranged to an upper portion of the ignitor case part.

In the above stated conventional ignition apparatus, in case where the ignition apparatus is a type where the ignition apparatus main body is received in a plug hole (in generally, a diameter of 23-25 mm), from an aspect of a size dimension, the outer case of an ignitor reception portion projects toward an upper portion of the plug hole. Further, the outer case of the ignitor reception portion has a complicated form having a step portion.

As a result, an accuracy in a cylindrical size dimension of a coil reception portion can not secure, or since the connector is arranged on the upper portion of the ignitor case part, a whole length of the ignition apparatus becomes long.

Further, since the ignition apparatus arranges adjacently to a combustion chamber of an internal combustion engine, an environment temperature in the plug hole reaches to 150 °C at maximum. Therefore, the ignition apparatus is necessary to correspond against a severe heat resistance environment condition.

On the other hand, with respect to the connector structure, the connector is necessary to correspond against a shock force. Such a shock force is added during an mounting time and an installing time or during a maintenance time of the ignition apparatus.

Therefore, the ignition apparatus is necessary to correspond against a connector having a different specification in accordance with a kind of the internal combustion engine and a kind of a control apparatus.

In a conventional ignition apparatus for use in an internal combustion engine, a sealing structure of the ignition apparatus has a sealing rubber member which prevents water leakage from a plug hole portion to a cylinder head cover of the internal combustion engine. The sealing rubber member is received fully in an interior portion of the plug hole portion and the received rubber portion of the sealing rubber member seals at a radial direction of the plug hole portion.

Summary of the Invention:

An object of the present invention is to provide an ignition apparatus for use in an internal combustion engine wherein an effective magnetic flux of a center core portion can pass with the most efficiency.

Another object of the present invention is to provide an ignition apparatus for use in an internal combustion engine wherein a floating capacity generated between a secondary coil and a side core can rationally delete.

A further object of the present invention is to provide an ignition apparatus for use in an internal combustion engine wherein a thickness or a length of a side core can vary in accordance with a material and a length of a cylinder head or a cylinder head cover of the internal combustion engine in which a plug hole portion for receiving the ignition apparatus is formed.

A further object of the present invention is to provide an ignition apparatus for use in an internal combustion engine wherein a number or a thickness of a magnet inserted on one end of a center core or both ends of the center core can vary and, as a result a low cost ignition apparatus for use in an internal combustion engine can obtain.

A further object of the present invention is to provide an ignition apparatus for use in an internal combustion engine wherein an ignition apparatus can correspond to a difference in an actual amounted environment condition or to various required connector specifications.

A further object of the present invention is to provide an ignition apparatus for use in an internal combustion engine where an ignition apparatus. having a superior high reliability can be obtained.

A further object of the present invention is to provide an ignition apparatus for use in an internal combustion engine where a position slip-off between a sealing rubber member and a plug hole portion can be seal surely.

A further object of the present invention is to provide an ignition apparatus for use in an internal combustion engine where a position slip-off between a sealing rubber member and a plug hole portion can be seal surely.

According to the present invention, an ignition apparatus for use in an internal combustion engine comprises a center core, a primary coil wound round on a primary bobbin, a secondary coil wound round on a secondary bobbin, an outer case, and a side core arranged on an outer peripherally of the outer case and made by using a silicon steel sheet, the primary coil and the secondary coil arranged between the center core and the outer case, the ignition apparatus is received in a plug hole which is formed by a cylinder head and a cylinder head cover of the internal combustion engine.

The side core has a slit between two horizontally extending side wall ends and the slit prevents an one-turn short of a magnetic flux of the side core, thereby a predetermined secondary voltage more than an engine requirement secondary voltage is obtained.

So as to attain the above stated objects, according to the present invention, in case where both the cylinder head and the cylinder head cover of the internal combustion engine are made by using the aluminum material, the side core is formed by making round in the substantially pipe form with, for example, one sheet of the single grain oriented silicon steel sheet having the sheet thickness of 0.3-0.5 mm or one sheet of the single grain non-oriented silicon steel sheet having the sheet thickness of 0.3-0.5 mm.

So as to attain the above stated objects, according to the present invention, in case where both the cylinder head and the cylinder head cover of the internal combustion engine are made by using the aluminum material, the side core is formed by making round in the substantially pipe form and laminating with, for example, two sheets or three sheets of the grain oriented silicon steel sheet having the sheet thickness of 0.3-0.5 mm per one sheet and then the side core has the total sheet thickness of more than 0.6 mm or one sheet of the single grain non-oriented silicon steel sheet having the sheet thickness of 0.3-0.5 mm and at least one sheet of the grain oriented silicon steel sheet having the sheet thickness of 0.3-0.5 mm per one sheet and then the side core has the total sheet thickness of more than 0.6 mm.

In the above both cases, the upper end of the side core positions substantial same to the upper end of the cylinder head cover, or the upper end of the side core positions lower than the upper end of the center core.

In case where the cylinder head of the internal combustion engine is made by using the aluminum material and the cylinder head cover of the internal combustion engine is made by using the thermoplastic synthetic resin material (for example, polypropylene, nylon 6, nylon 66, nylon 12, etc.), the side core is formed by making round in the substantially pipe form, for example, one sheet of the single grain oriented silicon steel sheet having the sheet thickness of 0.3-0.5 mm or one sheet of the single grain non-oriented silicon steel sheet having the sheet thickness of 0.3-0.5 mm.

In case where the cylinder head of the internal combustion engine is made by using the aluminum material and the cylinder head cover of the internal combustion engine is made by using the thermoplastic synthetic resin material (for example, polypropylene, nylon 6, nylon 66, nylon 12, etc.), the side core is formed by making round in the substantially pipe form and laminating with, for example, two sheets or three sheets of the grain oriented silicon steel sheet having

the sheet thickness of 0.3-0.5 mm per one sheet and then the side core has the total sheet thickness of more than 0.6 mm or one sheet of the single grain non-oriented silicon steel sheet having the sheet thickness of 0.3-0.5 mm and at least one sheet of the grain oriented silicon steel sheet having the sheet thickness of 0.3-0.5 mm per one sheet and then the side core has the total sheet thickness of more than 0.6 mm.

In the above both cases, the upper end of the side core positions substantial same to the upper end of the cylinder head, or the upper end of the side core positions lower than the upper end of the center core.

In case where the cylinder head of the internal combustion engine is made by using the aluminum material and the cylinder head cover of the internal combustion engine is made by using the thermoplastic synthetic resin material (for example, polypropylene, nylon 6, nylon 66, nylon 12, etc.), and in case where the iron made plug tube is inserted under pressure in the plug hole portion of the internal combustion engine, the side core is formed by making round in the substantially pipe form, for example, one sheet of the single grain oriented silicon steel sheet having the sheet thickness of 0.3-0.5 mm or one sheet of the single grain non-oriented silicon steel sheet having the sheet thickness of 0.3-0.5 mm.

In case where the cylinder head of the internal combustion engine is made by using the aluminum material and the cylinder head cover of the internal combustion engine is made by using the thermoplastic synthetic resin material (for example, polypropylene, nylon 6, nylon 66, nylon 12, etc.), and in case where the iron made plug tube is inserted under pressure in the plug hole portion of the internal combustion engine, the side core is formed by making round in the substantially pipe form, two sheets or three sheets of the grain oriented silicon steel sheet having the sheet thickness of 0.3-0.5 mm per one sheet and then the side core has the total sheet thickness of more than 0.6 mm or one sheet of the grain non-oriented silicon steel sheet having the sheet thickness of 0.3-0.5 mm and at least one sheet of the grain oriented silicon steel sheet having the sheet thickness of 0.3-0.5 mm per one sheet and then the side core has the total sheet thickness of more than 0.6 mm.

In the above both cases, the upper end of the side core positions substantial same to the higher upper end selected one from the upper end of the cylinder head and the upper end of the iron made plug tube, or the upper end of the side core positions lower than the upper end of the center core.

The magnet generates in the magnetic path the opposite side direction magnetic flux against the magnetic flux generated by the primary coil and the magnet is provided on one end of the center core or on both ends of the center core.

In case where both the cylinder head and the cylinder head cover are made by using the aluminum material together with, by inserting the magnet on the both ends of the side core, the good efficiency magnetic flux can generate.

In case the cylinder head is made by using the aluminum material and the cylinder head cover is made by using the thermoplastic synthetic resin material, by inserting the magnet on one end of the center core, the good efficiency magnetic flux can generate.

In the above case, the more good efficiency magnetic flux can generate by inserting the magnet to the center core at the side of the aluminum made cylinder head than the side of the thermoplastic synthetic resin material made cylinder head cover, thereby a low cost ignition apparatus for use in an internal combustion engine can obtain.

According to the present invention, an ignition apparatus for use in an internal combustion engine comprises a center core, a primary coil wound round on a primary bobbin, a secondary coil wound round on a secondary bobbin, an outer case, a side core arranged on an outer periphery of the outer case, and a reception body for receiving an ignitor case part and a coil case part, the ignitor case part having an electrically and adjacently arranged connector, the primary coil and the secondary coil arranged between the center core and the outer case.

The ignitor reception portion comprises an independent and individual ignitor reception portion and an independent and individual coil reception portion, and the ignitor reception portion and the coil reception portion are combined.

According to the present invention, an ignition apparatus for use in an internal combustion engine comprises a center core, a primary coil wound round on a primary bobbin, a secondary coil wound round on a secondary bobbin, an outer case, a side core arranged on an outer periphery of the outer case, a reception body for receiving an ignitor case part and a coil case part, the ignitor case part having an electrically and adjacently arranged connector, and a sealing member for sealing an environment of an inside and an outside of a plug hole portion of the internal combustion engine, the primary coil and the secondary coil arranged between the center core and the outer case.

The ignitor reception portion comprises an independent and individual ignitor reception portion and an independent and individual coil reception portion, the ignitor reception portion receives the ignitor case part at a portion where the sealing member fits into and inserts, and the ignitor reception portion and the coil reception portion are combined.

The above stated object according to the present invention is attained by an ignition apparatus for use in an internal combustion engine comprising an ignitor part having an electrically connected and adjacently arranged connector, and a coil case part, and a reception body for receiving the ignitor part and the coil case part.

The ignition apparatus for use in the internal combustion engine comprises a reception body has two parts comprised of an independent and individual coil reception portion and an independent and individual ignitor reception portion. The coil reception portion receives the coil case part and is inserted into a standardized plug hole of an internal combustion engine, and the ignitor reception portion receives the ignitor case part and is arranged at outside of the plug hole and has the connector which can connect to the other connector having a different specification.

The coil reception portion and the ignitor reception portion are integrally combined at a combination portion.

Further, another essential feature according to the present invention is an ignition apparatus for use an internal combustion engine comprising an ignitor case part having an electrically connected and adjacently arranged connector, and a coil case part, a reception body for receiving the ignitor case part and the coil case part, and a sealing body for sealing an environment of an inside and an outside of a plug hole, which fits into and inserts into the reception body, of the internal combustion engine.

The ignition apparatus for use in the internal combustion engine comprises the reception body has two part comprised of an independent and individual coil reception portion and an independent and individual ignitor reception portion at a portion in which the sealing body is fitted into. The coil reception portion receives the coil case part and inserts into the plug hole, and the ignitor reception portion receives the ignitor case part and arranges at the outside of the plug hole and has the connector which can connect to the other connector having a different specification.

The coil reception portion and the ignitor reception portion are integrally combined at the combination portion.

According to the present invention, the ignition apparatus can correspond with a difference in an actual mounted environment condition or various required connector specifications.

According to the present invention, an ignition apparatus for use in an internal combustion engine comprises a center core, a primary coil wound round on a primary bobbin, a secondary coil wound round on a secondary bobbin, an outer case, a side core arranged on an outer periphery of the outer case, the primary coil and the secondary coil arranged between the center core and the outer case, the ignition apparatus is received in a plug tube and a plug hole portion which is formed by a cylinder head, a cylinder head cover of the internal combustion engine, and an ignition plug is arranged at a lower portion of the plug hole portion, the ignition apparatus comprises further an inner cylindrical portion inserted to the plug hole and a sealing rubber member inserted and fitted into the inner cylindrical portion of the ignition apparatus so as to prevent water penetration into the plug hole.

The sealing rubber comprises a flange portion and a conical portion, the flange portion of the sealing rubber member has an extension face at a radial direction, the extension face contacts to a tip end portion of the cylinder head cover from an axial direction side and enable to bend at the axial direction side and to escape a radial direction slip-off, and the conical portion of the sealing rubber member forms a tapering form toward at a direction of the ignition plug so as to guide the sealing rubber member, when the conical portion of the sealing rubber member inserts to the plug tube.

Brief Description of the Drawings:

Fig. 1 is a cross-sectional view showing one embodiment of an ignition apparatus for use in an internal combustion engine according to the present invention;

Fig. 2 is a horizontal cross-sectional view showing an ignition apparatus for use in an internal combustion engine;

Fig. 3A is an oblique view showing an inner sheet of a side core of an ignition apparatus for use in an internal combustion engine according to the present invention;

Fig. 3B is an oblique view showing an outer sheet of a side core of an ignition apparatus for use in an internal combustion engine according to the present invention;

Fig. 4A is a side view showing a primary bobbin structure having grooves or notches of an ignition apparatus for use in an internal combustion engine according to the present invention;

Fig. 4B is a plan view showing the primary bobbin having the grooves of Fig. 4A;

Fig. 5 is a flow showing a magnetic flux in case where an ignition apparatus for use in an internal combustion according to the present invention is mounted on the internal combustion engine;

Fig. 6 is a relationship between a length of a side core and a secondary voltage of an ignition apparatus for use in an internal combustion engine according to the present invention;

Fig. 7 is a cross-sectional view showing an ignition apparatus for use in an internal combustion engine according to present invention where both a cylinder head and a cylinder head cover of the internal combustion engine are made by using an aluminum material;

Fig. 8 is a cross-sectional view showing an ignition apparatus for use in an internal combustion engine according to present invention where a cylinder head of the internal combustion engine is made by using an aluminum material and a cylinder head cover of the internal combustion engine is made by using a thermoplastic synthetic resin material;

Fig. 9 is a cross-sectional view showing an ignition apparatus for use in an internal combustion engine according to present invention where a cylinder head of the internal combustion engine is made by using an aluminum material and a cylinder head cover of the internal combustion engine is made by using a thermoplastic synthetic resin material and an iron made plug tube is inserted to a plug hole of the internal combustion engine;

Fig. 10A is an oblique view showing one example of a positional relationship between a center core and a magnet of an ignition apparatus for use in an internal combustion engine according to the present invention where the magnet positions at an upper portion of the center core;

Fig. 10B is an oblique view showing another example of a positional relationship between a center core and a magnet of an ignition apparatus for use in an internal combustion engine according to the present invention where the

magnet positions at a lower portion of the center core;

Fig. 10C is an oblique view showing a further example of a positional relationship between a center core and two magnets of an ignition apparatus for use in an internal combustion engine according to the present invention where the two magnets position at an upper portion and a lower portion of the center core;

Fig. 11 is a cross-sectional view showing another embodiment of an ignition apparatus for use in an internal combustion engine according to the present invention where an installation position of an ignition apparatus positions at a lower than an upper end of a center core;

Fig. 12 is an explanatory view showing heat flows which generate in an ignition apparatus for use in an internal combustion according to the present invention;

Fig. 13 is a circuitry showing an ignitor unit structure of an ignitor case part of an outer case of an ignition apparatus for use in an internal combustion according to the present invention;

Fig. 14 is a graph showing a secondary voltage comparison of a respective internal combustion engine having a different thickness of a side core of an ignition apparatus for use in an internal combustion according to the present invention;

Fig. 15 is a cross-sectional view showing a state where one embodiment of an ignition apparatus for use in an internal combustion engine shown according to the present invention is mounted on an internal combustion engine;

Fig. 16 is an oblique view showing one embodiment of an ignitor case part and a coil case part of an ignition apparatus for use in an internal combustion engine according to the present invention;

Fig. 17 is an oblique view showing one embodiment of an ignitor case part of an ignition apparatus for use in an internal combustion engine according to the present invention;

Fig. 18 is an oblique view showing one embodiment of a coil case part of an ignition apparatus for use in an internal combustion engine according to the present invention;

Fig. 19 is a cross-sectional view showing a state where a coil case part and an ignitor case part of one embodiment of an ignition apparatus for use in an internal combustion engine according to the present invention are integrally combined at a combination portion of the coil case part and the ignitor case part;

Fig. 20 is a cross-sectional view showing a state where a coil case part and an ignitor case part of another embodiment of an ignition apparatus for use in an internal combustion engine according to the present invention are integrally combined at a combination portion of the coil case part and the ignitor case part;

Fig. 21 is a cross-sectional view showing a state where a coil case part and an ignitor case part of a further embodiment of an ignition apparatus for use in an internal combustion engine according to the present invention are integrally combined at a combination portion of the coil case part and the ignitor case part;

Fig. 22 is a cross-sectional view showing a sealing rubber member of an ignition apparatus for use in an internal combustion according to the present invention; and

Fig. 23 is a cross-sectional view showing a sealing structure using a sealing rubber member of an ignition apparatus for use in an internal combustion according to the present invention.

Description of the Invention:

Hereinafter, one embodiment of an ignition apparatus for use in an internal combustion engine according to the present invention will be explained referring to Fig. 1 and Fig. 2.

Fig. 1 a cross-sectional view of one embodiment of an ignition apparatus for use in an internal combustion engine according to the present invention, and Fig. 2 is a horizontal cross-sectional view showing an ignition apparatus for use in an internal combustion engine.

An ignition apparatus (an ignition coil) 10 for use in an internal combustion engine mainly comprises a primary bobbin 11, a primary coil 12, a secondary bobbin 13, a secondary coil 14, an outer case 15, an epoxy resin material member 16, a center core (an open magnetic path iron core) 17, a side core (an outer iron core) 18, and a flexible epoxy resin material member 19.

The ignition apparatus (ignition coil) 10 comprises further a magnet 20 arranged at a lower end of the primary bobbin 11, a high voltage terminal 21, a spring member 22, a rubber boot member 23, an advance spark ignition prevention high voltage diode 24, a sealing rubber member 25, and an ignitor unit 30.

The ignitor unit 30 has a copper or aluminum made box form metal base 36 and this metal base 36 installs a power transistor chip 31, a hybrid IC circuit 38. An ignitor terminal 32 is adhered to a terminal stand 37 which is integrally formed with the metal base 36 thorough an adhesive agent 39. The ignitor terminal 32 is connected to a primary coil terminal 33 and a connector side terminal 35. The ignitor unit 30 has a connector 34.

The center core 17 is arranged at a center portion of the ignition apparatus 10 and this center core 17 is constituted by laminating under pressing operation of a grain oriented silicon steel sheet. The primary bobbin 11 fits into an outer periphery of the center core 17 and the primary coil 12 comprised of am enamel wire etc. is wound round an outer periphery of the primary bobbin 11.

The secondary bobbin 13 fits into at an outside of the primary bobbin 11. The plural divided secondary coil 14 is

wound round the secondary bobbin 13 with a predetermined interval. The outer case 15 is wound round at an outer periphery of the secondary bobbin 13.

The outer case 15 comprises an ignitor case part 15a and a coil case part 15b and the above coil case part 15b has a vertically extending projection member 15b1 at an outer portion. The side core 18 is arranged at an outside of the coil case part 15b of the outer case 15.

Fig. 3A is an oblique view showing an inner sheet of a side core of an ignition apparatus for use in an internal combustion engine according to the present invention and Fig. 3B is an oblique view showing an outer sheet of a side core of an ignition apparatus for use in an internal combustion engine according to the present invention.

The side core 18 comprises a laminated structure of two silicon steel sheets 18a and 18b which are an inner silicon steel sheet 18a and an outer silicon steel sheet 18b. Each of the two silicon steel sheets 18a and 18b is made by using a single grain oriented silicon steel sheet.

The inner sheet 18a of the side core 18 is made by using the single grain oriented silicon steel sheet having a sheet thickness of 0.35 mm. The inner sheet 18a is formed in a substantially pipe form having a vertically extending slit 18a1. This inner sheet 18a fits into the outer periphery of the outer case 15 and the slit 18a1 of the inner sheet 18a positions between a projection member 15b1 of the coil case part 15b. This projection member 15b1 of the coil case part 15b is not necessarily to provide on the coil case part 15b.

The outer sheet 18b of the side core 18 is made by using the single grain oriented silicon steel sheet having a sheet thickness of 0.35 mm. The outer steel 18b is formed in a substantially pipe form having a vertically extending slit 18b1. This outer sheet 18b is laminated and overlapped on an outer periphery of the inner sheet 18a.

Accordingly, a laminated structure of the side core 18 having a total sheet thickness of 0.7 mm comprised of the inner sheet 18a. The outer sheet 18b fits to the outside periphery of the outer case 15 and the slit 18b1 of the outer sheet 18b positions between the projection member 15b1 of the coil case part 15b.

In other words, in this embodiment of the ignition apparatus 10 according to the present invention, the laminated structure of the side core 18 comprised of the inner sheet 18a and the outer sheet 18b forms a gap (a space) g between the vertical side wall ends of the inner sheet 18a having the slit 18a1 and between the vertical side wall ends of the outer sheet 18b having the slit 18b1.

The slit 18a1 of the inner sheet 18a for forming the gap g and the slit 18b1 of the outer sheet 18b for forming the gap g can separate electrically by the projection member 15b1 of the coil case part 15b, and the slits 18a1 and 18b1 of the side core 18 prevent an one-turn short of a magnetic flux.

Now, with respect to the grain oriented silicon steel sheet and the grain non-oriented steel sheet employed for the side core 18 of the ignition apparatus 10, the established commercial base kinds of the sheet thickness of the silicon steel sheet are four which are 0.23 mm, 0.3 mm, 0.35 mm and 0.5 mm.

In particularly, in the present invention, as a single sheet structure a single silicon steel sheet having a sheet thickness of 0.5 mm can employ, and a laminated sheet structure of two silicon steel sheets of having a sheet thickness of 0.35 mm (in a total sheet thickness is 0.7 mm) can employ.

The primary bobbin 11 is manufactured by using a thermoplastic synthetic resin material, for example, denatured polyphenylene oxide (hereinafter, "denatured PPO" etc.).

To prevent an occurrence of an insulation destroy in which an electric field concentration occurs by peeling off the epoxy resin material member 16 for insulating between the primary bobbin 11 and a high voltage after a thermal shock test, the above stated primary bobbin 11 is made by using the denatured PPO taking under consideration about an adhesion characteristic with the epoxy resin material member 16.

Since the ignition apparatus 10 for use in the internal combustion engine according to the present invention is installed to a plug hole portion of the internal combustion engine, it is preferable to use a thermal deformation temperature of the denatured PPO having more than 150 °C as the material for the primary bobbin 11.

Fig. 4A is a side view showing a primary bobbin structure having grooves or notches of an ignition apparatus for use in an internal combustion engine according to the present invention and Fig. 4B is a plan view showing the primary bobbin having the grooves of Fig. 4A.

Further, as shown in Fig. 4A and Fig. 4B, two vertically extending grooves (notches) 11a and 11b are provided on the primary bobbin 11 and each of the grooves 11a and 11b has a depth of 0.1-0.5 mm to easily impregnate the high voltage insulation epoxy resin material member 16 in a winding portion of the primary coil 12.

The primary coil 12 is laminated and wound round with a total 100-300 times degree enamel wire having a diameter of 0.3-1.0 mm. This enamel wire is laminated and wound round extending several layers in which every one extending layer each comprises several ten times.

The secondary bobbin 13 is manufactured by using a thermoplastic synthetic resin material (for example, the denatured PPO etc.), and the secondary coil 14 is wound round on the secondary bobbin 13. The secondary bobbin 13 is arranged between the center core 17 and the secondary coil 14 and the secondary bobbin 13 works a role of an insulation of the high voltage generated in the secondary coil 14.

Herein, since the center core 17 floats with the ground (GND), the center core 17 has an intermediate potential of the voltage generated in the secondary coil 14. To insulate a potential difference between the center core 17 and the

secondary coil 14, the secondary bobbin 14 has a thickness of 0.5-1.2 mm.

Further, to prevent the electric field concentration between the secondary coil 14 and the center core 17, the flexible epoxy resin material member 19 is poured under vacuum condition in an inside portion of the secondary bobbin 13. The secondary coil 14 is formed by using the enamel wire having a wire diameter of 0.03-0.06 mm and is dividingly wound round with total 10,000-30,000 times degree.

The outer case 15 is made by using a thermoplastic synthetic resin material (for example, polybutylene terephthalate (hereinafter, "PBT") or polyphenylene sulfide (hereinafter, "PPS") etc..

The above stated outer case 15 has a gate at a side of the high voltage and then an occurrence in voids at the side of the high voltage can prevent. The center core 17 is laminated under pressing operation with a grain oriented silicon steel sheet having a sheet thickness of 0.2-0.7 mm per one sheet.

In case where the ignition apparatus (ignition coil) 10 mounts on the plug hole portion of the internal combustion engine, the side core 18 and the magnet 20, which is provided on a lower portion of the center core 17, are arranged to pass an effective magnetic flux ϕx of the center core 17 portion at maximum and to delete rationally a floating capacity C which generates between the secondary coil 14 and the side core 18.

As shown in Fig. 5, when the ignition apparatus 10 mounts on the plug hole portion of the internal combustion engine, the effective magnetic flux ϕx is divided into a magnetic flux $\phi 1$ of the side core 18 portion and a magnetic flux $\phi 0$ of the plug hole portion of the internal combustion engine.

According to the magnetic flux $\phi 0$ of the plug hole portion of the internal combustion engine, the head cover having the one turn short part of the internal combustion engine is made by using an aluminum material, a relationship between the thickness of the side core 18 and a secondary voltage of the ignition apparatus (ignition coil) 10 is shown as following.

$$\phi x \fallingdotseq \phi 1 + \phi 0$$

$$V_2 \fallingdotseq N \times d\phi x/dt$$

$$V_{2'} \fallingdotseq N \times d(\phi x - \phi 0)/dt$$

wherein, V_2 : a secondary voltage in case of a single ignition apparatus; $V_{2'}$: a secondary voltage of the ignition apparatus mounted on the internal combustion engine.

In this embodiment of the ignition apparatus 10 according to the present invention, since the side core 18 is formed by laminating with two grain oriented silicon steel sheets having a sheet thickness of 0.35 mm per one sheet and then the side core 18 having the total sheet thickness of 0.7 mm is formed on the outer case 15, as a result, an engine requirement secondary voltage can clear.

Fig. 6 shows a relationship between the length of the side core 18 and the secondary voltage of the ignition apparatus 10 in case where both a cylinder head and a cylinder head cover of the internal combustion engine are made by using the aluminum material.

As shown in Fig. 6, it is desirable to position an upper end portion of the side core 18 more than an upper end portion of the cylinder head cover of the internal combustion engine in which the plug portion forms, for example.

Namely, in concretely the upper end portion of the side core 18 positions more than the upper end portion of the cylinder head cover or the upper end portion of the side core 18 positions less than about 10 mm of the upper end portion of the cylinder head cover.

With the above state construction, since the secondary voltage (V1) of the ignition apparatus 10 has more than the engine requirement secondary voltage (V2) required by the engine, a good spark condition in the ignition apparatus (ignition coil) 10 for sparking surely to the internal combustion engine can obtain.

Fig. 7 is a cross-sectional view showing an ignition apparatus for use in an internal combustion engine according to present invention where both a cylinder head and a cylinder head cover of the internal combustion engine are made by using an aluminum material.

In Fig. 7, an aluminum made cylinder head 41a and an aluminum made cylinder head cover 42a forms a plug hole portion 43a which receives the ignition apparatus (ignition coil) 10. An ignition coil 44a is arranged at a lower portion of the ignition apparatus 10.

In case where an upper end 18c of the side core 18 is same or a higher upper end of an upper end 42a1 of the cylinder head cover 42a of the internal combustion engine, the secondary voltage of the ignition apparatus 10 does not vary.

However, in case where the upper end 18c of the side core 18 is lower than the upper end 42a1 of the cylinder head cover 42a of the internal combustion engine, the secondary voltage of the ignition apparatus 10 lowers.

The notch (the slit 18a or the slit 18b) is provided on at least one portion of a circumferential periphery of the above stated side core 18 and this notch 18a or 18b can prevent the one-turn short.

Herein, in case where both the cylinder head 41a and the cylinder head cover 42a are made by using the aluminum

material, the side core 18 is formed by making round in a substantially pipe form and laminating with two sheet or three sheet of a grain oriented silicon steel plate having a sheet thickness of 0.3-0.5 mm per one sheet and then the side core 18 formed in the laminated structure has a total sheet thickness of more than 0.6 mm.

The upper end 18c of the side core 18 is positioned substantial same to the upper end 42a1 of the cylinder head cover 42a or the upper end 18c of the side core 18 is positioned lower than an upper end 17a of the center core 17.

Fig. 8 is a cross-sectional view showing an ignition apparatus for use in an internal combustion engine according to present invention where a cylinder head of the internal combustion engine is made by using an aluminum material and a cylinder head cover of the internal combustion engine is made by using a thermoplastic synthetic resin material.

In Fig. 8, an aluminum made cylinder head 41b and a thermoplastic synthetic resin made cylinder head cover 42b forms a plug hole portion 43b which receives the ignition apparatus (ignition coil) 10. An ignition coil 44b is arranged at a lower portion of the ignition apparatus 10.

In case where the cylinder head 41b is made by using the aluminum material and the cylinder head cover 42b is made by using the thermoplastic synthetic resin material (for example, polypropylene, nylon 6, nylon 66, nylon 12, etc.), the side core 18 is formed by making round in a substantially pipe form with one sheet or two sheets of a grain oriented silicon steel sheet having a sheet thickness of 0.3-0.5 mm per one sheet and then the side core 18 formed by the single grain oriented sheet or by the laminated structure having a total sheet thickness of more than 0.6 mm.

The upper end 18c of the side core 18 is positioned substantial same to an upper end 42b1 of the cylinder head 4b or the upper end 18c of the side core 18 is positioned lower than the upper end 17a of the center core 17.

Fig. 9 is a cross-sectional view showing an ignition apparatus for use in an internal combustion engine according to present invention where a cylinder head is made by using an aluminum material and a cylinder head cover is made by using a thermoplastic synthetic resin material, and an iron made plug tube is inserted to a plug hole portion for receiving the ignition apparatus.

In Fig. 9, an aluminum made cylinder head 41c and an aluminum made cylinder head cover 42c forms a plug hole portion 43c which receives the ignition apparatus (ignition coil) 10. An iron made plug tube 45 is mounted on the cylinder head 41c and covers the ignition apparatus 10. An ignition coil 44c is arranged at a lower portion of the ignition apparatus 10.

In case where the cylinder head 41c is made by using the aluminum material and the cylinder head cover 42c is made by using the thermoplastic synthetic resin material (for example, polypropylene, nylon 6, nylon 66, nylon 12, etc.), and in case where the iron made plug tube 45 is inserted under pressure in the plug hole 43c of the internal combustion engine, the side core 18 is formed by making round in a substantially pipe form and laminating with one sheet of a grain non-oriented steel sheet or two sheets of a grain oriented silicon steel sheet having a sheet thickness of 0.3-0.5 mm and then, for example, the side core 18 is formed by the single grain non-oriented silicon steel sheet having a sheet thickness of 0.5 mm or the side core 18 is formed by the laminated structure having a total sheet thickness of more than 0.6 mm.

The upper end 18c of the side core 18 is positioned substantial same to a higher upper end selected from the upper end 41c1 of the cylinder head 41c and an upper end 45a of the iron made plug tube 45 or the upper end 18c of the side core 18 is positioned lower than the upper end 17a of the center core 17.

Various installing manners for the magnet 20 to the center core 17 will be explained referring to Fig. 10A, 10B and 10C.

As shown in Fig. 10A, the magnet 20a is provided on an upper end of the center core 17. This magnet 20a generates in a magnetic path an opposite side direction magnetic flux against a magnetic flux formed by the primary coil 12.

As shown in Fig. 10B, a magnet 20b is provided on a lower end of the center core 17. This magnet 20b generates in a magnetic path an opposite side direction magnetic flux against a magnetic flux formed by the primary coil 12.

As shown in Fig. 10C, two magnets 20c and 20d are provided on an upper portion and a lower end of the center core 17. These magnets 20c and 20d generate in a magnetic path an opposite side direction magnetic flux against a magnetic flux formed by the primary coil 12.

In case where both the cylinder head and the cylinder head cover are made by using the aluminum material, by inserting the magnets 20c and 20d in the both ends of the center core 17 as shown in Fig. 10C, the good efficiency magnetic flux can generate.

On the other hand, in case the cylinder head is made by using the aluminum material and the cylinder head cover is made by using the thermoplastic synthetic resin material, by inserting the magnet 20a or the magnet 20b in one end of the center core 17 as shown in Fig. 10A or Fig. 10B, the good efficiency magnetic flux can generate.

In the above case, the more good efficiency magnetic flux can generate by inserting the magnet 20a or the magnet 20b on a side of the aluminum made cylinder head than a side of the thermoplastic synthetic resin material made cylinder head cover of the center core 17, thereby a low cost ignition apparatus 10 for use in an internal combustion engine can obtain.

Further, in the conventional ignition apparatus, an installation position of the ignition coil can not be lower than the upper end of the center core.

Fig. 11 is a cross-sectional view showing another embodiment of an ignition apparatus for use in an internal com-

bustion engine according to the present invention where an installation position of an ignition apparatus positions at a lower than an upper end of a center core.

However, according to the present invention, as shown in Fig. 11, an installation position 46 of the ignition apparatus (ignition coil) 10 can be lower the upper end 17a of the center core 17.

As a result, the ignition apparatus 10 can install to the internal combustion engine which has a short distance starting from an installation position of an ignition plug to the installation position 46 of the ignition apparatus 10.

These construction components are arranged concentrically in order the center core 17, the secondary coil 14, the primary coil 12, the outer case 15, and the side core 18 from the inside portion of the ignition apparatus 10.

These coil portions are inserted into the outer case 15 and insulate the high voltage by the insulation layer 16 comprised of the epoxy resin material, etc.. As the epoxy resin material 16, to improve the thermal shock property (repeat test by -40 °C and 130 °C, etc.) and a high voltage withstanding characteristic under high temperature, the epoxy resin material 16 having a glass transfer point of 120-162 °C after hardening and further a thermal expansion coefficient of 10-50 x 10^{E-6} as a mean value in a temperature range less than the glass transfer temperature employs.

Fig. 12 is an explanatory view showing heat flows which generate in an ignition apparatus for use in an internal combustion according to the present invention.

In the cylindrical form ignition apparatus 10 received in the plug hole 43 (43a, 43b, 43c), a maximum problem is that how the heat generation in the primary coil 11 can make to escape in the air of an outside of the plug hole 43 of the internal combustion engine.

The heat generates in the primary coil 12 and the secondary coil 14. In general, the heat generation amount of the secondary coil 14 is less than of a half of the heat generation amount of the primary coil 12 and a total sum of an electric power loss in the primary coil 12 and the secondary coil 14 is about less than 4W.

The above stated heat, as shown in Fig. 12, becomes a thermal flow A for escaping to the air from the epoxy resin material 16 through the center core 17 and a thermal flow B for escaping to the air from the epoxy resin material 16 through the side core 18.

With the reasons stated in above, when the relationship between the heat (the electric power loss), the temperature rise in the primary coil 12 and the circumferential periphery temperature of the outside of the plug hole is expressed using a thermal resistance, the thermal resistance of the ignition apparatus is about 15 °C/W.

In case where the upper portion of the plug hole is cooled by the air, the thermal resistance of the ignition apparatus 10 is about 5 °C/W - 10 °C/W.

As a result, the ignition apparatus 10 is constituted by the structure having the good conductivity epoxy resin material 16.

The high voltage generated in the secondary coil 14 is supplied to the ignition plug 44 (44a, 44b, 44c) through the high voltage terminal 21, the spring member 22 etc.. A portion where the ignition plug 44 is inserted is insulated by the rubber boot 23 such as a silicon rubber member etc..

Fig. 13 is a circuitry showing an ignitor unit structure of an ignitor case part of an outer case of an ignition apparatus for use in an internal combustion according to the present invention.

An one-chip ignitor 50 installed on the upper portion of the coil portion, as shown in Fig. 13, comprises an insulation type bipolar transistor (hereinafter, "IGBT") 51, a current limitation circuit 52 and an input resistor 53. IGBT 51 comprises a main insulation type bipolar transistor (a main-IGBT 54) and a sub insulation type bipolar transistor (a sub-IGBT 55).

A current detection load 56 is provided between the sub-IGBT 55 and the ground (GND). A dual direction polysilicon zener diode 57 is inserted between a gate and a collector of the IGBT 51 and this diode 57 is constituted to have a superior temperature characteristic. Further, this diode 57 clamps the primary voltage with 350-450 V.

A bleeder resistor 58 is inserted between the input and the ground (GND) and a contact current of an input signal connection part is more than 1 mA. A full connection reliability about a soldering of the terminal, even in case the soldering is Sn soldering, can obtain.

In the above stated one-chip ignitor 50, as shown in Fig. 1, the copper or an aluminum made metal base for a heat radiation is adhered with a silicon adhesion agent at a lower portion of a heat sink of a side where IGBT 51 joins.

The IGBT 51 and the terminal are connected with an aluminum wire and are molded by an epoxy resin material and the mold member forms TO-3P type or TO-220 type.

Fig. 14 is a graph showing a secondary voltage comparison of a respective internal combustion engine having a different thickness of a side core of an ignition apparatus for use in an internal combustion according to the present invention.

As understood from Fig. 14, according to this embodiment of the ignition apparatus, even the internal combustion engine having the iron plug tube and even the internal combustion engine having the aluminum made cylinder head cover, the ignition apparatus can obtain the required necessary secondary voltage.

The thickness and the length of the side core can vary in accordance with the material or the length of the cylinder head or the cylinder head cover of the plug hole portion of the internal combustion engine.

Further, the number or the thickness of the magnet which is inserted to one end of the center core or both ends of

the center core can vary, as a result the low cost ignition apparatus for use in the internal combustion engine can obtain.

Fig. 15 is a cross-sectional view showing a state where one embodiment of the ignition apparatus for used in the internal combustion engine is mounted on the internal combustion engine.

One embodiment of the cylindrical form ignition apparatus 70 for use in the internal combustion engine according to the present invention, as shown in Fig. 15, is mounted on the internal combustion engine.

As shown in Fig. 16, the ignition apparatus 70 has an outer case (a reception portion) 71 and a side core 72. The outer case 71 comprises an ignitor case part 71a (an ignitor reception portion) and a coil case part 71b (a coil reception portion).

The internal combustion engine has a cylinder head 73 and a cylinder head cover 74. An ignition plug 76 projects and is fixed toward a combustion chamber of the internal combustion engine.

The ignition apparatus 70 for use in the internal combustion engine is fixed to the cylinder head cover 74 by an installation bolt 80 through an installation portion 71h which is provided on the ignitor case part 71a. The coil case part 71b of the ignition apparatus 70 for use in the internal combustion engine is inserted in a plug hole portion 75.

This plug hole portion 75 is drilled on the cylinder head 73 and the cylinder head cover 74 which easily receive a thermal energy generated in the combustion chamber. As a result, the coil case part 71b requires a high heat resistance property such as about 710 °C.

A hole diameter and a hole depth of the plug hole portion 75 to which the coil case part 71b is inserted are standardized at a predetermined rule with a predetermined kind of the internal combustion engine.

Next, the ignitor case part 71a and the coil case part 71b comprising the outer case 71 of this embodiment of the ignition apparatus 70 will be explained referring to Fig. 16 Fig. 17 and Fig. 18.

Fig. 16 is an oblique view showing one embodiment of an ignitor case part and a coil case part of an ignition apparatus for use in an internal combustion engine according to the present invention, Fig. 17 is an oblique view showing one embodiment of an ignitor case of an ignition apparatus for use in an internal combustion engine according to the present invention, and Fig. 18 is an oblique showing one embodiment of a coil case of an ignition apparatus for use in an internal combustion engine according to the present invention.

In Fig. 17, the ignitor case part 71a served as a connector 79 is formed by using PBT resin material from aspects of a shock strength and of an assurance of a size dimension accuracy required as the connector 79.

In particular, the connector 79 served as the ignitor case part 71a has various embodiments to correspond with a different specification of the other connector, and various kinds of the ignitor case part 71a are manufactured.

Since the connector 79 which fits into the other connector has a complicated form, the connector 79 is manufactured using a slide molding processing. Accordingly, to manufacture the ignitor case part 71a served as the connector 79, the ignitor case part 71a requires a material characteristic having an excellent molding property.

As stated in above, it is difficult to standardize the ignitor case part 71a, which has the connector 79 for corresponding the different specification of the other connector, in case where the outer case 71 has integrally formed as shown in the prior art.

Therefore, as shown in Fig. 16, Fig. 17 and Fig. 18, the outer case part 71b comprises the independent and individual ignitor case part 71a and the independent and individual coil case part 71b. Further, the ignitor case part 71a has a combination portion (namely, a fitting-into portion) with the coil case 71b to integrally form the ignitor case part 71a and the coil case part 71b.

A step portion 71c for preventing a slip off and a projection portion 71e for preventing a rotation stop and for determining a position are provided on the above stated combination portion. Further, a portion for receiving an ignitor case 78 etc. as the ignitor case part 71a forms a cup (inside box) form.

On the other hand, as shown in Fig. 18, the coil case part 71b is inserted in the standardized plug hole portion 75 as stated in above. The coil case part 71b is formed using PPS resin material from an aspect of a heat resistance property etc..

The coil case part 71b can form using a mixture resin material in which a denatured polyphenylene oxide resin material ("denatured PPO" or "denatured PPO resin material) being as a composition agent, for example 20 %, is blended to PPS resin material.

As a result, the combination portion (namely, the fitting-into portion) is provided on the ignitor case part 71a to integrate the coil case part 71b. A step portion 71e for preventing a slip off and a notch portion 71f for preventing a rotation stop and for determining a position are provided on the above stated combination portion.

Herein, to utilize the standardization of the plug hole portion 75, in response to the size dimension of the regulated plug hole portion 75, an appearance size dimension of the coil case part 71b (for example, diameter D20 of the step portion 71d, a diameter d21 and a whole length of the ignition apparatus case main body) can unify. Accordingly, a common use of the coil case part 71b can attain.

Further, the diameter D20 of the step portion 71d is the same size dimension of the dimension D20 of the step portion 71c as shown in Fig. 17. In particular, the diameter D20 of the step portion 71c is the same diameter of the ignitor case part 71a which is manufactured by a different form to correspond with the other connector having a different specification. The diameter D20 of the step portion 71c unify to utilize the standardization of the plug hole 75.

Fig. 19 is a cross-sectional view showing a state in case where at the combination portion of the coil case part and the ignitor case part, one embodiment of both the coil case part and the ignitor case part are integrally combined at the combination portion according to the present invention.

The outer case 71 comprised of the ignitor case part 71a and the coil case part 71b has two parts to correspond to the difference in the environment condition subjected to actually mount and the various kinds of the connector specification to subjected to require.

However, finally to use the ignition apparatus 70 for use in the internal combustion engine, the ignitor case part 71a and the coil case part 71b should integrally combine with at the fitting-into portion.

Therefore, at the combination portion, namely at the step portion 71c of the ignitor case part 71a and at the step portion 71d of the coil case part 71b, the ignitor case part 71a and the coil case part 71b are combined with at the fitting-into portion.

In other words, at the combination portion (namely, the fitting-into portion) corresponding to a portion which corresponds to a vicinity of an upper face of the plug hole portion 75 for receiving or inserting the ignitor case part 71a and the coil case part 71b to the internal combustion engine, the ignitor case part 71a and the coil case part 71b are fitted into and integrally combined with at the combination portion.

In concretely, in case of the embodiment shown in Fig. 19, an adhesive agent 82 is coated on V form groove 71g which is provided on the combination portion. The combination portion is combined using the adhesion processing, namely the combination portion is joined. In this case, the projection portion 71e and the notch portion 71f are meshed with and then the rotation direction fixes.

As stated in above, the outer case 71 according to the embodiment of the ignition apparatus comprises the independent and individual ignitor case part 71a and the independent and individual coil case part 71b. The above stated ignitor case part 71a is formed with various forms to correspond to the other connector having the different specification.

The above stated coil case part 71b has the standardized outer appearance (the diameter and the whole length) which corresponds to the standardized plug hole portion 75. The ignitor case part 71a and the coil case part 71b are integrally combined with at the combination portion.

Further, in the combination face (namely, the fitting-into face) of both step portions 71c and 71d, the rectangular angle degree between the axial direction of the coil case part 71b (namely, the hole axial direction of the plug hole portion 75) and the connection direction of the connector 79 (a right angle against the hole axial direction of the plug hole portion 75) and also the size dimension accuracy of a distance between an axial center of the coil case part 71b and a center of an installation portion 71h which is provided on the ignitor case part 71a can secure.

In other words, the combination face of both step portions 71c and 71d is formed to have a contact face which is vertical with the axial direction of a longitudinal direction of the coil case part 71b (namely, the hole axial direction of the plug hole portion 75) and a contact face which is concentrically with an axial center of the coil case part 71b. Accordingly, in the combination portion, both step portions 71c and 71d are fitted into and strongly joined with no aberration.

Table 1

material characteristic	PPS	PBT	denatured PPO	PPS + denatured PPO	connector requirement	coil case requirement
heat resistance	◎	○	△	◎		◎
shock strength	△	◎	○	△	◎	
chemical proof	◎	◎	△	○	◎	○
adhesion	△	○	◎	◎		○
voltage withstand	◎	○	○	○		◎

Table 1 is a table which is putted in order the material for use in the coil case part 71b and the material for use in the ignitor case part 71a served as the connector 79 by estimating the requirement characteristic of the coil case part 71b and the ignitor case part 71a.

In Table 1, with respect to the materials for use in the coil case part 71b and the connector 79, every characteristic item required from the use each, an order of a superior material characteristic and an order of a requirement degree are expressed by ◎, ○, △ and the results are shown.

Namely, the required characteristics of the coil case part 71b which is inserted in the plug hole portion 75 for receiving the coil unit are mainly the heat resistance characteristic and the voltage withstanding characteristic.

On the other hand, the required characteristics of the ignitor case part 71a which receives the ignitor unit 78 and has an important function as the connector 79 are mainly the shock strength and the chemical-proof characteristic.

As stated in above, each of the materials of the ignitor case part 71a and the coil case part 71b being the outer case 71 has respectively the different required characteristic.

Accordingly, it is desirable to constitute the two-divided part structure and the integral combination structure for the coil case part 71b and the connector 79 (namely, the ignitor case part 17a) and the above desires will be understood from Table 1.

The material for satisfying the required characteristics of the connector 79 is PBT resin material, for example. On the other hand, the material for satisfying the required characteristic of the coil case part 71b is PPS resin material or a mixture resin material of PPS and the denatured PPO, for example.

Herein, in case of the use of PPS resin material, it is necessary to consider about the adhesion property (or the stick property). Namely, since the adhesion property between the insulation epoxy resin material for filling up and enclosing and the coil case part 71b is inferior, the peel-off may occur and this causes a defect and further there is a possibility of an occurrence of an ignition failure.

Accordingly, to ensure the long period insulation property of the ignition apparatus 70, it is necessary to maintain the adhesion of the epoxy resin material and the coil case part 71b.

In concretely, the thermal stress under -40 °C and 130 °C, which is equivalence of the temperature environment condition of the internal combustion engine, alternatively and repeatedly adds and it is desirable to not generate the peel-off at more than 300 cycles.

As the material of the coil case part 71b, in case where PPS resin material is used individually, it is ascertained a case of the generation of the peel-off in less than 300 cycles according to the use condition.

On the other hand, the denatured PPO has a good adhesion property against the insulation epoxy resin material, in generally the denatured PPO is used as the material of a secondary coil of the ignition apparatus. However, since the denatured PPO is inferior in the chemical-proof property, the denatured PPO is not suitable for a portion where the substance exposes to the outside atmosphere.

Herein, as stated in above, a sealing rubber member 77 as the sealing body, which is inserted to the vicinity of the upper face of the plug hole portion 75 of the internal combustion engine, isolates the environment of the inside and the outside of the plug hole portion 75.

In addition to the prevention of the water intrusion, the above stated sealing rubber member 77 works an important role that it does not expose the coil case part 71b to the outside atmosphere. Accordingly, there is a possibility that the denatured PPO can use to the coil case part 71b.

Herein, relating to the material for the coil case part 71b, it can correspond using a following mixture material. The mixture material comprises PPS resin material having the superior heat resistance property, the superior chemical-proof property and the superior voltage withstanding property, and the denatured PPO having the superior adhesion property to the insulation epoxy resin material.

For example, PPS resin material becomes a base material and 20 % degree denatured PPO is mixed with PPS resin material, therefore the coil case part 71b is made by using the mixture material of the respective characteristic of PPS resin material and the denatured PPO.

Namely, as the material for the coil case part 71b, it is desirable to mix the base material having the material characteristics of the superior heat resistance property and the superior voltage withstanding property and the mixture agent having the material characteristic of the superior adhesion property to the insulation resin material for insulating the coil part. Further, it is desirable to form the mixture material for utilizing the material characteristic which has the respective resin material.

In other words, it is possible to utilize the function of the sealing rubber member 77 for isolating the environment of the inside and the outside of the plug hole portion 75.

Namely, the ignition apparatus 70 for use in the internal combustion engine comprises an ignitor part having an electrically connected and adjacently arranged connector 79, and the coil case part 71b, and the reception body 71 (71a and 71b) for receiving the ignitor part and the coil part.

The reception body 71 has two parts comprised of a coil reception portion 71b and an ignitor reception portion 71a. The coil reception portion 71b receives the coil part and is inserted into a standardized plug hole portion 75 of the internal combustion engine.

The ignitor reception portion 71a receives the ignitor part and is arranged at outside of the plug hole and has the connector 79 which is connected to the other connector having a different specification. The coil reception portion 71b and the ignitor reception portion 71a are integrally combined at the combination portion.

Besides, in case where an allowable range exists in the required environment specification, it is possible to make the coil case part 71b and the ignitor case part 71a using the same material.

In this case, since each of both the coil case part 71b and the ignitor case part 71a forms separately, the molding conditions, such as a mold parting line direction, an injection gate position and a push-out pin position of the mold form which suits to the respective form, can set appropriately.

Accordingly, it can make a good use of the merits where the defect by the molding lessens and the superior case having the above stated rectangular angle degree and size dimension accuracy is manufactured. The use range can enlarge according to the above stated merits.

With respect to this embodiment, it is desirable to employ PPS resin material which is well-balanced in the heat resistance property, the chemical-proof property and the voltage withstanding property in comparison with the other resin materials.

To sum up the above, the essential feature of the present invention is that the reception body 71 being as the outer body comprises two parts comprised of the coil case part 71b and the ignitor case part 71a.

The coil case part 71b serves as the coil reception portion, the coil case part 71b receives mainly the coil part and is inserted into the plug hole portion 75 in which a hole diameter is standardized of the internal combustion engine.

The ignitor case part 71a serves as the ignitor reception portion and the ignitor case part 71a receives mainly the ignitor part and has the connector 79 which is connected to the other connector having the different specification. The coil case part 71b and the ignitor case part 71b are integrally combined at the combination portion.

In other words, the reception body 71 comprises two parts comprised of the coil reception portion 71b inserted in the plug hole portion 75 and the ignitor reception portion 71a positioned at the outside of the plug hole portion 75 by making the boundary of the inside portion and the outside portion of the plug hole 75 of the internal combustion engine in which the environment required specification differs, this environment required specification is determined by the environment where the reception body 71 arranges.

The coil reception portion 71b and the ignitor reception portion 71a comprise the parts and integrally combined at the combination portion.

Further, the coil case part 71b for receiving the ignition apparatus main body and the ignitor case part 71a for serving as the connector 79 and for receiving the ignitor unit 78 are separated.

Then the coil case part 71b is made by using the synthetic resin material having the superior heat resistance property, the superior voltage withstanding property and the superior adhesion property with the coil insulation resin material.

Fig. 20 is a cross-sectional view showing another embodiment of a state where a coil case part and an ignitor case part are integrally combined at a combination portion of the coil case part and the ignitor case part according to the present invention.

As shown in Fig. 20, the coil case part 71b has an extension portion (a development portion) in which the step portion 71d of the coil case part 71b develops and extends along toward a bottom portion of the ignitor case part 71a.

Since the development portion exists, the above stated rectangular angle degree and the size dimension accuracy can improve. Further, since the contact face enlarges, the stability of the fitting-into at the combination portion can obtain.

The development portion of the coil case part 71b having the superior heat resistance property covers the ignitor case part 71a, the heat resistance property of the bottom portion of the ignitor case part 71a which arranges oppositely to the cylinder head cover 74 etc. of the internal combustion engine can improve.

Namely, even the employment of the ignitor case part 71a which is made by the synthetic resin material having a little inferior heat resistance property, it can obtain a merit for corresponding the severe environment condition wherein the part for facing to the cylinder head cover 74 etc. of the internal combustion engine which is provided the outside of the plug hole portion 75 reaches to 130 °C at maximum temperature.

The fixture between the coil case part 71b the ignitor case part 71a can carry out by a joining method using the adhesion agent 82, a fixture method for injecting and for fixing by using a fill-up insulation epoxy resin material, a fixture method for manufacturing separately in advance the coil case part 71b and the ignitor case part 71a and after that for integrally molding and for fixing them, etc.. Any method can employ.

Fig. 21 is a cross-sectional view showing a further embodiment of a state where a coil case part and an ignitor case are integrally combined at a combination portion of the coil case part and the ignitor case part according to the present invention.

Namely, this figure shows a view of a cross-section of the molding state of the both cases according to the method for integrally molding and for fixing stated in above.

In Fig. 21, the cross-section has a left sliding metal mold 83a1 and a right sliding metal mold 83a2 for molding a metal mold and a core mold 83b, and an arrow mark shows a movable sliding direction of the respective mold.

In case of the integral molding, one of the step portion 71c or the step portion 71d is buried against the other side case for integrally molding. As a result, the buried step portion serves as a role of the pull-out prevention or the rotation stop prevention, and with one tome process of the mold processing, the combination (join) and the pull-out prevention or the rotation stop prevention carries out effectively.

As stated in above, the coil case part 71b and the ignitor case part 71a for receiving the ignitor unit 78 etc. and serving as the connector 79 are separately formed. As a result, the cylindrical form ignition apparatus 70 for use in the internal combustion engine for satisfying the respective required characteristic for the connector 79 and the coil case part 71b can obtain.

Further, the ignitor case part 71a arranges to form an arrangement where the connector 79 extends toward the lateral direction of the ignitor unit 78, namely the connector 79 extends toward the rectangular direction with the hole axial direction of the plug hole portion 75 of the internal combustion engine.

Accordingly, the whole length in the vertical direction of the ignition apparatus 70 for use in the internal combustion engine becomes short and a space effect can improve.

Further, in generally, the ignition apparatus 70 is connected to a control apparatus having the other part connector having the different specification. The other connector has the different connector direction and also the different installation position and this connector having the different form for corresponding to the respective internal combustion engine.

According to the present invention, the above stated correspondence can perform in accordance with the size dimension alternation of only the side of the ignitor case part 71a. As a result, the common use of the ignitor case part 71a and the coil case part 71b can attain and the standardization in the components can realize, and the low cost ignition apparatus for use in the internal combustion engine can obtain.

According to the present invention, in response to the required specification (the characteristic), the respective most suitable size dimension and the respective most suitable material can select, as a result the strength and the size dimension of the connector 79, and the durability of the coil part of the ignition apparatus 70 for use in the internal combustion engine can improve.

Further, in case of the manufacture of the ignition apparatus 70 for use in the internal combustion having the different specification, it can correspond according to the alternation of only the ignitor case part 71a, the common use of the ignitor case part 71a with the coil case part 71b can attain.

Accordingly, for example, in case of the cylindrical form ignition apparatus 70, the high durability and the high reliability ignition apparatus 70 for use in the internal combustion engine having the short whole length, the high accuracy dimension and the high strength of the connector 79, the superior heat resistance shock property and superior voltage withstanding property can obtain.

Next, a sealing rubber member structure and a sealing structure having a sealing rubber member of an ignition apparatus for use in an internal combustion engine according to the present invention will be explained.

Fig. 22 is a cross-sectional view showing a sealing rubber member structure of an ignition apparatus for use in an internal combustion engine according to the present invention and Fig. 23 is a cross-sectional view showing a sealing structure having a sealing rubber member of an ignition apparatus for use in an internal combustion engine according to the present invention.

A construction and an operation of one embodiment of a sealing rubber member structure and a sealing structure will be explained referring to Fig. 22 and Fig. 23.

As shown in Fig. 23, one embodiment of an ignition apparatus 90 comprises a coil case part 91, a side core 92 having several hemisphere form projection portions 92a, and a sealing rubber member 95. The internal combustion engine has a plug tube 93 and a cylinder head cover 94.

In Fig. 23, D is an outer diameter of an inner cylindrical portion of the ignition apparatus 90, D9 is an inner diameter of the cylinder head cover 94, D5 is an inner diameter of the plug tube 93, and D4 is an outer diameter of the projection portion 92a of the side core 92.

As shown in Fig. 23, the sealing rubber member 95 comprises a conical portion 95a having an inner diameter D1, a step portion 95b, an inside cylindrical portion 95c having an inner diameter D2 and an outer diameter D3, a flange portion 95d for forming a radial direction extending face, an upper end portion 95e, a dent portion 95f, and an outside cylindrical portion 95g. The step portion 95b makes a dimension size to have $D1 < D < D2$ and the dent portion 95f is provided on the flange portion 95d.

The sealing rubber member 95 with the above stated structure is inserted under pressure and fixed to the inner cylindrical portion of the ignition apparatus 90.

Since the sealing rubber member 95 has the step portion 95b where the dimension size is formed to have $D1 < D < D2$, a pressure-in dimensional tolerance at a side of the conical portion 95a can make large.

In other words, in the inside cylindrical portion 95c having the inner diameter D2 of the sealing rubber member 95, the inner diameter D2 of the inside cylindrical portion 95c is larger than the outer diameter D of the inner cylindrical portion of the ignition apparatus 90. Therefore, the sealing rubber member 95 can easily insert to the inner cylindrical portion of the ignition apparatus 90.

On the other hand, in the conical portion 95a having the inner diameter D1 of the sealing rubber member 95, a thickness of the conical portion 95a for inserting under pressure can be secured fully.

Further, since the pressure-in dimensional tolerance at the conical portion 95a of the sealing rubber member 95 is made large, a pressure-in force can also made large, in case where the ignition apparatus 90 is received at the plug tube 93 in the plug hole portion, a turn up of the conical portion 95a of the sealing rubber member 95 can prevent.

On the other hand, in case where the ignition apparatus 90 is received at the plug tube 93 in the plug hole portion, a tapering face of the conical portion 95a of the sealing rubber member 95 works a role of a guide member.

Namely, in a state where the sealing rubber member 95 is inserted into the inner cylindrical portion of the ignition

apparatus 90, the sealing rubber member 95 has the conical portion 95a and a conical tip end portion 95s of the conical portion 95a. The conical portion 95a having the conical tip end portion 95s has the tapering form where the outer diameter reduces gradually toward a tip end at the side of an ignition plug.

Further, an outer periphery face of the outer diameter D3 of the inside cylindrical portion 95c of the sealing rubber member 95 forms a non-contacting state (D3 < D9) with respect to an inner periphery face of the inner diameter D9 of the plug hole portion in the cylinder head cover 94. As a result the sealing rubber member 95 can insert easily to the plug hole.

The projection portion 92a of the side core 92 forming the inner cylindrical portion has a projection form which projects toward a part or a whole periphery of the outer periphery of the cylindrical portion of the ignition apparatus 90.

The above stated tip end portion 95s of the conical portion 95a of the sealing rubber member 95 becomes the tip end of the side of the ignition plug of the sealing rubber member 95 which has inserted into the inner cylindrical portion of the ignition apparatus 90. The projection portion 92a of the side core 92 positions at a nearer side of the ignition plug than the conical tip end portion 95s of the conical portion 95a of the sealing rubber member 95.

The outer diameter D4 of the projection portion 92a of the side core 92 has a dimension size relationship of D < D4 < D5. An outer diameter of the conical tip end portion 95s of the inserted sealing rubber member 95 forms smaller than the outer diameter D4 of the projection portion 92a of the side core 92. Therefore, the turn up of the sealing rubber member 95 can prevent.

Namely, in the state where the sealing rubber member 95 is inserted into the inner cylindrical portion of the ignition apparatus 90, the conical tip end portion 95s of the sealing rubber member 95 positions at a rear portion of the projection portion 92a of the side core 92.

Therefore, when the ignition apparatus 90 inserts into the plug hole portion and the plug tube 93, the turn up of the sealing rubber member 95 can prevent. The projection portion 92a, which works a role of the inner cylindrical portion, of the side core 92 can provide on the coil case part 91.

On the other hand, in the sealing rubber member 95 of this embodiment of the ignition apparatus 90 according to the present invention, as shown in Fig. 22, when the ignition apparatus 90 inserts into the plug hole portion, the flange portion 95d for forming the radial direction extending face of the sealing rubber member 95 contacts to a tip end portion 94a of the cylinder head cover 94.

With the above stated state, the sealing structure having the sealing rubber member 95 of the ignition apparatus 90 can form. As a result, the water penetration into the cylinder head cover 94 can prevent.

Namely, as stated in above, in the tip end portion 94a in the plug hole portion, a dimensional scatter size occurs about 1 mm degree at the axial direction.

However, when the flange portion 95d of the sealing rubber member 95 contacts to the tip end portion 94a of the cylinder head cover 94 and is pushed under pressure, the flange portion 95d of the sealing rubber member 95 deforms, accordingly the water penetration etc. can prevent.

The extension face formed on the above stated flange portion 95d and for extending toward the radial direction indicates a face for extending and expanding toward the radial direction of the inner cylindrical portion of the ignition apparatus 90.

Even the tip end portion 94a of the cylinder head cover 94 slips off about 1 mm degree toward the radial direction, the extension face contacts at always to the slipped-off tip end portion 94a of the cylinder head cover 94. Therefore, an excellent the sealing property of the ignition apparatus 90 can surely obtain.

A necessary extent of the extension face of the flange portion 95d of the sealing rubber member 95 is one where the position slip-off of the plug hole can absorb fully, in other words, where the slip-off toward the radial direction of the tip end portion 94a (the outside cylindrical end portion) of the cylinder head cover 94 can escape.

For example, the extent is more than one which has a total dimension size of an end portion dimension size of the tip end portion 94a of the cylinder head cover 94 in addition to the maximum slip-off dimension size.

On the other hand, the tapering form conical portion 95a of the sealing rubber member 95 works a role of the guide member in case where the inner cylindrical portion of the ignition apparatus 90 inserts into the plug hole portion and the plug tube 93. Therefore, an alignment between the cylindrical portion of the ignition apparatus 90 and the plug tube 93 takes precedence.

Accordingly, the maximum slip-off dimension size must absorb between the plug hole portion formed by the cylinder head cover 94 and the sealing rubber member 95. Therefore, the extension face of the sealing rubber member 95 can absorb the positional slip-off and further can work a role of the sealing function.

The above sealing structure of the ignition apparatus according to the present invention is exemplified with the ignition apparatus where the internal combustion engine has the plug tube in addition to the cylinder head and the cylinder head cover of the internal combustion engine.

However, the above stated sealing structure according to the present invention can employ with the ignition apparatus where the internal combustion engine has the cylinder head and the cylinder head cover but has no plug tube.

Claims

1. An ignition apparatus for use in an internal combustion engine comprises:

a center core (17);
a primary coil (12) wound round on a primary bobbin (11);
a secondary coil (14) wound round on a secondary bobbin (13);
an outer case (15); and
a side core (18) arranged on an outer peripherally of said outer case (15) and made by using a silicon steel sheet;
said primary coil (12) and said secondary coil (14) arranged between said center core (17) and said outer case (15);
the ignition apparatus is received in a plug hole (43a) which is formed by a cylinder head (41a) and a cylinder head cover (42a) of the internal combustion engine; wherein
said side core (18) has a slit between two horizontally extending side wall ends and said slit prevents an one-turn short of a magnetic flux of said side core (18);
thereby a predetermined secondary voltage more than an engine requirement secondary voltage is obtained.

2. An ignition apparatus for use in an internal combustion engine according to claim 1, wherein

said side core (18) comprises one selected from a single grain oriented silicon steel sheet having a slit between two horizontally extending side wall ends and a single grain non-oriented silicon steel sheet having a slit between two horizontally extending side wall ends.

3. An ignition apparatus for use in an internal combustion engine according to claim 1, wherein

said side core (18) comprises one selected from a laminated sheet structure comprised of at least two grain oriented silicon steel sheets, each having a slit between two horizontally extending side wall ends, and said plural slits align at a substantially same position.

4. An ignition apparatus for use in an internal combustion engine according to claim 1, wherein

said side core (18) comprises one selected from a laminated sheet structure comprised of one grain non-oriented silicon steel sheet having a slit between two horizontally extending side wall ends and at least one grain oriented silicon steel sheet having a slit between two horizontally extending side wall ends, and said slit of said one grain non-oriented silicon steel sheet and said slit of said at least one grain oriented silicon steel sheet align at a substantially same position.

5. An ignition apparatus for use in an internal combustion engine according to claim 1, wherein

in case where both said cylinder head (41a) and said cylinder head cover (42a) are made by using an aluminum material,
said side core (18) is formed by making round in a substantially pipe form and laminating with two sheets or three sheets of a grain oriented silicon steel sheet, each having a sheet thickness of 0.3-0.5 mm, said side core (18) has a total sheet thickness of more than 0.6 mm, and each having a slit between two horizontally extending side wall ends and said plural slits align at a substantially same position.

6. An ignition apparatus for use in an internal combustion engine according to claim 5, wherein

an upper end of said side core positions substantial same to an upper end of said cylinder head cover (42a) or said upper end of said side core positions lower than an upper end of said center core (17).

7. An ignition apparatus for use in an internal combustion engine according to claim 1, wherein

in case where said cylinder head (41a) is made by using an aluminum material and said cylinder head cover (42a) is made by using a thermoplastic synthetic resin material,
said side core (18) is formed by making round in a substantially pipe form and laminating with two sheet or three sheet of a grain oriented silicon steel sheet, each having a sheet thickness of 0.3-0.5 mm and said side core has a total sheet thickness of more than 0.6 mm, and each having a slit between two horizontally extend-

ing side wall ends and said plural slits align at a substantially same position.

8. An ignition apparatus for use in an internal combustion engine according to claim 7, wherein

an upper end of said side core positions substantial same to an upper end of said cylinder head cover (42a) or said upper end of said side core positions lower than an upper end of said center core (17).

9. An ignition apparatus for use in an internal combustion engine according to claim 1, wherein

in case where an iron made plug tube (45) is inserted under pressure in said plug hole (43a) of the internal combustion engine,
said side core (18) is formed by making round in a substantially pipe form and laminating with one selected from a single grain non-oriented steel sheet having a slit between two horizontally extending side wall ends and having a sheet thickness of 0.3-0.5 mm and a single grain oriented steel sheet having a slit between two horizontally extending side wall ends and having a sheet thickness of 0.3-0.5 mm.

10. An ignition apparatus for use in an internal combustion engine according to claim 9, wherein

an upper end of said side core positions substantial same to an upper end of said cylinder head cover (42a) or said upper end of said side core positions lower than an upper end of said center core (17).

11. An ignition apparatus for use in an internal combustion engine according to claim 5, wherein

in case where an iron made plug tube (45) is inserted under pressure in said plug hole (43a) of the internal combustion engine,
said side core (18) is formed by making round in a substantially pipe form and laminating with one selected from a single grain non-oriented steel sheet having a slit between two horizontally extending side wall ends and having a sheet thickness of 0.3-0.5 mm and a single grain oriented steel sheet having a slit between two horizontally extending side wall ends and having a sheet thickness of 0.3-0.5 mm.

12. An ignition apparatus for use in an internal combustion engine according to claim 11, wherein

an upper end of said side core positions substantial same to a higher upper end selected from said upper end of said cylinder head cover (42a) or said upper end of said iron made plug tube (45), and
said upper end of said side core positions lower than an upper end of said center core (17).

13. An ignition apparatus for use in an internal combustion engine according to claim 1, wherein a magnet for generating in a magnetic path an opposite side direction magnetic flux against a magnetic flux formed by said primary coil (12) is provided on one end of said center end or on both ends of said center core (17).

14. An ignition apparatus for use in an internal combustion engine comprises:

a center core (17);
a primary coil (12) wound round on a primary bobbin (11);
a secondary coil (14) wound round on a secondary bobbin (13);
an outer case (15);
a side core (18) arranged on an outer periphery of said outer case (15); and
a reception body (71) for receiving an ignitor case part and a coil case part, said ignitor case part having an electrically and adjacently arranged connector (79);
said primary coil (12) and said secondary coil (14) arranged between said center core (17) and said outer case (15); wherein
said ignitor reception portion comprises an independent and individual ignitor reception portion and an independent and individual coil reception portion, and
said ignitor reception portion and said coil reception portion are combined.

15. An ignition apparatus for use in an internal combustion engine comprises:

a center core (17);
a primary coil (12) wound round on a primary bobbin (11);

a secondary coil (14) wound round on a secondary bobbin (13);
an outer case (15);
a side core (18) arranged on an outer periphery of said outer case (15);
a reception body (71) for receiving an ignitor case part and a coil case part, said ignitor case part having an electrically and adjacently arranged connector (79); and
a sealing member for sealing an environment of an inside and an outside of a plug hole portion of the internal combustion engine;
said primary coil (12) and said secondary coil (14) arranged between said center core (17) and said outer case (15); wherein
said ignitor reception portion comprises an independent and individual ignitor reception portion and an independent and individual coil reception portion,
said ignitor reception portion receives said ignitor case part at a portion where said sealing member fits into and inserts, and
said ignitor reception portion and said coil reception portion are combined.

16. An ignition apparatus for use in an internal combustion engine according to claim 14 or claim 15, wherein

said coil reception portion is formed by using a mixture material in which a composition agent having a superior adhesion material characteristic with an insulation resin material for insulating said coil part mixes with a base resin material having a superior heat resistance property and a superior voltage withstanding property.

17. An ignition apparatus for use in an internal combustion engine according to claim 16, wherein

said base resin material is polyphenylene sulfide resin material, and
said composition agent is a denatured polyphenylene oxide resin material.

18. An ignition apparatus for use in an internal combustion engine according to claim 14 or claim 15, wherein

said coil reception portion is formed by using polyphenylene sulfide resin material.

19. An ignition apparatus for use in an internal combustion engine according to claim 14 or claim 15, wherein

a combination portion between said ignitor reception portion and said coil reception portion has one contact face which is vertical to an axial direction of said coil reception portion and another contact face which is concentrically with an axial center of said coil reception portion.

20. An ignition apparatus for use in an internal combustion engine according to claim 14 or claim 15, wherein

a combination between said ignitor reception portion and said coil reception portion is combined by a manner in which said ignitor reception portion is integrally formed to a beforehand manufacture coil reception portion.

21. An ignition apparatus for use in an internal combustion engine comprises:

a center core (17);
a primary coil (12) wound round on a primary bobbin (11);
a secondary coil (14) wound round on a secondary bobbin (13);
an outer case (15);
a side core (18) arranged on an outer periphery of said outer case (15);
said primary coil (12) and said secondary coil (14) arranged between said center core (17) and said outer case (15);
the ignition apparatus is received in a plug tube (45) and a plug hole portion which is formed by a cylinder head (41a), a cylinder head cover (42a) of the internal combustion engine; and
an ignition plug (44) is arranged at a lower portion of said plug hole portion;
the ignition apparatus comprises further an inner cylindrical portion inserted to said plug hole (43a) and a sealing rubber member (77) inserted and fitted into said inner cylindrical portion of the ignition apparatus so as to prevent water penetration into said plug hole (43a); wherein
said sealing rubber comprises a flange portion and a conical portion,
said flange portion of said sealing rubber member (77) has an extension face at a radial direction,
said extension face contacts to a tip end portion of said cylinder head cover (42a) from an axial direction side

and enable to bend at the axial direction side and to escape a radial direction slip-off, and

said conical portion of said sealing rubber member (77) forms a tapering form toward at a direction of said ignition plug (44) so as to guide said sealing rubber member (77), when said conical portion of said sealing rubber member (77) inserts to said plug tube (45).

22. An ignition apparatus for use in an internal combustion engine according to claim 21, wherein

said flange portion of said sealing rubber member (77) has a space portion, and
said space portion of said sealing rubber member (77) enables to escape an axial direction bent and deformation expansion of said flange portion of said sealing rubber member (77).

23. An ignition apparatus for use in an internal combustion engine according to claim 21, wherein

said inner cylindrical portion of the ignition apparatus has at least one projection portion (92a),
said projection portion (92a) of said sealing rubber member (77) forms near to a side of said ignition plug (44) than a side of a conical tip end portion of said conical portion of said sealing rubber member (77), and
said projection portion (92a) of said sealing rubber member (77) has an outer diameter larger than an outer diameter of said conical tip end portion of said conical portion of said sealing rubber member (77).

24. An ignition apparatus for use in an internal combustion engine according to claim 21, wherein

said cylindrical portion has an outer diameter of D, and
said sealing rubber member (77) comprises further a conical portion including a conical tip end portion and having an inner diameter of D1, an inside cylindrical portion having an inner diameter of D2, and a step portion for forming a respective inner dimension size having a relationship of $D1 < D < D2$.

FIG. 1

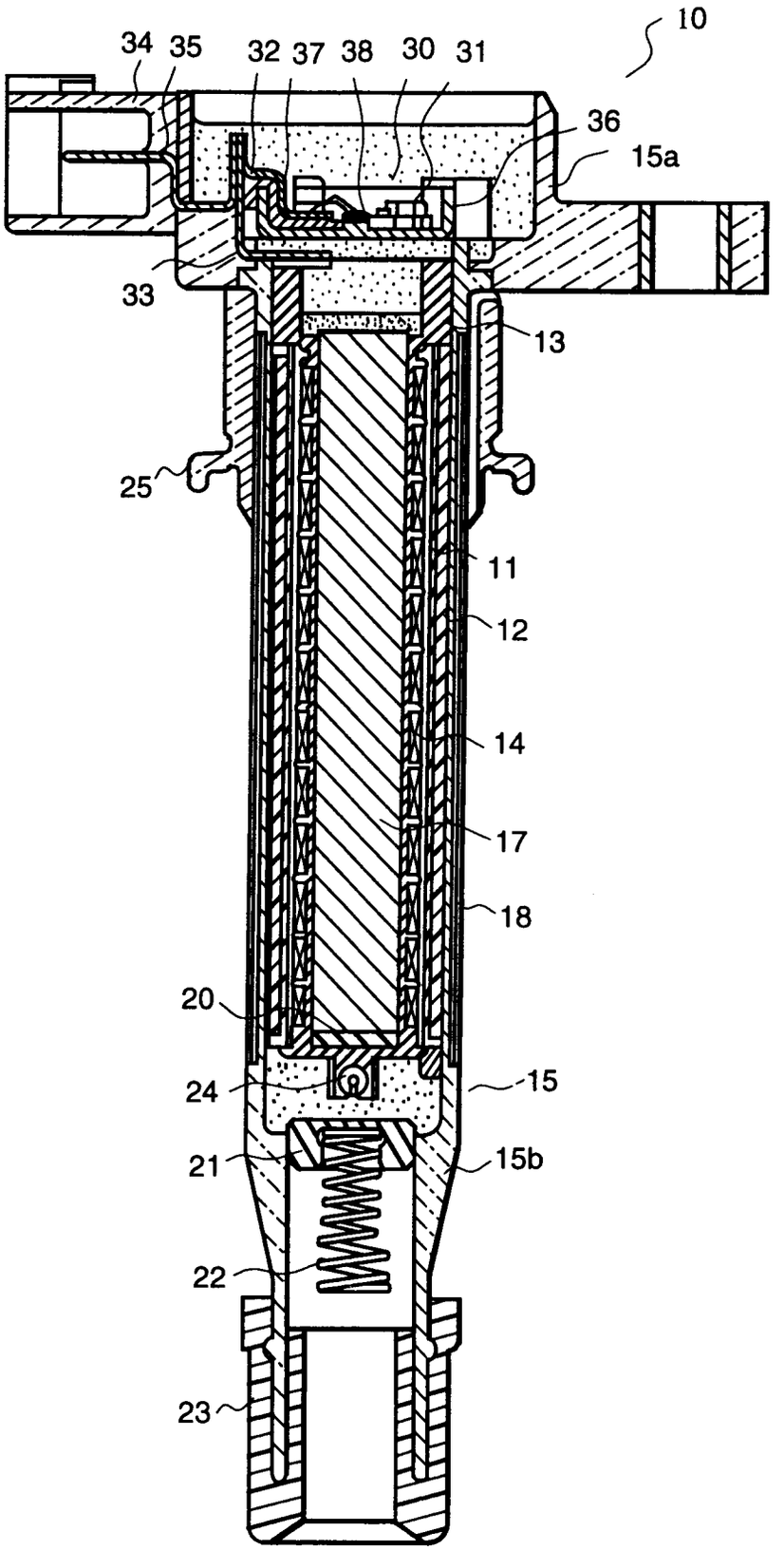
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FIG. 2

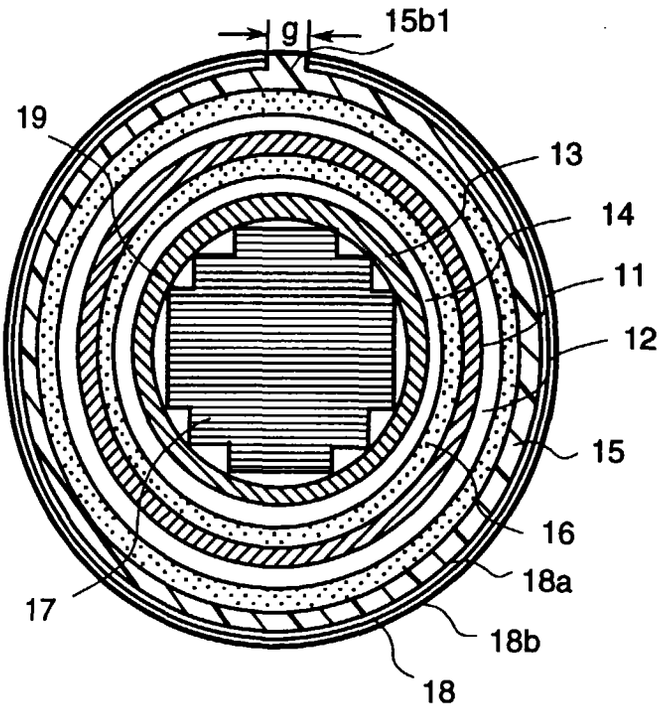

FIG. 3A

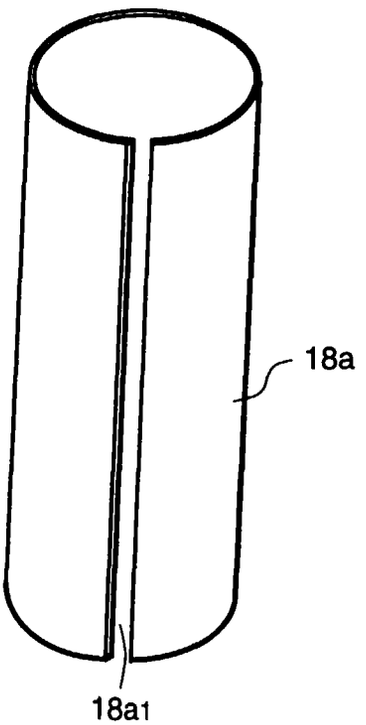

FIG. 3B

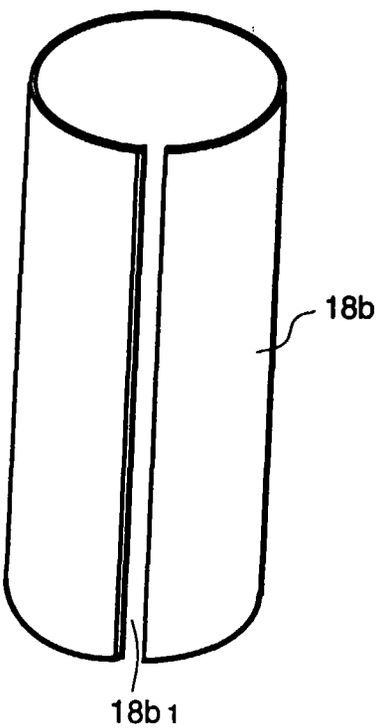

FIG. 4A

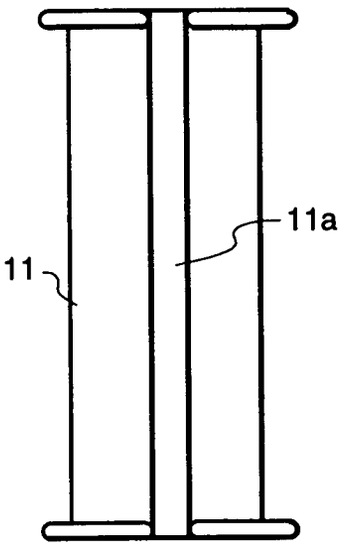

FIG. 4B

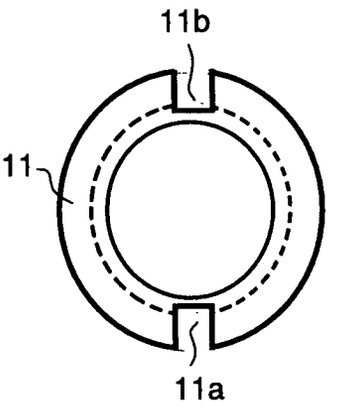

FIG. 5

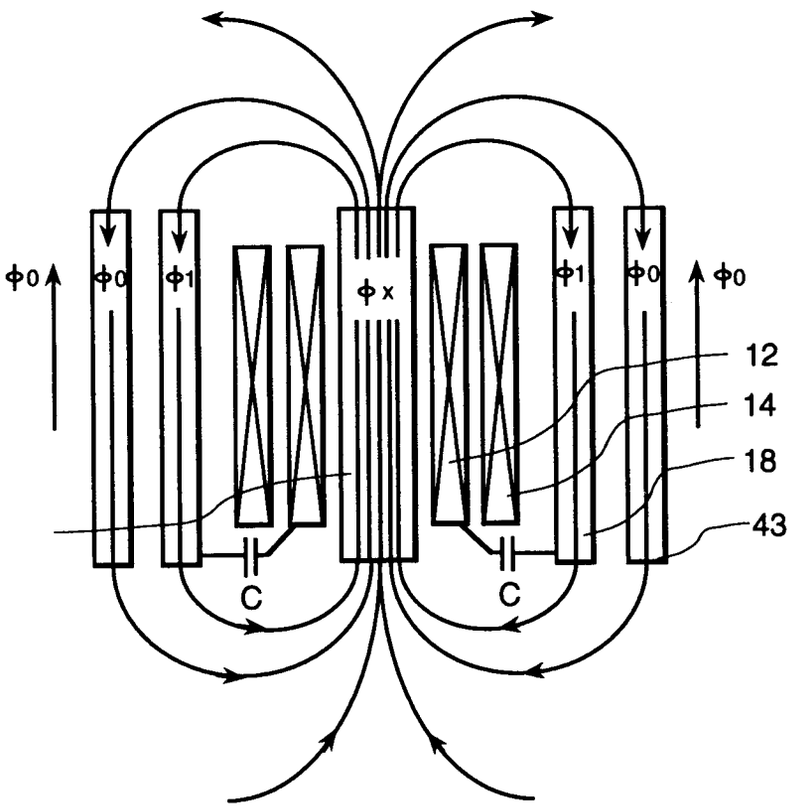

FIG. 6

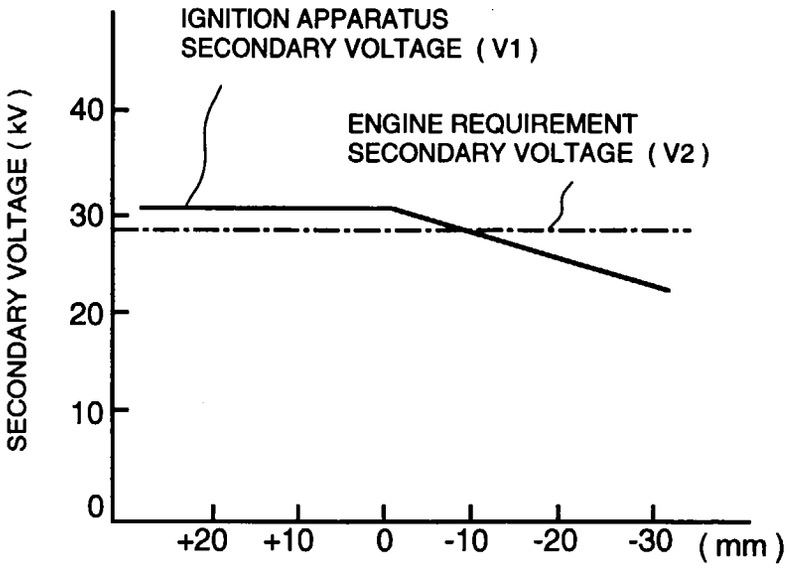

FIG. 10A FIG. 10B FIG. 10C

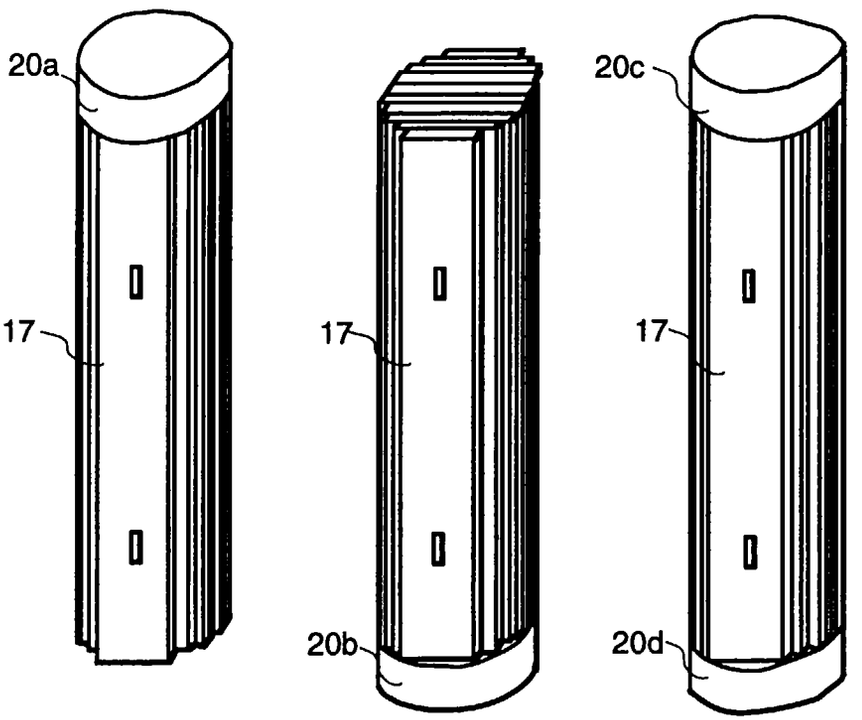

FIG. 7

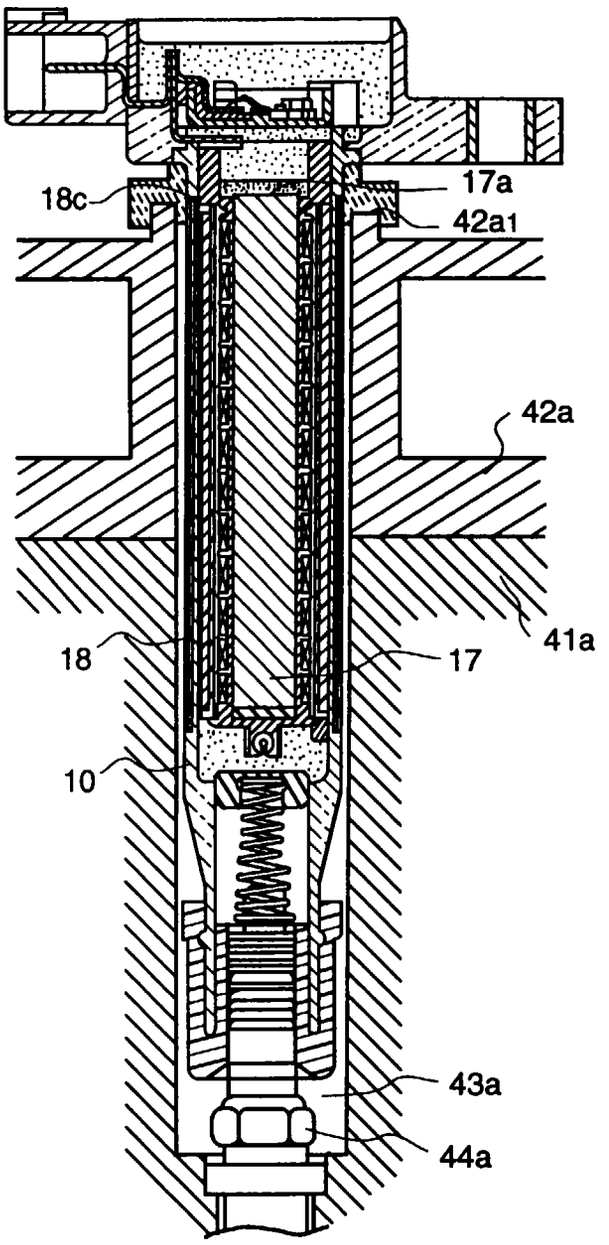

FIG. 8

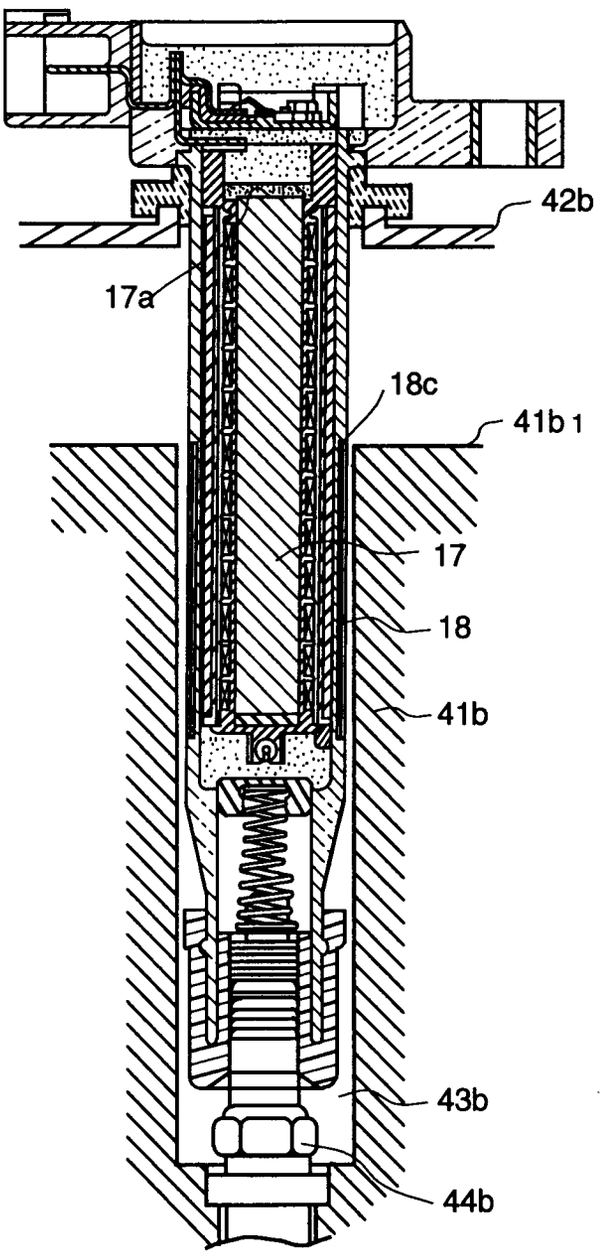

FIG. 9

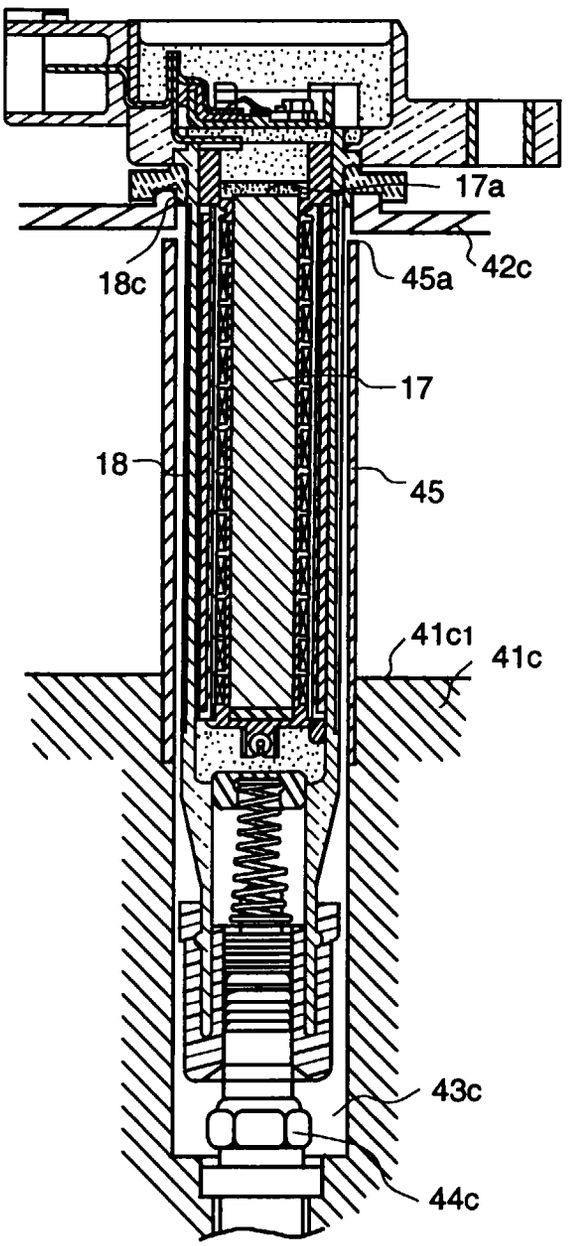

FIG. 11

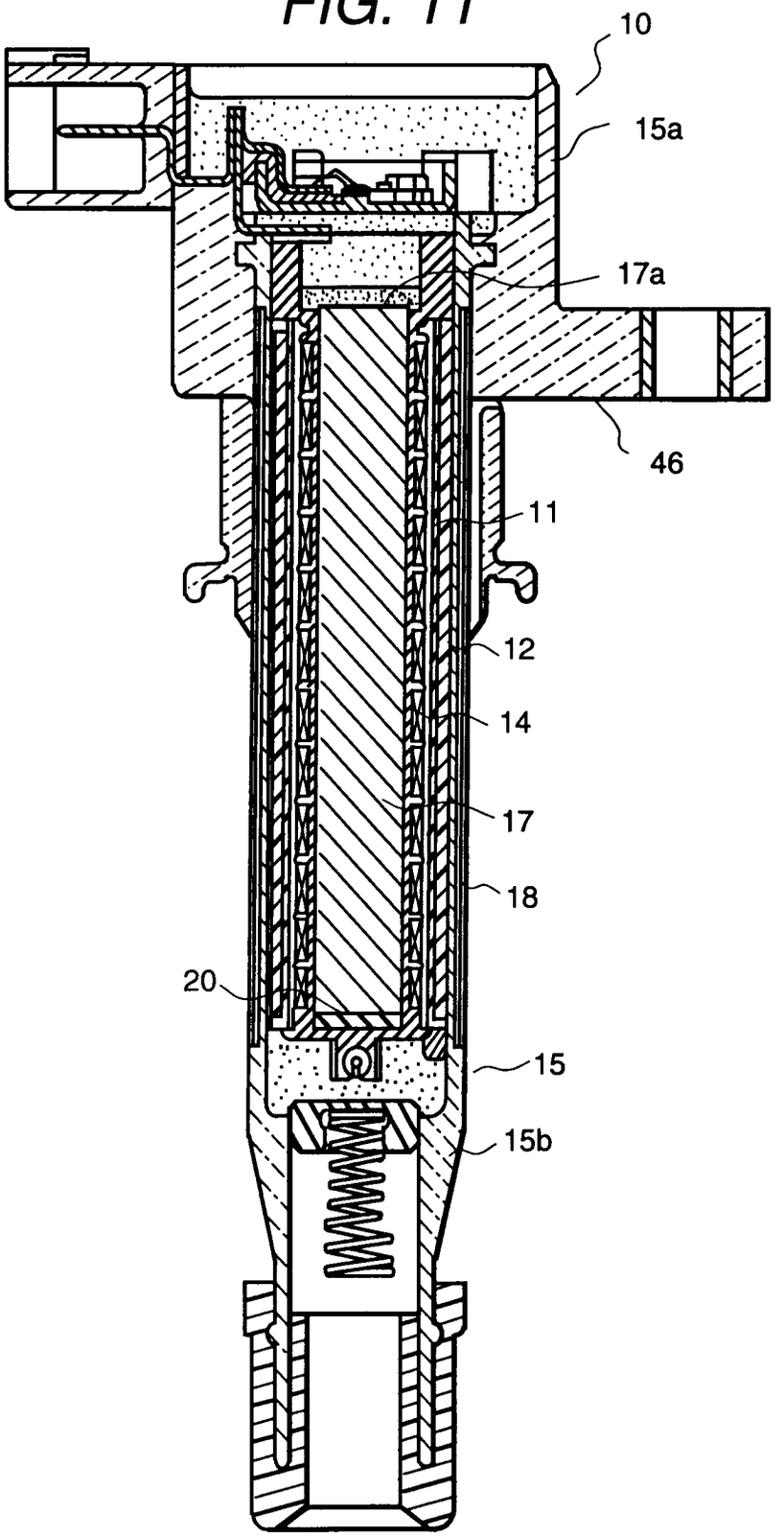

FIG. 12

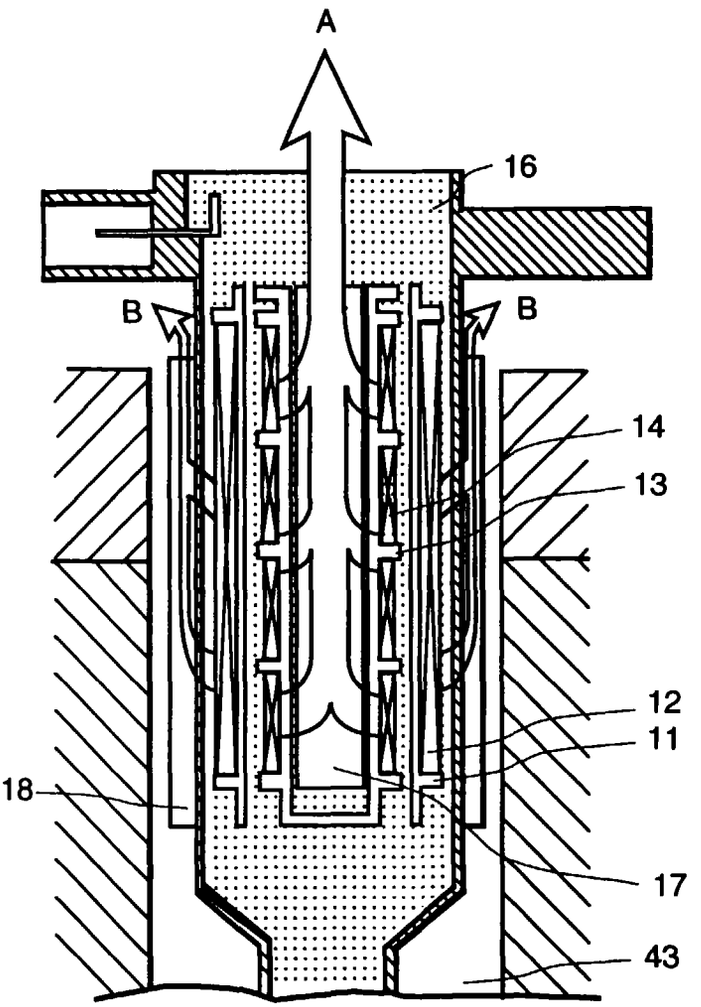

FIG. 13

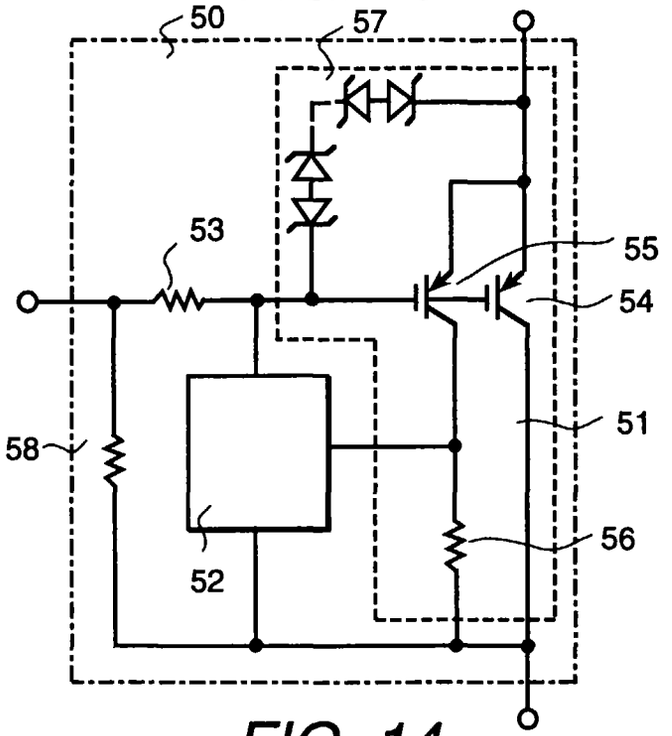
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FIG. 14

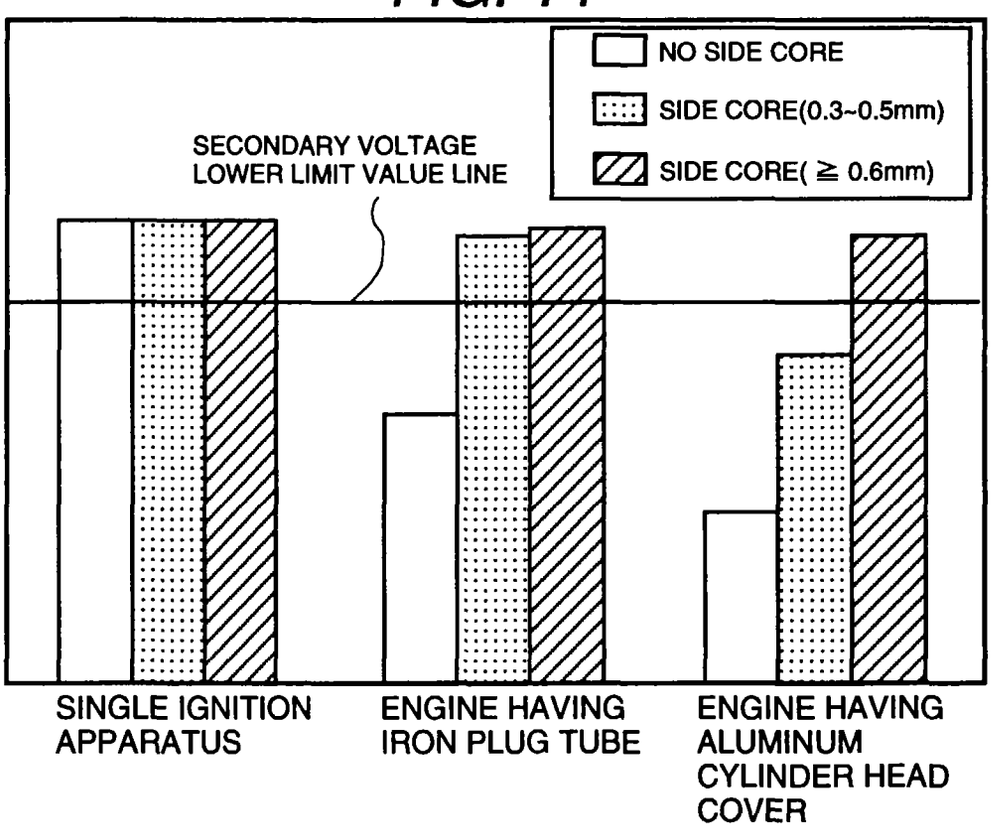

NO SIDE CORE
SIDE CORE(0.3~0.5mm)
SIDE CORE(≧ 0.6mm)
SECONDARY VOLTAGE
LOWER LIMIT VALUE LINE
SINGLE IGNITION APPARATUS
ENGINE HAVING IRON PLUG TUBE
ENGINE HAVING ALUMINUM CYLINDER HEAD COVER

FIG. 15

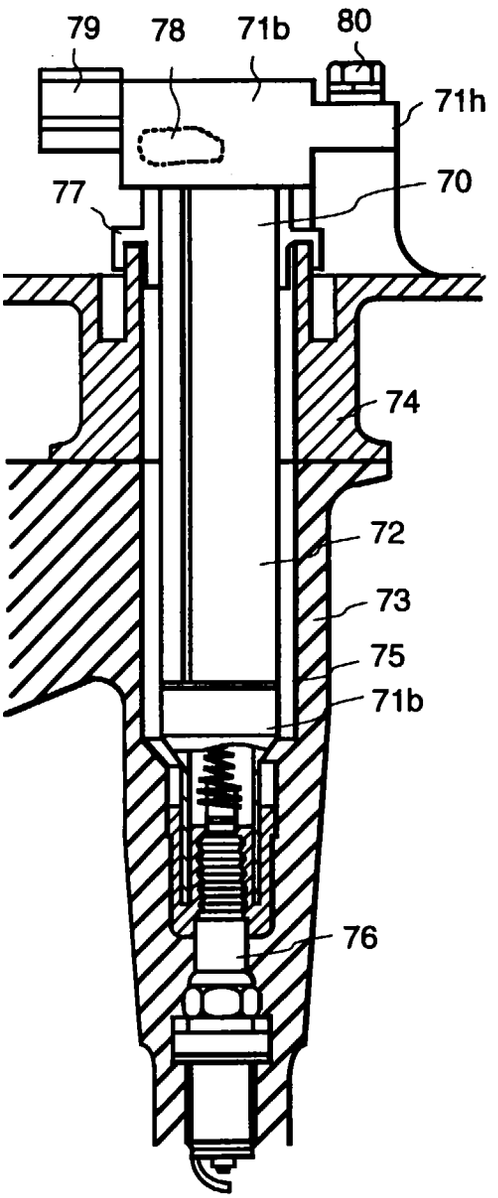


FIG. 16

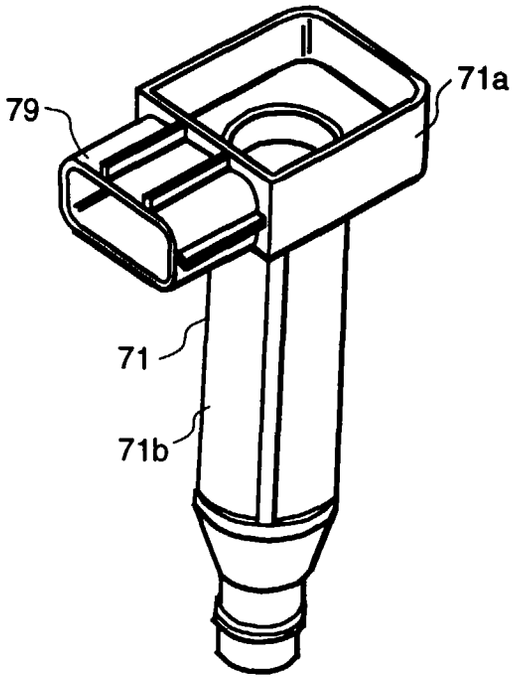


FIG. 17

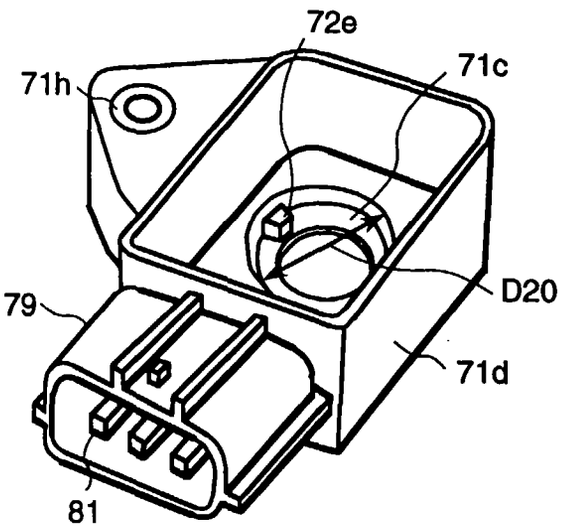


FIG. 18

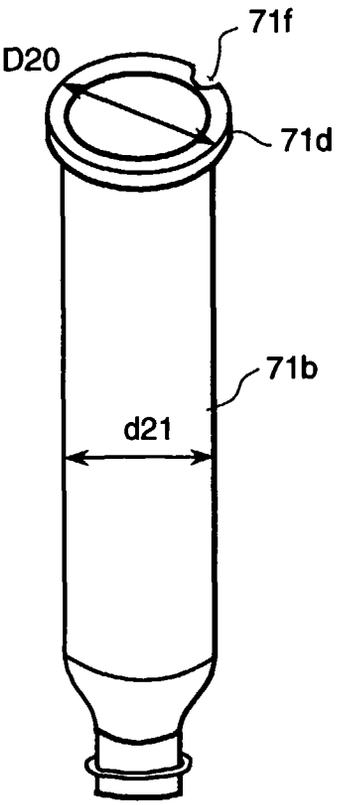


FIG. 19

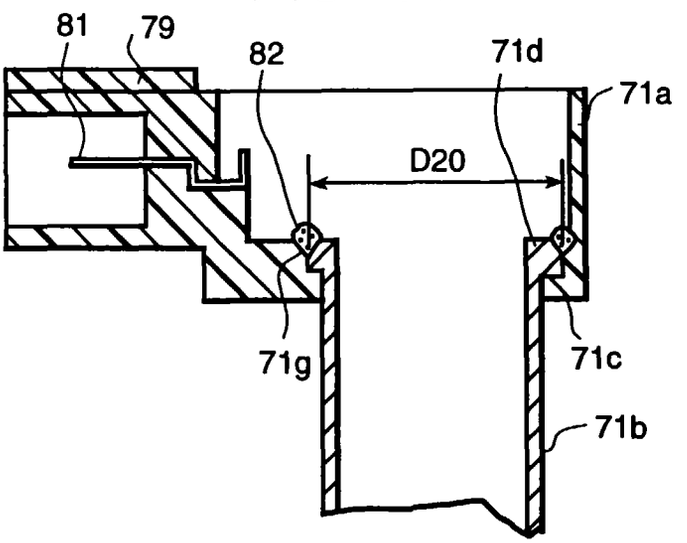


FIG. 20

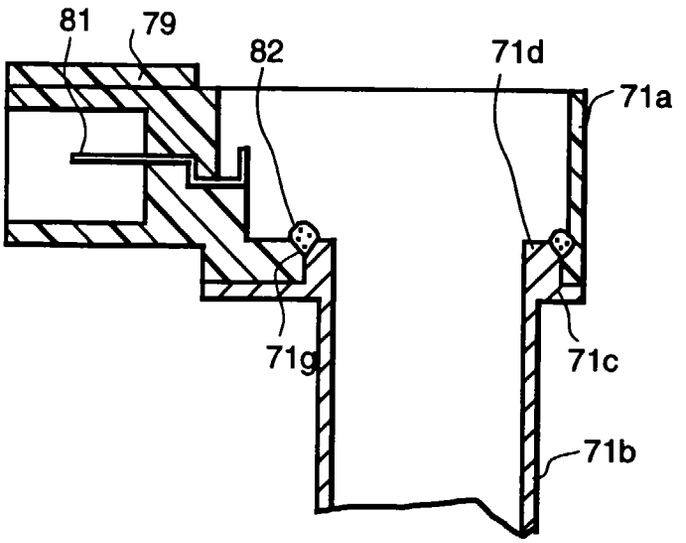


FIG. 21

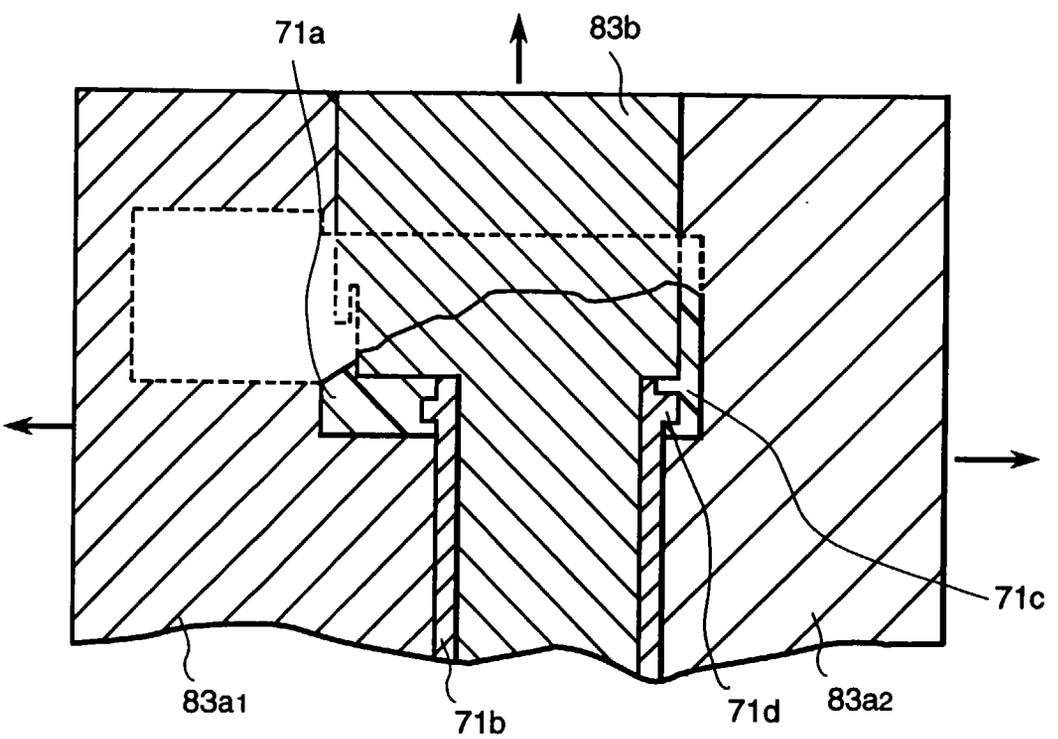
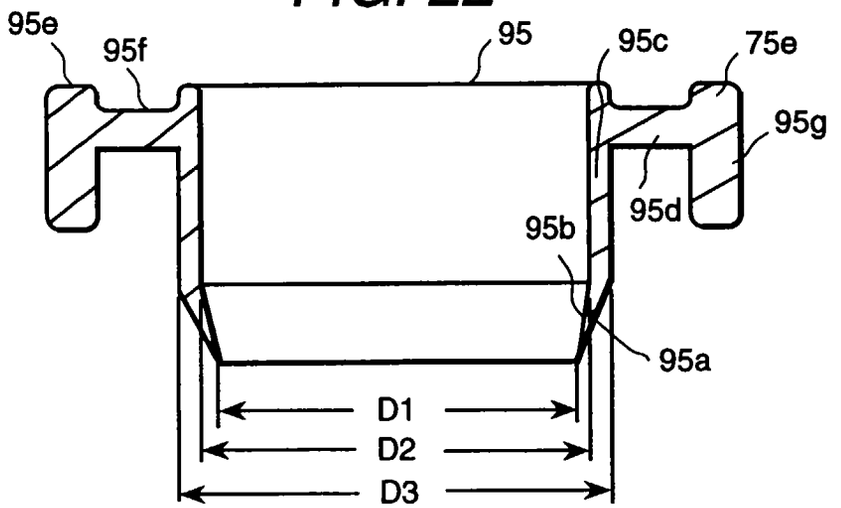


FIG. 22


95e
95f
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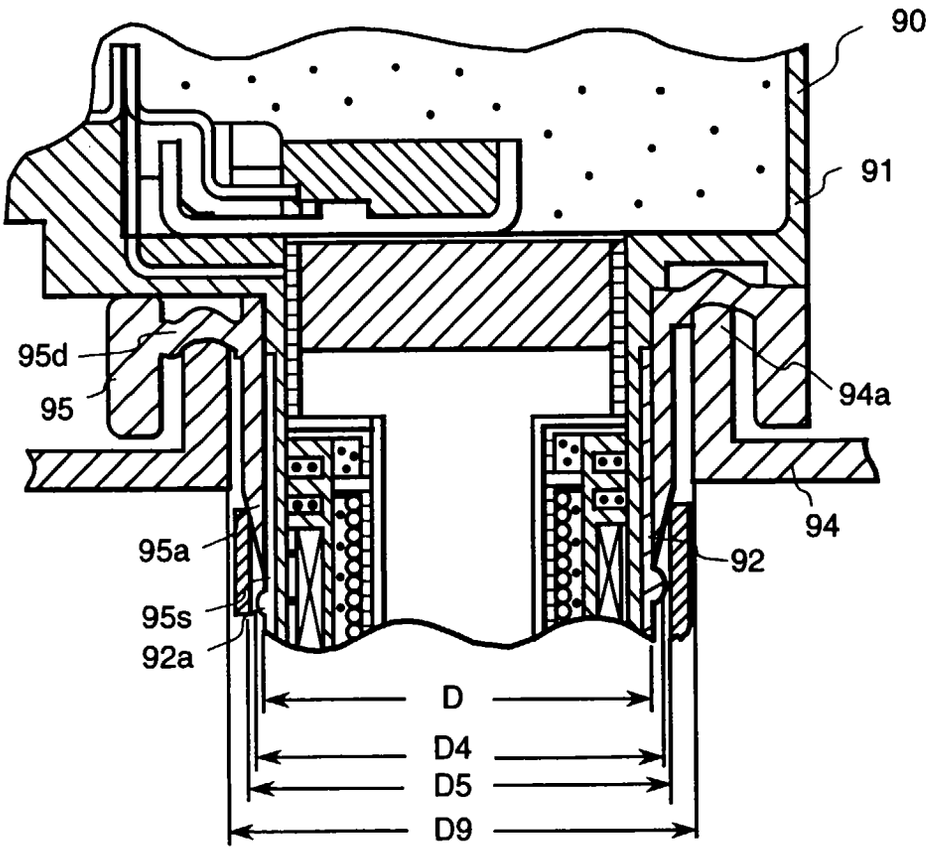
95c
75e
95g
95d
95b
95a
D1
D2
D3

FIG. 23


90
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94a
94
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92
95s
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D
D4
D5
D9