



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
28.12.2016 Bulletin 2016/52

(51) Int Cl.:
F04D 13/06 (2006.01)

(21) Application number: **16175158.1**

(22) Date of filing: **20.06.2016**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME
Designated Validation States:
MA MD

- **HIRATA, Masahiro**
Chuo-ku,, Osaka 540-6207 (JP)
- **KUSAKABE, Tsuyoshi**
Chuo-ku,, Osaka 540-6207 (JP)
- **FUKUDA, Tetsuya**
Chuo-ku,, Osaka 540-6207 (JP)
- **KUROKI, Koji**
Chuo-ku,, Osaka 540-6207 (JP)
- **SEKI, Takafumi**
Chuo-ku,, Osaka 540-6207 (JP)

(30) Priority: **26.06.2015 JP 2015128974**

(71) Applicant: **Panasonic Intellectual Property
Management Co., Ltd.**
Osaka-shi, Osaka 540-6207 (JP)

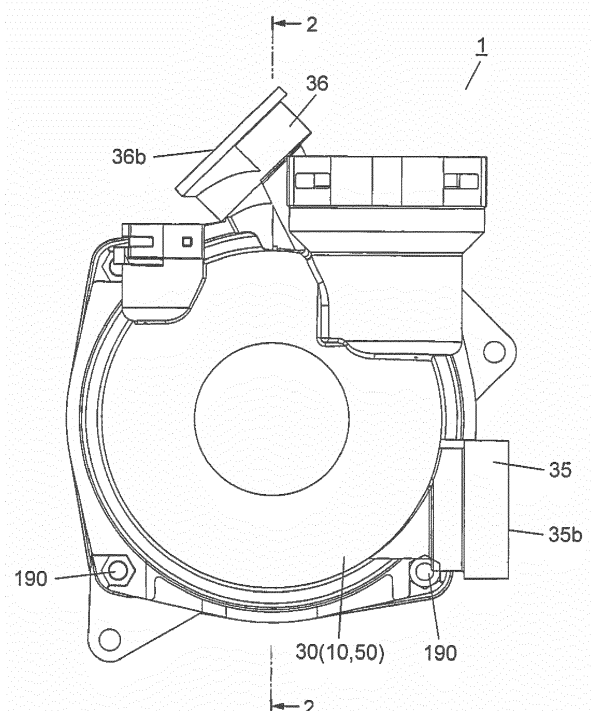
(74) Representative: **Grünecker Patent- und
Rechtsanwälte
PartG mbB
Leopoldstraße 4
80802 München (DE)**

(72) Inventors:
• **HIROHATA, Akihito**
Chuo-ku,, Osaka 540-6207 (JP)

(54) **CANNED MOTOR PUMP AND METHOD FOR MANUFACTURING CANNED MOTOR PUMP**

(57) A canned motor pump includes a resin molded body formed by molding a separator (41), a magnetically drive part (42) and a spacer (180) using a resin. In forming the resin molded body, the resin molded body is formed by molding the spacer (180) using a resin in a state where leg portions (182) of the spacer (180) are deflected. With such a configuration, there are provided a canned motor pump and a method for manufacturing a canned motor pump which can suppress lowering of reliability of a product while imparting general-purpose property to a usage environment.

FIG. 1



Description

BACKGROUND

1. Technical Field

[0001] The present disclosure relates to a canned motor pump and a method for manufacturing a canned motor pump.

2. Description of the Related Art

[0002] Conventionally, a canned motor pump which includes a stator, a control board, a rotor, an impeller, a separator and the like is disclosed in Unexamined Japanese Patent Publication No. 2009-284704 (hereinafter, referred to as "PTL 1"). A coil is wound around the stator, and a magnetic field is generated by the stator. The control board controls the generation of a magnetic field by the stator. The rotor is rotatably driven by the generated magnetic field. The impeller is fixed to the rotor, and sucks in or discharges a liquid. The separator isolates the stator and the rotor from each other.

[0003] In the canned motor pump disclosed in PTL 1, coil terminals to which coils are connected are connected to the control board. With such a configuration, the control board controls the generation of a magnetic field by the stator.

[0004] The control board is molded using a resin together with the stator and the separator. With such a configuration, the prevention of the intrusion of water which may be caused by water leakage, the prevention of corrosion which may be caused by highly humid installation environment, the reduction of noises and vibrations, the heat dissipation from electronic parts can be performed efficiently.

[0005] That is, the control board, the stator and the separator form a resin molded body by molding using a resin. With such a configuration, even when a temperature of water to be used is approximately 90°C, heat generated from electronic parts mounted on the control board is efficiently dissipated through the resin of the resin molded body.

[0006] In general, the resin molded body is formed as follows using a thermosetting resin such as unsaturated polyester. First, the control board, the stator and the separator are mounted in the inside of a mold die. In a state where these parts are mounted in the inside of the mold die, a resin is injected into the mold die through a gate formed in the mold die. The resin molded body is formed in this manner.

[0007] Recently, along with the progress of diversification of usage environment of a canned motor pump, the number of cases is increased where hot water higher than a temperature of conventional hot water is used. In such cases, heat from hot water having a temperature is transmitted to respective electronic parts and soldered portions mounted on a control board embedded in a resin

molded body through a resin of the resin molded body. Accordingly, there is a possibility that the respective electronic parts and the soldered portions become a high temperature due to the transferred heat and cause defects.

[0008] In view of such circumstances, conventionally, coil terminals to which coils are connected are exposed from a surface of the resin of the resin molded body. Further, the coil terminals and the control board are connected to each other outside the resin molded body. With such a configuration, it is possible to suppress the influence of heat transmitted from the resin molded body exerted on the control board.

[0009] More specifically, the control board is disposed outside the resin molded body, and the coil terminals are exposed from the surface of the resin of the resin molded body. Further, in a state where an inner surface of the molding die is brought into contact with surfaces of the coil terminals in a radial direction, the resin molded body is formed. In this case, it is necessary to prevent the resin from routing around the surfaces of the coil terminals in a radial direction.

[0010] However, in the method for forming the resin molded body by bringing the inner surface of the molding die into contact with the surfaces of the coil terminals in a radial direction, there may be the case where irregularities occur in the positions where the coil terminals are disposed due to the influence of size tolerance or the like. When the irregularities occur in such positions, there is a possibility that the coil terminals are collapsed by the molding die at the time of forming the resin molded body.

[0011] Further, there may be a case where a gap is formed between the surface of the coil terminal in a radial direction and the inner surface of the molding die. In this case, the coil terminal is covered with a resin leaked around the coil terminal. Accordingly, there is a possibility that the coil terminal and the control board cannot be electrically connected to each other.

[0012] In view of the above, a method is considered where a resin molded body is formed using a spacer in which a coil terminal is press-fitted, for example, for preventing covering of a coil terminal with a resin. More specifically, a molding die is brought into contact with a surface of the spacer positioned on an outer periphery of the coil terminal (a surface extending in a direction which intersects with a projecting direction of the coil terminal) thus suppressing the formation of a gap. With such a configuration, routing of a resin around the coil terminal is suppressed.

[0013] However, when the above-mentioned spacer is used, a thickness of a stacked stator, stacking tolerances of other parts or the like influences the formation of the resin molded body as described below. That is, when the stacking tolerances take positive values, the spacer which is brought into contact with the molding die pushes the stator and the like. Accordingly, there is a possibility that the molding die or the stator is broken. On the other hand, when the stacking tolerances take negative values,

a gap is formed between the molding die and the spacer. Accordingly, there is a possibility that burrs occur around the coil terminal or a connection failure occurs due to covering of the coil terminal with a mold resin.

[0014] That is, in the above-mentioned related art, at the time of imparting general-purpose property to the usage environment of the canned motor pump, there is a possibility that the reliability of products is lowered.

SUMMARY

[0015] It is an object of the present disclosure to provide a canned motor pump and a method for manufacturing a canned motor pump which can suppress lowering of reliability of a product while imparting general-purpose property to a usage environment of the canned motor pump.

[0016] That is, a canned motor pump according to the present disclosure includes: a magnetically driven part which is rotatably and pivotally supported by a shaft; an impeller formed on one end side of the magnetically driven part in an axial direction; and a pump body where a pump chamber housing the impeller is formed. The canned motor pump further includes a magnetically drive part which has: a coil disposed on an outer peripheral side of the magnetically driven part and generating a rotary magnetic field for rotating the magnetically driven part; and a stator core around which coils are wound. The canned motor pump further includes: a separator which separates the magnetically driven part and the magnetically drive part from each other; coil terminals electrically connected to the coils; a spacer on which the coil terminals are mounted; and a control board electrically connected to the coil terminals.

[0017] The separator includes: a bottomed cylindrical portion which has one end side opened in the axial direction and in which a housing portion for housing the magnetically driven part is formed; and a flange portion disposed so as to extend outward in a radial direction from an opening side of the bottomed cylindrical portion. The magnetically drive part is disposed on an outer peripheral side of the bottomed cylindrical portion and on the other end side in the axial direction with respect to the flange portion.

[0018] The separator, the magnetically drive part and the spacer are embraced in a resin molded body by molding using a resin.

[0019] The spacer is configured such that the coil terminals which extend in an axial direction are mounted on the spacer, portions of the coil terminals are disposed outside the resin molded body in an exposed manner, and portions of the exposed coil terminals are electrically connected to the control board.

[0020] The spacer includes: a plate portion disposed on the other end side of the bottomed cylindrical portion in an axial direction; and a leg portion extending toward one end side in an axial direction from the plate portion and being brought into contact with the flange portion.

[0021] The spacer is disposed in an inside of the resin molded body in a state where the leg portion is deflected.

[0022] In a method for manufacturing a canned motor pump according to the present disclosure, in the canned motor pump having the above-mentioned configuration, the method includes at least a resin molded body forming step of forming the resin molded body by molding the separator, the magnetically drive part and the spacer using a resin.

[0023] The resin molded body forming step includes a magnetically drive part disposing step of disposing the magnetically drive part on the other end side in the axial direction with respect to the flange portion disposed on an opening side of the bottomed cylindrical portion opening on one end side of the separator in the axial direction and extending toward the outside in a radial direction.

[0024] The method further includes a spacer disposing step of disposing a plate portion extending in an axial direction of the spacer and mounting the coil terminal thereon on the other end side of the bottomed cylindrical portion in the axial direction, and bringing the leg portion extending toward one end side in the axial direction from the plate portion into contact with the flange portion.

[0025] The method further includes: a spacer clamping step for forming a cavity by clamping the molding die, the separator and the spacer; and an injection step of injecting a resin into the cavity in a state where the spacer is clamped.

[0026] With such a configuration, a resin molded body can be formed without being influenced by size tolerances of the stator and the like. Accordingly, the formation of a gap between the plate portion of the spacer and the molding die can be suppressed. Accordingly, breaking of the stator or the occurrence of burrs around the coil terminal can be suppressed. Further, covering of the coil terminal with a resin can be suppressed. As a result, the occurrence of a connection failure between the coil terminal and the control board can be prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

FIG. 1 is a plan view showing a canned motor pump according to an exemplary embodiment of the present disclosure;

FIG. 2 is a cross-sectional view taken along a line 2-2 in FIG. 1;

FIG. 3 is a perspective view showing a separator according to the exemplary embodiment;

FIG. 4 is a view of the separator according to the exemplary embodiment as viewed from a rear surface side;

FIG. 5 is a cross-sectional view schematically showing an arrangement relationship between the separator and a stator core according to the exemplary embodiment;

FIG. 6 is a cross-sectional view taken along a line

6-6 in FIG. 5;

FIG. 7 is a perspective view showing a spacer according to the exemplary embodiment;

FIG. 8 is a side view showing the spacer according to the exemplary embodiment;

FIG. 9 is a view of the spacer according to the exemplary embodiment as viewed from a plate portion side;

FIG. 10 is a view of the spacer according to the exemplary embodiment as viewed from a leg portion side;

FIG. 11 is a cross-sectional view taken along a line 11-11 in FIG. 10;

FIG. 12 is a view showing a state where the stator core and a relay board are disposed on the separator according to the exemplary embodiment as viewed from a rear surface side;

FIG. 13 is a cross-sectional view taken along a line 13-13 in FIG. 12;

FIG. 14 is a view showing a state where the stator core and the relay board are disposed on the spacer according to the exemplary embodiment as viewed from a rear surface side;

FIG. 15 is a cross-sectional view taken along a line 15-15 in FIG. 14;

FIG. 16 is an enlarged cross-sectional view showing a portion F in FIG. 15 in an enlarged manner;

FIG. 17 is a view showing a state where the spacer is clamped between a molding die and the separator according to the exemplary embodiment as viewed from a rear surface side;

FIG. 18 is a cross-sectional view taken along a line 18-18 in FIG. 17;

FIG. 19 is a perspective view of a resin molded body according to the exemplary embodiment as viewed in one direction; and

FIG. 20 is a perspective view of the resin molded body according to the exemplary embodiment as viewed in the other direction.

DETAILED DESCRIPTION

[0028] Hereinafter, an exemplary embodiment of the present disclosure is described in detail with reference to the drawings. The present disclosure is not limited by the exemplary embodiment. Further, in the description made hereinafter, the description is made by defining a rotational axis direction of an impeller (hereinafter, described as "axial direction") as a fore-and-aft direction.

EXEMPLARY EMBODIMENT

[0029] Hereinafter, the configuration of a canned motor pump according to the exemplary embodiment of the present disclosure is described with reference to FIG. 1 and FIG. 2.

[0030] As shown in FIG. 1 and FIG. 2, canned motor pump 1 of this exemplary embodiment includes at least:

pump body 10 which forms a shell of canned motor pump 1; and rotating body 20 constituted of impeller 70 or the like. Rotating body 20 is housed in rotating body housing chamber 51 formed in the inside of pump body 10.

[0031] Pump body 10 is formed of casing 30, volute portion 130, drive block 40 and the like. Volute portion 130 is formed as a part separate from casing 30, and has pump chamber 131 which opens rearward. Drive block 40 has housing portion 41a which opens frontward. A partition plate described later is also a member which forms pump body 10 as necessary.

[0032] Drive block 40 is disposed behind casing 30 and volute portion 130. Housing portion 41a of drive block 40 is communicated with pump chamber 131 of volute portion 130. Housing portion 41a and pump chamber 131 form above-mentioned rotating body housing chamber 51 which houses whole rotating body 20.

[0033] Drive block 40 further includes separator 41, magnetically drive part 42, control part 43, and resin material 44 which forms a shell of drive block 40.

[0034] Firstly, the configuration of separator 41 is described with reference to FIG. 2 to FIG. 4.

[0035] Separator 41 is made of a synthetic resin such as a polyphenylene sulfide (PPS) resin, for example. Separator may be formed using metal, for example, provided that separator does not influence magnetic driving.

[0036] As shown in FIG. 2 to FIG. 4, separator 41 is formed into a container shape which opens frontward. More specifically, separator 41 is formed of bottomed cylindrical portion 41k having a bottomed cylindrical shape, flange portion 41d and the like. Bottomed cylindrical portion 41k has its front surface (front side) opened, and has its rear surface (rear side) closed by bottom portion 41b. Flange portion 41d is disposed in a projecting manner in a radially outward direction from a front edge portion of peripheral wall portion 41c of bottomed cylindrical portion 41k. In this exemplary embodiment, flange portion 41d of separator 41 is formed over the entire length in a circumferential direction of peripheral wall portion 41c. Bottomed cylindrical portion 41k includes housing portion 41a which houses magnetically driven part 80 described later.

[0037] That is, in canned motor pump 1 of this exemplary embodiment, housing 50 in which rotating body housing chamber 51 for housing rotating body 20 such as impeller 70 is defined is formed of casing 30, volute portion 130 and separator 41. Partition plate 140 described later is also a member which forms housing 50 as necessary.

[0038] Bottomed cylindrical portion 41k of separator 41 includes rear shaft fixing portion 41e which forms a shaft support portion projecting frontward at a center of bottom portion 41b (a depth-side center in the inside of housing portion 41a). Rear shaft fixing portion 41e fixes a rear end portion of shaft 60 which is made of ceramics, for example, and supports rotating body 20 in a rotatable manner. Shaft 60 is held by separator 41 in a non-rotatable manner. More specifically, a profile shape of the rear

end portion of shaft 60 is formed into a D shape, for example. Similarly, an inner peripheral surface of rear shaft fixing portion 41e is formed into a D shape which corresponds to the D shape of the rear end portion of shaft 60. The D-shaped rear end portion of shaft 60 is fitted into rear shaft fixing portion 41e. With such a configuration, shaft 60 is held by separator 41 in a non-rotatable manner.

[0039] Magnetically drive part 42 of drive block 40 is formed of a stator having stator core 42a, coil 42b, and insulation portion 42c. Stator core 42a is formed of an electromagnetic steel sheet, for example. Coil 42b is disposed in a state where coil 42b is wound around stator core 42a. Insulation portion 42c electrically insulates stator core 42a and coil 42b from each other. Magnetically drive part 42 is disposed such that magnetically drive part 42 surrounds peripheral wall portion 41c of bottomed cylindrical portion 41k of separator 41 (for example, see FIG. 12 and FIG. 13).

[0040] As shown in FIG. 5, stator core 42a of magnetically drive part 42 is formed into an annular shape as viewed in a top plan view, for example, and includes a yoke portion (not shown in the drawing), and a plurality of tooth portions 42d around which coils 42b are wound. The yoke portion is disposed concentrically to rotational axis center direction CA (see FIG. 2) of magnetically driven part 80 described later. Tooth portions 42d are disposed in a projecting manner toward peripheral surface 41f of separator 41 from a side surface of the yoke portion which oppositely faces peripheral surface 41f of peripheral wall portion 41c of separator 41. Magnetically drive part 42 of this exemplary embodiment is formed of a three-phase motor where six tooth portions 42d are formed substantially equidistantly (including equidistantly) in the circumferential direction, for example (see FIG. 12).

[0041] Further, stator core 42a includes magnetic pole portions 42e which are disposed so as to oppositely face peripheral surfaces 41f of separator 41 at a distal end side (peripheral surface 41f side) of respective tooth portions 42d. Magnetic pole portion 42e has magnetic pole surface 42f (see FIG. 5) which is formed into a curved shape along peripheral surface 41f of separator 41 as viewed in a top plan view. That is, stator core 42a of this exemplary embodiment has magnetic pole surfaces 42f which face peripheral surface 41f which is an outer peripheral surface of bottomed cylindrical portion 41k of separator 41 in an opposed manner.

[0042] Stator core 42a is formed by stacking a plurality of plate members constituted of electromagnetic steel sheets, for example, in rotational axis center direction CA (fore-and-aft direction) of magnetically driven part 80.

[0043] Insulation portion 42c of magnetically drive part 42 is made of a material such as, for example, a PBT (polybutylene terephthalate) resin having insulation property, heat resistance and flexibility which makes insulation portion 42c minimally broken even when insulation portion 42c has a thin wall thickness.

[0044] That is, as shown in FIG. 5 and FIG. 6, magnetically drive part 42 of this exemplary embodiment is mounted on separator 41 such that magnetic pole surface 42f of stator core 42a oppositely faces peripheral surface 41f of separator 41 with a predetermined clearance d4 therebetween. A clearance at a portion where a distance between magnetic pole surface 42f and peripheral surface 41f which oppositely face each other becomes minimum in a state where magnetically drive part 42 is normally mounted on separator 41 (in a state where there is no positional displacement between magnetically drive part 42 and separator 41) is set as clearance d4 (see FIG. 6).

[0045] Flange portion 41d of separator 41 is formed into a shape where an outer peripheral side of flange portion 41d is folded back rearward (bottom portion 41b side). Annular groove 41i is formed on flange portion 41d formed on the outer periphery of a front portion of peripheral wall portion 41c of bottomed cylindrical portion 41k (see FIG. 2 and FIG. 3). A front end of magnetically drive part 42 is housed in annular groove 41i by inserting magnetically drive part 42 into annular groove 41i from behind bottomed cylindrical portion 41k (bottom portion 41b) along peripheral wall portion 41c. With such a configuration, magnetically drive part 42 is mounted on separator 41.

[0046] After magnetically drive part 42 is mounted on separator 41, resin material 44 of drive block 40 is formed such that resin material 44 covers magnetically drive part 42. Resin material 44 is made of a thermosetting resin having conductivity such as an unsaturated polyester resin, for example. Resin material 44 protects magnetically drive part 42 and, at the same time, discharges heat generated in magnetically drive part 42 to the outside efficiently. That is, in this exemplary embodiment, resin molded body 200 is formed by performing so-called mold filling operation where resin material 44 is filled so as to cover magnetically drive part 42. Resin material 44 of resin molded body 200 is disposed outside separator 41, and integrally embraces separator 41 and magnetically drive part 42 therein.

[0047] Separator 41 is configured such that a plurality of ribs 41g are formed on peripheral surface 41f of peripheral wall portion 41c of bottomed cylindrical portion 41k radially. Ribs 41g are disposed such that ribs 41g extend in rotational axis center direction CA (fore-and-aft direction) of magnetically driven part 80 and project in a radially outward direction. Ribs 41g decide the position of magnetically drive part 42 with respect to separator 41 (see FIG. 3, FIG. 5 and FIG. 12).

[0048] As shown in FIG. 2, peripheral wall portion 41c of bottomed cylindrical portion 41k of separator 41 is formed into a tapered shape where a diameter of peripheral wall portion 41c is gradually decreased toward a bottom portion 41b side from an opening (flange portion 41d) side. Here, on a flange portion 41d side of bottomed cylindrical portion 41k, straight portions 41h which extend along rotational axis center direction CA (fore-and-aft di-

rection) are formed at positions opposedly facing magnetic pole surfaces 42f of stator core 42a (see FIG. 5 and FIG. 6). Straight portions 41h allow magnetic pole surfaces 42f of stator core 42a to opposedly face peripheral surface 41f of separator 41 with predetermined (fixed) clearance d4 therebetween even when the position of magnetically drive part 42 in rotational axis center direction CA (fore-and-aft direction) is displaced.

[0049] Control part 43 of canned motor pump 1 is formed of a control board for controlling magnetically drive part 42. Control part 43 is disposed behind separator 41 and magnetically drive part 42, and various electronic parts are mounted on control part 43. Control part 43 is electrically connected to coils 42b of magnetically drive part 42 through coil terminals 45. Control part 43 supplies electricity to coils 42b of magnetically drive part 42 thus allowing magnetically drive part 42 to generate a magnetic field for rotating magnetically driven part 80 of rotating body 20 described later.

[0050] A Hall IC element (not shown in the drawing) which detects a rotational position of magnetically driven part 80 is disposed in a vicinity of separator 41 on an upper side (front side) of control part 43. Control part 43 controls a magnetic force generated by magnetically drive part 42 based on a rotational position of magnetically driven part 80 detected by the Hall IC element.

[0051] As shown in FIG. 2, rotating body 20 of canned motor pump 1 is formed of impeller 70, magnetically driven part 80 and the like. Impeller 70 is disposed in front of rotating body 20, and functions as a pump portion. Magnetically driven part 80 is disposed behind impeller 70. Impeller 70 and magnetically driven part 80 are connected to each other by way of connecting portion 90. Impeller 70, magnetically driven part 80 and connecting portion 90 are formed as an integral body. In such a configuration, impeller 70 is integrally formed with a front portion (one end (front) side in shaft 60 direction) of magnetically driven part 80.

[0052] Magnetically driven part 80 of rotating body 20 is housed in housing portion 41a of rotating body housing chamber 51, and impeller 70 is housed in pump chamber 131.

[0053] Magnetically driven part 80 forms a rotor which is rotatably and pivotally supported by shaft 60.

[0054] That is, magnetically driven part 80 is formed of rotor portion 81, magnet portion 82, bearing 83 and the like. Rotor portion 81 is made of a synthetic resin such as polyphenylene ether (PPE) resin, for example. Magnet portion 82 is formed of a permanent magnet made of ferrite or SmFe, for example, and is disposed on an outer peripheral side of rotor portion 81. Bearing 83 is formed of, for example, a slide member made of a resin containing carbon or ceramics, and is disposed at a center portion of rotor portion 81.

[0055] Rotor portion 81 includes: cylindrical bearing fixing portion 81a in which a hole is formed in a penetrating manner in the fore-and-aft direction; and magnet fixing portion 81b which surrounds bearing fixing portion

81a. Bearing fixing portion 81a has small diameter portion 81c on its front portion (front side), and large diameter portion 81d on its rear portion (rear side). Bearing 83 is fixed by being inserted into small diameter portion 81c having a diameter smaller than that of large diameter portion 81d. Shaft 60 is inserted into bearing 83. Shaft 60 rotatably supports rotating body 20 in a shaft rotating direction.

[0056] Magnet fixing portion 81b is formed into a circular cylindrical shape, and a front portion (front side) of an inner peripheral surface of magnet fixing portion 81b is integrally connected with small-diameter portion 81c of bearing fixing portion 81a.

[0057] Further, magnet housing groove 81e is formed on an outer peripheral surface of magnet fixing portion 81b. Magnet housing groove 81e houses magnet portion 82 covered by stainless magnet cover 82a, for example. Magnet portion 82 may be housed in magnet housing groove 81e without magnet cover 82a so that the outer peripheral surface of magnet portion 82 is exposed.

[0058] Magnet portion 82 is formed on the outer peripheral portion of rotor portion 81, and is disposed in the inside of magnetically drive part 42. Peripheral wall portion 41c of bottomed cylindrical portion 41k of separator 41 is disposed between magnet portion 82 and magnetically drive part 42. Gap d1 is formed between magnet portion 82 and peripheral wall portion 41c (in this exemplary embodiment, separator cover 160). Due to the formation of gap d1, the rotation of magnetically driven part 80 is allowed.

[0059] Impeller 70 is formed of blade portion 71, rear surface shroud 72, and front surface shroud 73. Impeller 70 is disposed in front of magnetically driven part 80. A plurality of blade portions 71 are disposed in the circumferential direction of impeller 70. Rear surface shroud 72 is formed into a disc shape, and covers the rear side of respective blade portions 71. Front surface shroud 73 covers the front side of respective blade portions 71.

[0060] The center portion of rear surface shroud 72 is connected to a front end of rotor portion 81 by way of connecting portion 90.

[0061] Magnet portion 82, magnet cover 82a, bearing 83, and connecting portion 90 which form magnetically driven part 80 are integrally formed with rear surface shroud 72 and rotor portion 81. That is, magnetically driven part 80 is formed by insert molding where rear surface shroud 72 and rotor portion 81 are inserted into a molding die.

[0062] Front surface shroud 73 is formed of: conical portion 73a whose diameter is gradually decreased toward a front portion (front side) thereof; and circular cylindrical portion 73b which is formed on a front portion of conical portion 73a. Circular cylindrical portion 73b has suction port 74 which penetrates circular cylindrical portion 73b in the fore-and-aft direction at the front portion thereof.

[0063] An outer peripheral edge (outer peripheral edge of conical portion 73a) of front surface shroud 73 and

outer peripheral edge of rear surface shroud 72 are disposed at the same position in a radial direction of impeller 70, for example. The outer peripheral edge of front surface shroud 73 and the outer peripheral edge of rear surface shroud 72 may not be always disposed at the same position.

[0064] A gap is formed between an outer peripheral edge portion of front surface shroud 73 and an outer peripheral edge portion of rear surface shroud 72. The gap communicates with suction port 74 through flow passages 75 each of which is formed between neighboring blade portions 71 between front surface shroud 73 and rear surface shroud 72. Discharge portion 76 of impeller 70 is formed of such a gap.

[0065] Blade portions 71 are formed in a region ranging from an inner peripheral side to the outer peripheral edge (that is, the outer peripheral edge of rear surface shroud 72) of front surface shroud 73. Front ends of blade portions 71 are integrally connected to a rear surface of conical portion 73a of front surface shroud 73. Blade portions 71 and front surface shroud 73 are formed as an integral body. On the other hand, rear ends of blade portions 71 are mounted on the front surface of rear surface shroud 72.

[0066] Blade portions 71 apply a pressure in a radial direction to a fluid introduced into flow passages 75 through suction port 74 when blade portions 71 are rotated. With such an action, a fluid which is supplied to flow passages 75 from suction port 74 is fed to an outer peripheral side of impeller 70. Further, the fluid is discharged to an outer peripheral side from discharge portion 76 of impeller 70.

[0067] As shown in FIG. 1 and FIG. 2, casing 30 of pump body 10 is formed into a container shape which opens rearward. Casing 30 has wall portion 32. An outer peripheral side rear edge of wall portion 32 is disposed so as to be brought into contact with an outer peripheral portion on a front surface side of flange portion 41d of separator 41. With such a configuration, casing 30 is configured to cover a front side of housing portion 41a.

[0068] An outer peripheral portion of wall portion 32 of casing 30 is mounted on an outer peripheral portion of drive block 40 which includes flange portion 41d by a plurality of fixing members 190 such as screws or bolts. With such a configuration, casing 30 is mounted on drive block 40 (see FIG. 1). Sealing material 100 is disposed in an interposing manner at a joint portion between casing 30 and flange portion 41d. With such a configuration, water tightness of rotating body housing chamber 51 can be ensured (see FIG. 2).

[0069] As shown in FIG. 1, wall portion 32 of casing 30 includes suction pipe 35 and discharge pipe 36. Suction pipe 35 is connected to a pipe (not shown in the drawing) or the like, and introduces a fluid into pump chamber 131. Discharge pipe 36 is connected to a pipe or the like, and discharges a fluid into pump chamber 131 to the outside (connected pipe and the like).

[0070] Suction flow passage 35a is formed in the inside

of suction pipe 35. On an upstream side of suction flow passage 35a, suction port 35b which communicates with a flow passage such as a connected pipe is formed. On a downstream side of suction flow passage 35a, opening 35c (see FIG. 2) which opposedly faces suction port 74 of impeller 70 and into which volute portion 130 is inserted is formed.

[0071] On the other hand, discharge flow passage 36a is formed in the inside of discharge pipe 36. On a downstream side of discharge flow passage 36a, discharge port 36b which communicates with the flow passage such as a connected pipe is formed. Discharge port 36b opens in a direction which intersects with the shaft 60 direction (a direction perpendicular to shaft 60 in the first exemplary embodiment).

[0072] As described above, in canned motor pump 1 of this exemplary embodiment, volute portion 130 is formed as a part separate from casing 30.

[0073] Volute portion 130 is formed into a stepped shape such that annular projecting portion 137 is formed on a front side (a casing 30 side) of rear stage portion 136. Projecting portion 137 has a front side and a radially inner side thereof opened, and communicates with suction flow passage 35a. Pump chamber 131 described previously is formed in volute portion 130.

[0074] Pump chamber 131 is formed of impeller housing chamber 131a having a circular shape as viewed in a plan view, and volute structure 131b having a spiral shape as viewed in a plan view. Impeller 70 is housed in impeller housing chamber 131a. Volute structure 131b is formed on an outer periphery of impeller housing chamber 131a and generates an effect of increasing a pressure of a fluid.

[0075] That is, a fluid discharged to an outer peripheral side of impeller 70 from discharge portion 76 is introduced into volute structure 131b. The pressure of the introduced fluid is increased in volute structure 131b. Further, volute structure 131b is disposed so as to be communicated with an upstream side of discharge flow passage 36a in a state where volute portion 130 is assembled to casing 30. With such a configuration, the fluid is discharged to volute structure 131b from discharge portion 76 of impeller 70. The pressure of the discharged fluid is increased in volute structure 131b. The pressure-increased fluid is discharged to the outside of canned motor pump 1 through discharge port 36b of discharge flow passage 36a.

[0076] Volute portion 130 includes front shaft fixing portion 133 which is positioned at a center portion of rotating body housing chamber 51 and forms the shaft support portion. A front end portion of shaft 60 is fixed to front shaft fixing portion 133.

[0077] As described previously, shaft 60 is held by separator 41 in a non-rotatable manner. Casing 30 and separator 41 are fixed to each other, and volute portion 130 is fixed to casing 30. Accordingly, even when the front end portion of shaft 60 is not held by front shaft fixing portion 133 of volute portion 130 in a non-rotatable man-

ner, the rotation of shaft 60 relative to volute portion 130 can be restricted.

[0078] In this exemplary embodiment, front shaft fixing portion 133 of volute portion 130 is integrally formed with volute portion 130 by way of a plurality of support ribs 134 (in this exemplary embodiment, three support ribs 134). Support ribs 134 extend toward pump chamber 131 from an inner surface side of projecting portion 137. It is not particularly necessary to form front shaft fixing portion 133 integrally with volute portion 130.

[0079] Front shaft fixing portion 133 is formed of: corn-shaped projecting portion 133a which projects toward a front portion (forward); and cylindrical bearing portion 133b. Bearing portion 133b is connected to a rear portion of projecting portion 133a, and supports a front end portion of shaft 60.

[0080] Front shaft fixing portion 133 is disposed so as to be brought into contact with shaft 60 and bearing 83 by way of bearing plate 110 and buffer member 120. Bearing plate 110 receives a load applied to bearing 83 in a thrust direction. Buffer member 120 absorbs vibrations and the like generated by shaft 60.

[0081] In general, casing 30 is formed of a PPS (polyphenylenesulfide) resin having high heat resistance, high rigidity and high hardness, for example. On the other hand, as described later, volute portion 130 does not require a strength compared to casing 30 and hence, volute portion 130 is formed of a PPE resin, for example.

[0082] As described previously, in this exemplary embodiment, volute portion 130 on which front shaft fixing portion 133 is formed is formed as a part separate from casing 30. With such a configuration, volute portion 130 and front shaft fixing portion 133 can be configured such that volute portion 130 and front shaft fixing portion 133 are minimally influenced by water pressure. Accordingly, volute portion 130 and front shaft fixing portion 133 can be formed using a low-cost material having a strength lower than a strength of a material for forming casing 30. It is needless to say that volute portion 130 and casing 30 can be formed as an integral body. With such a configuration, assembling of these parts can be facilitated.

[0083] Next, driving of canned motor pump 1 is described.

[0084] In driving canned motor pump 1, first, electricity is supplied to coils 42b by control part 43. When electric current flows through coils 42b, a magnetic field is generated in magnetically driven part 42. Accordingly, magnet portion 82 which rotating body 20 includes is attracted to or repelled from magnetically driven part 42. Accordingly, magnetically driven part 80 rotates about shaft 60. As a result, impeller 70 rotates about shaft 60 extending in the fore-and-aft direction.

[0085] Next, when impeller 70 rotates, a fluid which is introduced into flow passages 75 of impeller 70 through suction port 74 is discharged to the outer peripheral side of impeller 70 from discharge portion 76. Most of the fluid which is discharged to the outer peripheral side of impel-

ler 70 is basically introduced into volute structure 131b. The pressure of the introduced fluid is increased by volute structure 131b. The pressure-increased fluid is discharged to the outside of canned motor pump 1 through discharge port 36b.

[0086] However, a part of the fluid attempts to pass through gap d3 of the flange portion formed between the outer peripheral edge of rear surface shroud 72 and flange portion 41d of separator 41, to flow into a rear side of rear surface shroud 72, and to flow into housing portion 41a.

[0087] In such a case, when a foreign substance (a magnetic substance such as iron powder, for example) is mixed in the fluid, the foreign substance is adhered to magnet portion 82. The adhered foreign substance is rotated together with magnetically driven part 80 and damages an inner surface of separator 41. Accordingly, there is a possibility that the rotation of rotating body 20 is obstructed or locked.

[0088] In view of the above, in canned motor pump 1 of this exemplary embodiment, separator cover 160 made of SUS (stainless steel), for example, is disposed on the inner surface of separator 41. Separator cover 160 prevents separator 41 from being damaged by the intruded foreign substance.

[0089] Further, canned motor pump 1 of this exemplary embodiment has the following configuration for suppressing the intrusion of a foreign substance mixed in a fluid into housing portion 41a.

[0090] More specifically, an outer diameter of magnet fixing portion 81b disposed on the front end portion (end portion on an impeller 70 side) of the magnetically driven part 80 which forms a rotor is set larger than an outer diameter of magnet portion 82. With such a configuration, gap d2 formed between an outer peripheral edge of magnet fixing portion 81b and peripheral wall portion 41c of separator 41 is set smaller than gap d1 formed between magnet portion 82 and peripheral wall portion 41c.

[0091] That is, an outer peripheral portion of magnet fixing portion 81b where an outer diameter of rotor portion 81 is larger than an outer diameter of magnet portion 82 is disposed in the outer periphery of a front end portion of magnetically driven part 80. With such a configuration, it is possible to suppress the intrusion of a foreign substance contained in a fluid in the inside of pump chamber 131 into a gap formed between magnetically driven part 80 and separator 41. It is preferable that gap d2 be set to, for example, 0.5mm or less by taking into account tolerances of parts, a wear amount of the bearing at the end of life or the like.

[0092] Further, in canned motor pump 1 of this exemplary embodiment, annular partition plate 140 made of a PPE (polyphenylene ether) resin, for example, is disposed on an inner peripheral surface of the opening portion of separator 41 and flange portion 41d. As shown in FIG. 2, end surface 140a of partition plate 140 on a casing 30 side forms a portion of volute structure 131b. The outer periphery of end surface 140a of partition plate 140 on a

casing 30 side is pushed by rear end surface 130a of volute portion 130. The outer periphery of end surface 140a on a casing 30 side is interposed between rear end surface 130a and separator 41. With such a configuration, partition plate 140 is fixed.

[0093] Further, in canned motor pump 1 of this exemplary embodiment, ribs 140c are formed on a rear side of partition plate 140 in a projecting manner along an inner peripheral surface of the opening portion of separator 41. Ribs 140c press flange portion 160a of separator cover 160. With such a configuration, separator cover 160 is fixed in a state where separator cover 160 is sandwiched between separator 41 and partition plate 140.

[0094] Canned motor pump 1 of this exemplary embodiment uses impeller 70 where a gap formed between the outer peripheral portion of impeller 70 and the inner peripheral portion of flange portion 41d is large. Accordingly, partition plate 140 is disposed on the outer periphery of impeller 70. With such a configuration, it is possible to make the gap formed between the outer peripheral portion of impeller 70 and the inner peripheral portion of flange portion 41d small.

[0095] When impeller 70 having a large outer diameter where a gap formed between the outer peripheral portion of impeller 70 and the inner peripheral portion of flange portion 41d is small is used for enhancing pump efficiency, it is not particularly necessary to provide partition plate 140.

[0096] As described hereinafter, canned motor pump 1 of this exemplary embodiment can use high-temperature water of 90°C or above so that canned motor pump 1 of this exemplary embodiment has general-purpose property with respect to the usage environment of canned motor pump 1.

[0097] In view of the above, control part 43 is disposed outside resin molded body 200. With such a configuration, it is possible to suppress the transfer of heat generated by high-temperature water to electronic parts and soldered portions mounted on the control board of control part 43 through resin molded body 200. As a result, it is possible to suppress the electronic parts and the soldered portions from becoming high temperature.

[0098] More specifically, coil terminals 45 around which coils 42b of magnetically drive part 42 are wound are exposed from the surface of resin material 44 of resin molded body 200. Further, coil terminals 45 and the control board of control part 43 are connected to each other outside resin molded body 200. That is, portions of coil terminals 45 are exposed to the outside of resin molded body 200, and these exposed portions of coil terminals 45 from resin molded body 200 and control part 43 are electrically connected to each other.

[0099] As shown in FIG. 2, lid portion 170 is disposed on a rear portion of resin molded body 200. Lid portion 170 covers control part 43 connected to coil terminals 45 outside resin molded body 200. Lid portion 170 also forms a portion of pump body 10 which forms the shell. With such a configuration, control part 43 is housed in the in-

side of space portion S1 formed outside resin molded body 200 of canned motor pump 1.

[0100] Further, in canned motor pump 1 of this exemplary embodiment, resin molded body 200 is formed in a state where coil terminals 45 are exposed from the surface of resin material 44. Accordingly, spacer 180 into which coil terminals 45 are press-fitted is used. With such a configuration, at the time of molding, pressing surface 181c (see FIG. 18) of spacer 180 positioned on the outer periphery of coil terminals 45 is brought into contact with molding die 300. As a result, routing of resin material 44 around coil terminals 45 can be further surely suppressed.

[0101] Canned motor pump 1 of this exemplary embodiment has the above-mentioned configuration.

[0102] Next, the configuration of above-mentioned spacer 180 is described in detail with reference to FIG. 7 to FIG. 11.

[0103] Hereinafter, the description is made while defining the fore-and-aft direction as shown in FIG. 7 to FIG. 11 with reference to an arrangement state of spacer 180 shown in FIG. 2.

[0104] As shown in FIG. 7 to FIG. 11, spacer 180 includes plate portion 181 having a substantially annular shape (including an annular shape) on which coil terminals 45 are mounted. Plate portion 181 is disposed in an extending manner in a direction orthogonal to (intersecting with) rotational axis center direction CA (fore-and-aft direction).

[0105] Pressing surfaces 181c are formed on rear surface 181b (the other surface in an axial direction) of plate portion 181. As described above, pressing surfaces 181c form surfaces which are pressed in a state where pressing surfaces 181c are brought into contact with inner surface 301 of molding die 300. Accordingly, pressing surfaces 181c are formed in a rearwardly projecting manner from rear surface 181b (see FIG. 7).

[0106] Plate portion 181 includes ribs 184 which project rearward from pressing surface 181c, and insertion hole 18 is formed in each rib 184. Coil terminal 45 is press-fitted into insertion hole 184a of rib 184 in a state where a portion of coil terminal 45 is exposed to a rear side.

[0107] Plate portion 181 includes temperature detector mounting portion 185. For example, a fuse or the like which detects a temperature of coil 42b is mounted on temperature detector mounting portion 185. Accordingly, after resin molded body 200 is formed by molding, fuse insertion groove 202 is formed on resin molded body 200 at a position facing temperature detector mounting portion 185 (see FIG. 19 and FIG. 20).

[0108] Spacer 180 includes leg portions 182 which extend frontward from plate portion 181 respectively. Leg portions 182 are disposed such that leg portions 182 are brought into contact with rear surface 41n of flange portion 41d.

[0109] That is, a plurality of leg portions 182 are disposed on a front surface 181a side of plate portion 181

along the circumferential direction, and are formed of outer-peripheral-side leg portions 182a and inner-peripheral-side leg portions 182b. Outer-peripheral-side leg portions 182a are formed on an outer peripheral side of plate portion 181 having a substantially annular shape (including an annular shape). Inner-peripheral-side leg portions 182b are formed on an inner peripheral side of plate portion 181. For example, eight outer-peripheral-side leg portions 182a are disposed on the outer peripheral side of plate portion 181 along the circumferential direction. For example, four inner-peripheral-side leg portions 182b are disposed on the inner peripheral side of plate portion 181 along the circumferential direction.

[0110] As shown in FIG. 10, leg portions 182 are disposed such that one inner-peripheral-side leg portion 182b is disposed between two outer-peripheral-side leg portions 182a which are disposed adjacently to each other in the circumferential direction, viewed from a front side. With such a configuration, one set of support portion 186 (see a portion surrounded by a dotted chain line in FIG. 10) is provided where the support is made by three points, that is, two outer-peripheral-side leg portions 182a and one inner-peripheral-side leg portion 182b disposed between two outer-peripheral-side leg portions 182a. In this exemplary embodiment, the case is exemplified where four sets of support portions 186 are provided.

[0111] Support portions 186 are formed such that two pairs of support portions 186 are respectively disposed on both sides of rotational axis center direction CA. That is, support portions 186 are disposed so as to opposedly face each other at positions in point symmetry with respect to rotational axis center direction CA. Four sets of support portions 186 are disposed substantially in line symmetry (including line symmetry) with respect to a straight line L which passes rotational axis center direction CA and temperature detector mounting portion 185.

[0112] More specifically, four sets of support portions 186 are disposed on a straight line which is obtained by rotating straight line L by approximately 60 degrees (including 60 degrees) about rotational axis center direction CA and a straight line which is obtained by rotating straight line L by approximately 120 degrees (including 120 degrees) about rotational axis center direction CA respectively. With such an arrangement, respective support portions 186 are disposed such that the distance (circumferential distance) between each two support portions 186 disposed adjacently to each other in the circumferential direction differs among the respective support portions 186. That is, respective support portions 186 are disposed such that the distance between support portions 186 disposed on the same side with respect to straight line L becomes shorter than the distance between support portions 186 disposed on sides opposite to each other with respect to straight line L.

[0113] Above-mentioned pressing surface 181c is formed on plate portion 181 of spacer 180 on a side opposite to a side where respective support portions 186

are formed.

[0114] As shown in FIG. 2, canned motor pump 1 of this exemplary embodiment includes annular magnetically drive part 42. Magnetically drive part 42 is disposed between outer-peripheral-side leg portions 182a and inner-peripheral-side leg portions 182b which respectively form leg portions 182.

[0115] More specifically, magnetically drive part 42 is disposed between the plurality of outer-peripheral-side leg portions 182a disposed on the outer peripheral side of plate portion 181 of spacer 180 and the plurality of inner-peripheral-side leg portions 182b disposed on the inner peripheral side of plate portion 181.

[0116] Portions of the plurality of outer-peripheral-side leg portions 182a at a distal end side of outer-peripheral-side leg portions 182a disposed on plate portion 181 are connected to each other by connecting ring 183 which forms a connecting portion. In this exemplary embodiment, all eight outer-peripheral-side leg portions 182a are connected to each other by connecting ring 183.

[0117] Plate portion 181 of spacer 180 having the above-mentioned configuration is disposed at the position behind magnetically drive part 42 in a state where distal ends of leg portions 182 are directed frontward (see FIG. 2 and FIG. 15). In such a configuration, leg portions 182 (outer-peripheral-side leg portions 182a and inner-peripheral-side leg portions 182b) are respectively housed in housing portions 41m formed on rear surface 41n of flange portion 41d of separator 41. With such a configuration, spacer 180 is positioned with respect to separator 41.

[0118] As shown in FIG. 3, each housing portion 41m of separator 41 is formed such that side surfaces of projecting portions 41j which project rearward from rear surface 41n of flange portion 41d face side surfaces of the distal end of leg portion 182 in an opposed manner.

[0119] As described above, in canned motor pump 1 of this exemplary embodiment, a three-phase motor where six tooth portions 42d are formed substantially equidistantly (including equidistantly) in the circumferential direction is used as magnetically drive part 42. Coil terminals 45 of three coils of the three-phase motor are electrically connected to the control board of control part 43 respectively. Accordingly, three coil terminals 45 are formed equidistantly in the circumferential direction corresponding to respective tooth portions 42d.

[0120] In this exemplary embodiment, as shown in FIG. 7, three coil terminals 45 are disposed in a rearwardly projecting manner on the same side defined by straight line L.

[0121] More specifically, coil terminal 45 is formed of first coil terminal 45a and second coil terminal 45b. Coil 42b is connected to first coil terminal 45a. Second coil terminal 45b is mounted on plate portion 181, and is electrically connected to the control board of control part 43 (see FIG. 15 and FIG. 16).

[0122] First coil terminals 45a and second coil terminals 45b are electrically connected to each other via relay

board 46. When such a configuration is viewed in the fore-and-aft direction, the position of first coil terminal 45a and the position of second coil terminal 45b in the fore-and-aft direction as well as in the circumferential direction are displaced from each other. With such a configuration, for example, second coil terminal 45b which forms coil terminal 45 can be disposed in a projecting manner from the desired position.

[0123] Accordingly, three second coil terminals 45b are provided in a rearwardly projecting manner on the same side with respect to straight line L. With such a configuration, three second coil terminals 45b are disposed such that connecting positions where three second coil terminals 45b and the control board of control part 43 are connected to each other are not scattered.

[0124] Resin molded body 200 is formed as follows using above-mentioned spacer 180.

[0125] First, magnetically drive part 42 is disposed between spacer 180 and separator 41. At the same time, portions of three coil terminals 45 electrically connected to coils 42b respectively are disposed in a rearwardly projecting manner from plate portion 181 of spacer 180. In such a state of arrangement, these parts are molded by resin material 44 such that the portions of coil terminals 45 are exposed. Resin molded body 200 is formed in this manner.

[0126] In this exemplary embodiment, as shown in FIG. 18, spacer 180 is formed such that leg portions 182 of spacer 180 are molded by resin material 44 in a deflected state.

[0127] More specifically, first, spacer 180 is clamped by molding die 300 and separator 41 thus forming cavity S2. At this stage of the processing, leg portions 182 of spacer 180 are deflected by a clamping force of molding die 300.

[0128] Next, in a state where leg portions 182 are deflected, resin material 44 is filled into cavity S2. At this stage of the processing, it is preferable to set molding die 300 such that spacer 180 is deflected by a clamping force even when a length of leg portions 182 of spacer 180 becomes short due to a size tolerance. Further, it is preferable to set a length of leg portions 182 such that leg portions 182 are not broken even when a length of leg portions 182 of spacer 180 becomes large due to a size tolerance.

[0129] In this exemplary embodiment, outer-peripheral-side leg portions 182a are disposed at substantially symmetrical (including symmetrical) positions (line symmetrical and point symmetrical positions) along the circumferential direction on the outer peripheral side of plate portion 181. Accordingly, outer-peripheral-side leg portions 182a are deflected in a projecting manner in a radially outward direction. In FIG. 18, to facilitate the understanding of the description, outer-peripheral-side leg portions 182a are illustrated in a largely deflected manner such that outer-peripheral-side leg portions 182a project in a radially outward direction. However, in an actual configuration, outer-peripheral-side leg portions 182a are

slightly deflected, and in this exemplary embodiment, outer-peripheral-side leg portions 182a are deflected by approximately 1mm, for example.

[0130] Spacer 180 is made of a resin having excellent resiliency such as PA66 (polyamide 66: 66 nylon), for example.

[0131] Spacer 180 is configured as described above, and is formed in the inside of resin molded body 200 in a deflected state.

[0132] Hereinafter, a method for manufacturing canned motor pump 1 according to the first exemplary embodiment is described.

[0133] Manufacturing methods other than a method for forming resin molded body 200, a method for disposing control part 43 and a method for mounting lid portion 170 can be performed using known manufacturing methods and hence, the description of such manufacturing methods is omitted.

[0134] Hereinafter, the method for forming resin molded body 200, the method for disposing control part 43, and the method for mounting lid portion 170 are mainly described.

[0135] First, canned motor pump 1 is formed in a resin molded body forming step. The resin molded body forming step is a step of forming resin molded body 200 by molding separator 41, magnetically drive part 42 and spacer 180 by resin material 44.

[0136] Resin molded body 200 is formed through a magnetically drive part disposing step, a spacer disposing step, a spacer clamping step, an injection step and the like which form the resin molded body forming step. These steps are described hereinafter.

[0137] First, in the magnetically drive part disposing step, as shown in FIG. 12 and FIG. 13, magnetically drive part 42 is disposed on a rear surface 41n side of flange portion 41d extending in a radially outward direction on an opening side of bottomed cylindrical portion 41k of separator 41 which opens frontward.

[0138] Then, magnetically drive part 42 is inserted from behind separator 41 along peripheral wall portion 41c. Then, the front end of magnetically drive part 42 is housed in annular groove 41i of separator 41. With such a configuration, magnetically drive part 42 is mounted on separator 41.

[0139] Then, first coil terminals 45a to which coils 42b are connected respectively are connected to relay board 46.

[0140] Next, in the spacer disposing step, plate portion 181 which extends in a direction orthogonal to (intersecting with) fore-and-aft direction of spacer 180 and on which coil terminals 45 are mounted is disposed behind magnetically drive part 42. At the same time, leg portions 182 extending frontward from plate portion 181 are brought into contact with rear surface 41n of flange portion 41d. Spacer 180 is disposed in this manner.

[0141] That is, the plurality of leg portions 182 (outer-peripheral-side leg portions 182a and inner-peripheral-side leg portions 182b) are respectively housed in hous-

ing portions 41m formed on rear surface 41n of flange portion 41d. With such a configuration, leg portions 182 are brought into contact with rear surface 41n of flange portion 41d.

[0142] Then, portions of second coil terminals 45b are connected to relay board 46 in a state where the portions of second coil terminals 45b are exposed to the rear side and are press-fitted into insertion holes 184a of ribs 184 of spacer 180. With such a configuration, first coil terminals 45a and second coil terminals 45b are electrically connected to each other via relay board 46 (see FIG. 14 to FIG. 16).

[0143] Next, in the spacer clamping step, spacer 180 is clamped by molding die 300 and separator 41. Then, cavity S2 into which resin material 44 is to be filled is formed.

[0144] As shown in FIG. 18, molding die 300 includes upper die 300a and lower die 300b. Upper die 300a is a die where housing portions 302 in which ribs 184 of spacer 180 and exposed portions of second coil terminals 45b are housed are formed. The exposed portions of second coil terminals 45b are portions which are exposed without being covered by resin material 44 at the time of forming resin molded body 200. Lower die 300b is a die for supporting separator 41.

[0145] In a state where spacer 180, separator 41 and the like are housed in molding die 300, upper die 300a and lower die 300b of molding die 300 are clamped to each other. With such an operation, spacer 180 disposed between molding die 300 and separator 41 is clamped thus forming cavity S2.

[0146] At this stage of the processing, as shown in FIG. 18, while bringing inner surface 301 of upper die 300a of molding die 300 into face contact with rear surface 181b of plate portion 181, spacer 180 is pressed to a separator 41 side. With such an operation, molding die 300 clamps spacer 180 in a state where leg portions 182 of spacer 180 are deformed by deflection.

[0147] That is, spacer 180 is clamped in a state where pressing surfaces 181c of plate portion 181 are brought into surface contact with inner surface 301 of molding die 300.

[0148] At this stage of the processing, portions of second coil terminals 45b are press-fitted into insertion holes 184a of ribs 184 in a rearwardly exposed manner. Above-mentioned exposed portions of ribs 184 and exposed portions of second coil terminals 45b are housed in housing portions 302 of upper die 300a of molding die 300.

[0149] Then, inner surface 301 of molding die 300 is disposed so as to be brought into surface contact with pressing surfaces 181c formed on the periphery of rib 184 of spacer 180 over the whole periphery of rib 184. Accordingly, housing portions 302 of molding die 300 which respectively house the exposed portions of ribs 184 and exposed portions of second coil terminals 45b therein are disposed so as not to communicate with cavity S2.

[0150] Next, in the injection step, resin material 44 is

injected into cavity S2 in a state where spacer 180 is clamped between upper die 300a of molding die 300 and separator 41 of lower die 300b.

[0151] At this stage of the processing, housing portions 302 of molding die 300 in which the exposed portions of ribs 184 and the exposed portions of second coil terminals 45b are housed are disposed so as not to communicate with cavity S2. Accordingly, it is possible to suppress the exposed portions of second coil terminals 45b from being covered by resin material 44.

[0152] In accordance with the above-mentioned respective steps which form the resin molded body forming step, resin molded body 200 shown in FIG. 19 and FIG. 20 is formed.

[0153] Then, canned motor pump 1 of this exemplary embodiment is formed using resin molded body 200 which is formed in the above-described resin molded body forming step as follows.

[0154] First, magnetically driven part 80 and volute portion 130 are disposed on a front side of resin molded body 200, and casing 30 is mounted on resin molded body 200.

[0155] Next, the control board which forms control part 43 is disposed on a rear side of resin molded body 200, and lid portion 170 is mounted on resin molded body 200. At this stage of the processing, the control board is disposed in a state where the control board is placed on projection 201 which is formed on the center of a rear portion of resin molded body 200 shown in FIG. 2.

[0156] Canned motor pump 1 shown in FIG. 1 and FIG. 2 is formed in accordance with the above-mentioned steps.

[0157] As has been described heretofore, canned motor pump 1 of this exemplary embodiment includes: magnetically driven part 80 which is rotatably and pivotally supported by shaft 60; and impeller 70 formed on the front side in the fore-and-aft direction (one end side in the axial direction) of magnetically driven part 80. Further, canned motor pump 1 includes pump body 10 where pump chamber 131 housing impeller 70 is formed. Canned motor pump 1 further includes magnetically drive part 42 which has: coils 42b disposed on the outer peripheral side of magnetically driven part 80 and generating a rotary magnetic field for rotating magnetically driven part 80; and stator core 42a around which coils 42b are wound. Canned motor pump 1 further includes: separator 41 which separates magnetically driven part 80 and magnetically drive part 42 from each other; and coil terminals 45 electrically connected to coils 42b. Further, canned motor pump 1 includes: spacer 180 on which coil terminals 45 are mounted; and control board electrically connected to coil terminals 45.

[0158] Separator 41 includes bottomed cylindrical portion 41k in which housing portion 41a opening frontward in the fore-and-aft direction (toward one end side in the axial direction) and capable of housing magnetically driven part 80 therein is formed. Further, separator 41 includes the flange portion disposed in an extending man-

ner in a radially outward direction from an opening side of bottomed cylindrical portion 41k. Magnetically drive part 42 is disposed behind flange portion 41d (on the other end side in the axial direction) on the outer peripheral side of bottomed cylindrical portion 41k.

[0159] Separator 41, magnetically drive part 42 and spacer 180 are embraced in resin molded body 200 by molding using resin material 44. Spacer 180 is extended in an axial direction, and coil terminals 45 are mounted on the axially extending portion of spacer 180.

[0160] The portions of coil terminals 45 are disposed outside resin molded body 200 in an exposed manner, and the exposed portions of coil terminals 45 are electrically connected to control board.

[0161] Spacer 180 includes plate portion 181 disposed behind (on the other end side in the axial direction) of bottomed cylindrical portion 41k. Further, spacer 180 includes leg portions 182 extending frontward (toward one end side in an axial direction) from plate portion 181 and being brought into contact with rear surface 41n (the other surface in the axial direction) of flange portion 41d.

[0162] Spacer 180 is disposed in an inside of resin molded body 200 in a state where leg portions 182 are deflected.

[0163] With such a configuration, resin molded body 200 can be formed without being influenced by size tolerances of magnetically drive part 42 and the like. Accordingly, the formation of a gap between plate portion 181 of spacer 180 and molding die 300 can be suppressed.

[0164] Accordingly, breaking of magnetically drive part 42 and the like can be suppressed. Further, the generation of burrs around coil terminals 45 and covering of coil terminals 45 by resin material 44 can be suppressed.

[0165] As a result, it is possible to obtain canned motor pump 1 which can suppress the lowering of reliability while having general-purpose property with respect to usage environment thereof.

[0166] Leg portions 182 of canned motor pump 1 of this exemplary embodiment include: outer-peripheral-side leg portions 182a formed on the outer peripheral side of plate portion 181; and inner-peripheral-side leg portions 182b formed on the inner peripheral side of plate portion 181, and magnetically drive part 42 is disposed between outer-peripheral-side leg portions 182a and inner-peripheral-side leg portions 182b.

[0167] In canned motor pump 1 of this exemplary embodiment, the plurality of leg portions 182 are disposed along the circumferential direction of plate portion 181.

[0168] With such a configuration, the deflection direction of leg portions 182 of spacer 180 can be restricted. Accordingly, leg portions 182 can be deflected such that plate portion 181 moves substantially parallel (including parallel). As a result, the formation of the gap between plate portion 181 of spacer 180 and molding die 300 can be suppressed more certainly.

[0169] That is, the generation of burrs around coil terminals 45 and covering of coil terminals 45 by resin ma-

terial 44 can be suppressed more certainly.

[0170] Leg portions 182 (outer-peripheral-side leg portions 182a) of canned motor pump 1 of this exemplary embodiment are connected to each other by connecting portion.

[0171] With such a configuration, at the time of molding spacer 180, it is possible to suppress expanding of leg portions 182 (outer-peripheral-side leg portions 182a) in the outer peripheral direction. As a result, size accuracy of leg portions 182 (outer-peripheral-side leg portions 182a) can be further enhanced.

[0172] Flange portion 41d of canned motor pump 1 of this exemplary embodiment includes housing portions 41m for housing leg portions 182 on rear surface 41n (on the other end side surface in the axial direction) thereof.

[0173] With such a configuration, positional displacement of leg portions 182 of spacer 180 can be suppressed. Accordingly, the deflection direction of leg portions 182 can be restricted more certainly. Further, leg portions 182 can be deflected such that plate portion 181 moves substantially parallel (including parallel). As a result, the formation of the gap between plate portion 181 of spacer 180 and molding die 300 can be further surely suppressed.

[0174] That is, the generation of burrs around coil terminals 45 and covering of coil terminals 45 by resin material 44 can be suppressed more certainly.

[0175] Bottomed cylindrical portion 41k of canned motor pump 1 of this exemplary embodiment has a tapered shape where a diameter of bottomed cylindrical portion 41k is gradually decreased toward a bottom surface side from an opening side, and stator core 42a has magnetic pole surface 42f on a side where stator core 42a faces peripheral surface 41f (outer peripheral surface) of bottomed cylindrical portion 41k. Further, separator 41 is provided with straight portion 41h extending in the fore-and-aft direction (axial direction) on a portion facing magnetic pole surface 42f.

[0176] With such a configuration, even when leg portions 182 of spacer 180 are deflected and the position of stator core 42a is displaced in the fore-and-aft direction (axial direction), it is possible to keep clearance d4 between peripheral surface (outer peripheral surface) 41f of bottomed cylindrical portion 41k and magnetic pole surface 42f of stator core 42a at an approximately fixed value (including fixed value). With such a configuration, at the time of resin molding, the movement of stator core 42a in the radial direction and the inclination of stator core 42a with respect to shaft 60 generated by an injection pressure at the time of injecting resin material 44 can be suppressed. As a result, the increase of vibrations of canned motor pump 1 caused by eccentricity of magnetically driven part 80 and rotation of magnetically driven part 80 in an inclined state can be suppressed.

[0177] Coil terminals 45 of canned motor pump 1 of this exemplary embodiment include first coil terminals 45a to which coils 42b are connected, and second coil terminals 45b which are mounted on plate portion 181

and are electrically connected to the control board of control part 43. Further, first coil terminals 45a and second coil terminals 45b are electrically connected to each other via relay board 46, and first coil terminals 45a and second coil terminals 45b are disposed at respective positions displaced from each other as viewed from the fore-and-aft direction (axial direction).

[0178] With such a configuration, positions where coil terminals 45 electrically connected to the control board of control part 43 project can be set at desired positions. Accordingly, coil terminals 45 can be connected to portions of control board of control part 43 at desired positions.

[0179] The method for manufacturing a canned motor pump according to this exemplary embodiment includes at least the resin molded body forming step of forming resin molded body 200 by molding separator 41, magnetically drive part 42, and spacer 180 by resin material 44. The resin molded body forming step includes the magnetically drive part disposing step of disposing magnetically drive part 42 behind in the fore-and-aft direction (on the other end side in the axial direction) of flange portion 41d extending outward in the radial direction on an opening side of bottomed cylindrical portion 41k which opens frontward in the fore-and-aft direction (toward one end side in the axial direction).

[0180] The resin molded body forming step further includes the spacer disposing step of disposing plate portion 181 which extends in the fore-and-aft direction (axial direction) of spacer 180 and on which coil terminals 45 are mounted behind (on the other end side in the axial direction of) bottomed cylindrical portion 41k and, at the same time, bringing leg portions 182 extending from plate portion 181 frontward (toward one end side in the axial direction) into contact with flange portion 41d.

[0181] The resin molded body forming step further includes the spacer clamping step of clamping spacer 180 by molding die 300 and separator 41 to form cavity S2.

[0182] The resin molded body forming step further includes the injection step of injecting resin material 44 into cavity S2 in a state where spacer 180 is clamped.

[0183] In the spacer clamping step in the method for manufacturing a canned motor pump according to this exemplary embodiment, spacer 180 is clamped in a state where leg portions 182 are deformed by deflection by pressing spacer 180 to a separator 41 side while bringing inner surface 301 of molding die 300 into face contact with pressing surface 181c of plate portion 181 of spacer 180.

[0184] According to these methods, resin molded body 200 can be formed into a predetermined shape without being influenced by size tolerances of magnetically drive part 42 and the like. Accordingly, the formation of a gap between plate portion 181 of spacer 180 and molding die 300 can be suppressed.

[0185] Accordingly, breaking of magnetically drive part 42 and the like can be suppressed. Further, the generation of burrs around coil terminals 45 and covering of coil

terminals 45 by resin material 44 can be suppressed.

[0186] As a result, it is possible to stably form canned motor pump 1 which can suppress the lowering of reliability while having general-purpose property with respect to usage environment thereof.

[0187] Although the preferred exemplary embodiment of this disclosure has been described heretofore, the present disclosure is not limited to the above-mentioned exemplary embodiment, and various modifications are conceivable.

[0188] For example, specifications (shape, size, layout and the like) of the casing, the suction pipe, and other detailed portions can be changed appropriately.

Claims

1. A canned motor pump comprising:

a magnetically driven part rotatably and pivotally supported by a shaft;
an impeller formed on one end side of the magnetically driven part in an axial direction of the magnetically driven part;
a pump body in which a pump chamber for housing the impeller is formed;
a magnetically drive part having: coils disposed on an outer peripheral side of the magnetically driven part and generating a rotary magnetic field for rotating the magnetically driven part; and a stator core around which the coils are wound;
a separator separating the magnetically driven part and the magnetically drive part from each other;
coil terminals electrically connected to the coils;
a spacer on which the coil terminals are mounted; and
a control board electrically connected to the coil terminals,
wherein the separator includes:

a bottomed cylindrical portion which has one end side opened in the axial direction and in which a housing portion for housing the magnetically driven part is formed; and
a flange portion disposed in an extending manner in a radially outward direction from an opening side of the bottomed cylindrical portion,

the magnetically drive part is disposed on an other end side in the axial direction with respect to the flange portion on an outer peripheral side of the bottomed cylindrical portion,
the separator, the magnetically drive part, and the spacer are embraced in a resin molded body by molding using a resin material,
the spacer is extended in the axial direction, and

the coil terminals are mounted on the spacer, portions of the coil terminals are disposed outside the resin molded body in an exposed manner, and the exposed portions of the coil terminals are electrically connected to the control board, the spacer includes:

a plate portion disposed on the other end side in the axial direction of the bottomed cylindrical portion; and
a leg portion extending toward one end side in an axial direction from the plate portion and being brought into contact with the flange portion, and

the spacer is disposed in an inside of the resin molded body in a state where the leg portion is deflected.

2. The canned motor pump according to claim 1, wherein the leg portion includes:

an outer peripheral side leg portion formed on an outer peripheral side of the plate portion; and
an inner peripheral side leg portion formed on an inner peripheral side of the plate portion, and

the magnetically drive part is disposed between the outer peripheral side leg portion and the inner peripheral side leg portion.

3. The canned motor pump according to claim 1 or claim 2, wherein a plurality of the leg portions are disposed along a circumferential direction of the plate portion.

4. The canned motor pump according to claim 3, wherein the leg portions are connected to each other by a connecting portion.

5. The canned motor pump according to claim 1, wherein the flange portion includes a housing portion for housing the leg portion on an other end side surface in the axial direction.

6. The canned motor pump according to claim 1, wherein the bottomed cylindrical portion has a tapered shape where a diameter of the bottomed cylindrical portion is gradually decreased toward a bottom surface side from the opening side, the stator core has magnetic pole surfaces on a side where the stator core faces an outer peripheral surface of the bottomed cylindrical portion, and the separator is provided with straight portions extending in the axial direction on portions of the sep-

arator facing the magnetic pole surfaces.

7. The canned motor pump according to claim 1, wherein the coil terminals include first coil terminals to which the coils are connected, and second coil terminals which are mounted on the plate portion and are electrically connected to the control board, the first coil terminals and the second coil terminals are electrically connected to each other via a relay board, and the first coil terminals and the second coil terminals are disposed at respective positions displaced from each other as viewed from the axial direction.

8. A method for manufacturing a canned motor pump which includes:

a magnetically driven part rotatably and pivotally supported by a shaft;

an impeller formed on one end side of the magnetically driven part in an axial direction of the magnetically driven part;

a pump body in which a pump chamber for housing the impeller is formed;

a magnetically drive part having: coils disposed on an outer peripheral side of the magnetically driven part and generating a rotary magnetic field for rotating the magnetically driven part; and a stator core around which the coils are wound; a separator separating the magnetically driven part and the magnetically drive part from each other and having a bottomed cylindrical portion and a flange portion;

coil terminals electrically connected to the coils; a spacer on which the coil terminals are mounted; and

a control board electrically connected to the coil terminals,

the method comprising at least a resin molded body forming step of forming a resin molded body by molding the separator, the magnetically drive part, and the spacer using a resin material,

wherein the resin molded body forming step includes:

a magnetically drive part disposing step of disposing the magnetically drive part on the other end side in the axial direction of the flange portion extending outward in the radial direction on an opening side of the bottomed cylindrical portion which opens toward one end side in the axial direction,

a spacer disposing step of disposing the plate portion which extends in the axial direction of the spacer and on which the coil terminals are mounted on the other end side in the axial di-

rection of the bottomed cylindrical portion and,
at the same time, bringing a leg portion extend-
ing from the plate portion toward one end side
in the axial direction into contact with the flange
portion; 5
a spacer clamping step of clamping the spacer
by a molding die and the separator thus forming
a cavity; and
an injection step of injecting a resin material into
the cavity in a state where the spacer is clamped. 10

9. The method for manufacturing a canned motor pump
according to claim 8, wherein
in the spacer clamping step,
the spacer is pressed toward the separator side while 15
bringing an inner surface of the molding die into face
contact with the other end side surface in the axial
direction of the plate portion of the spacer, and
the spacer is clamped in a state where the leg portion
is deformed by deflection. 20

25

30

35

40

45

50

55

FIG. 1

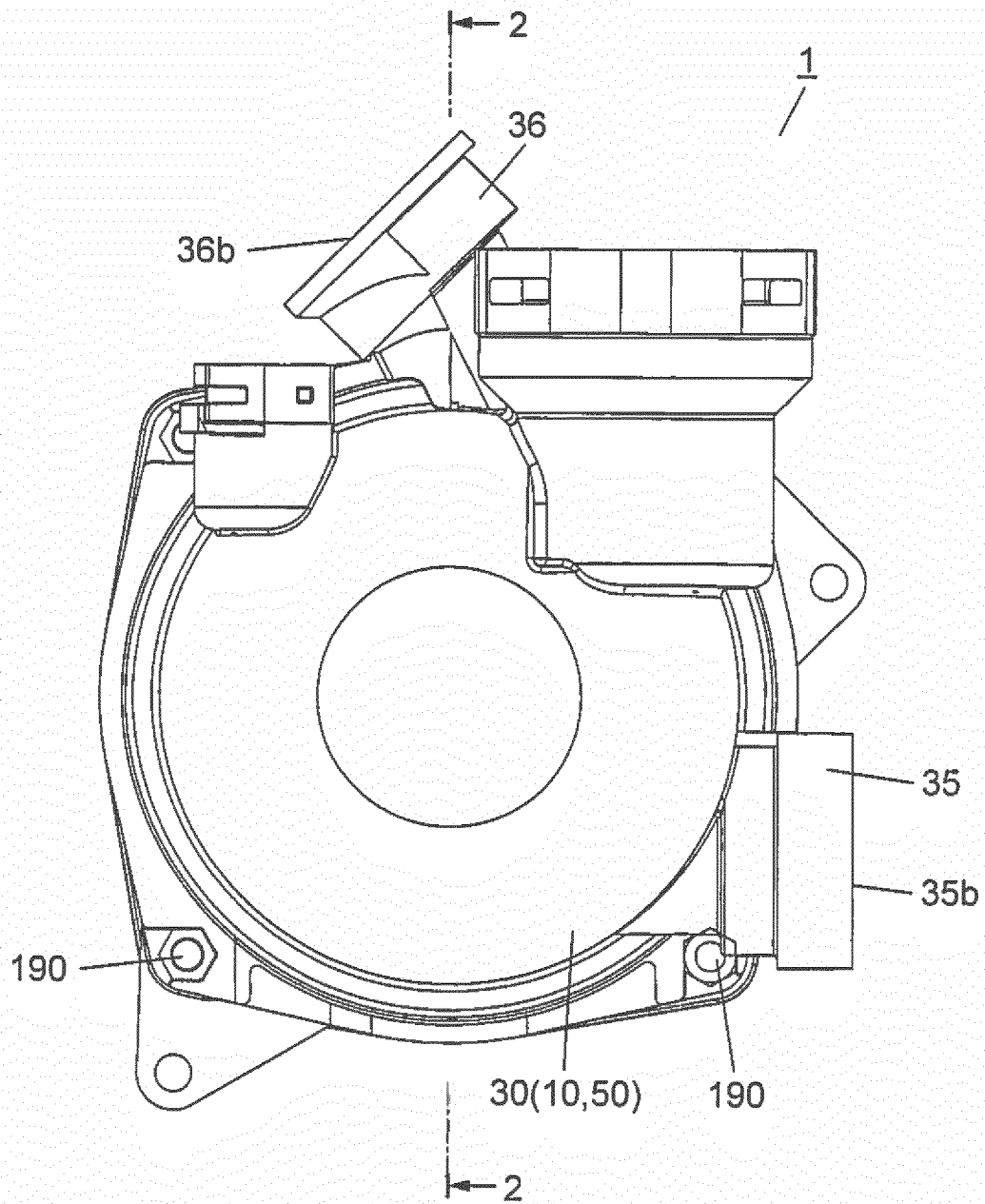


FIG. 2

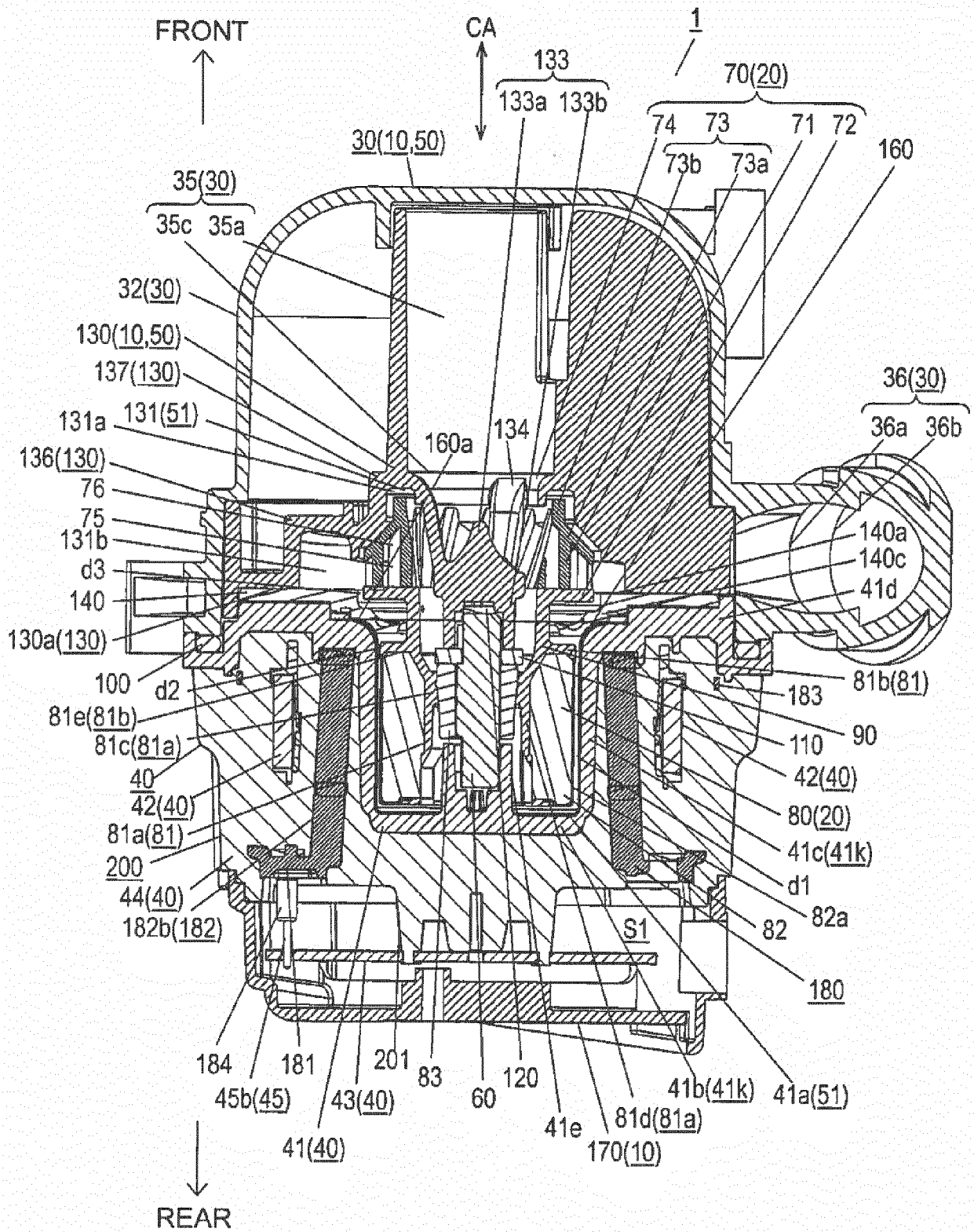


FIG. 3

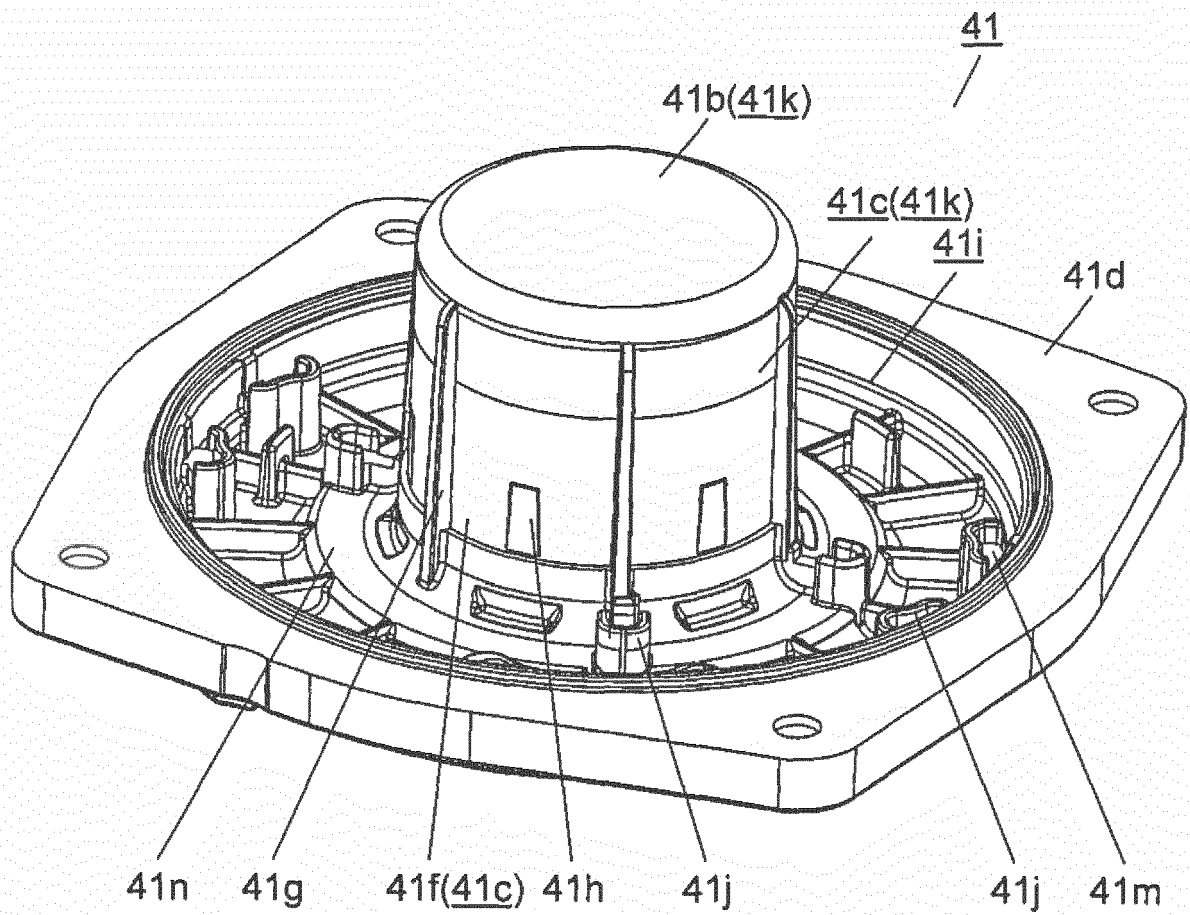


FIG. 4

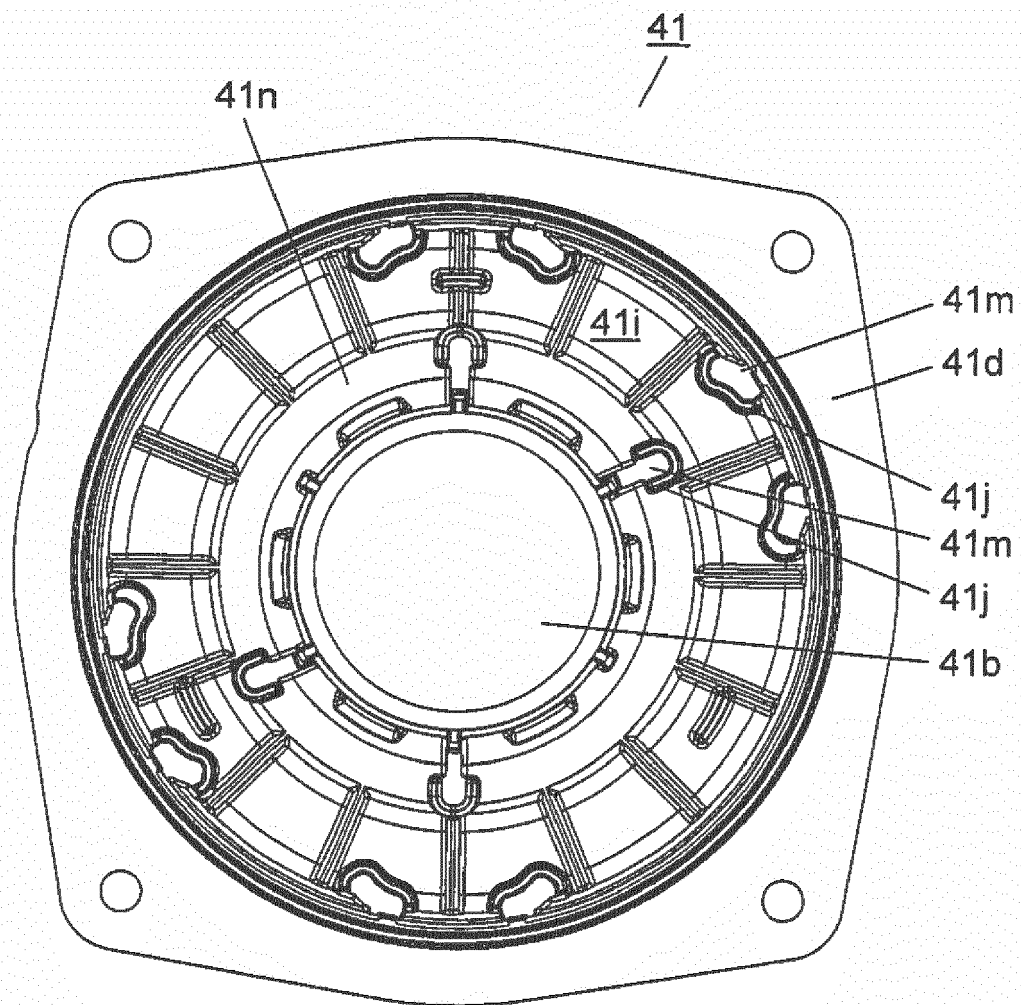


FIG. 5

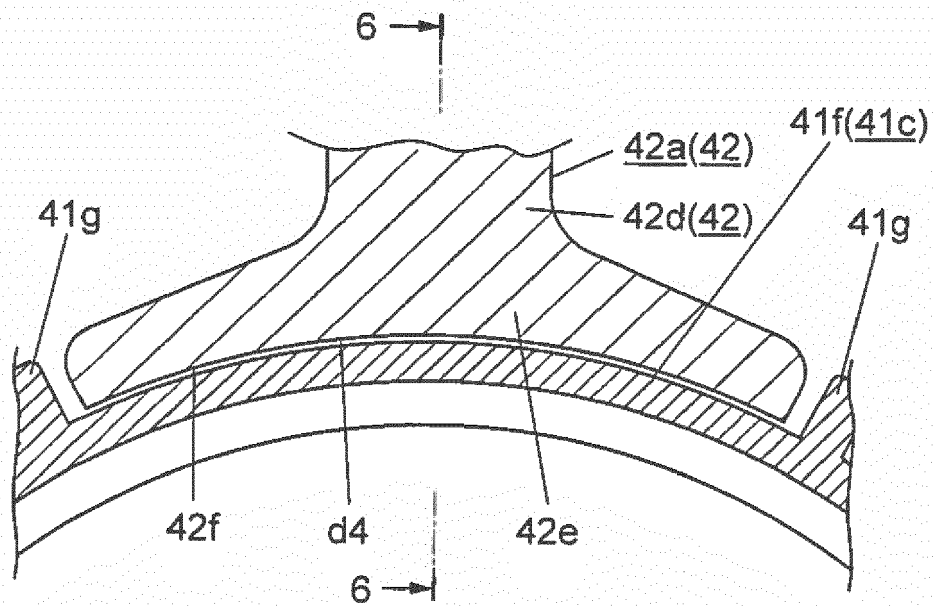


FIG. 6

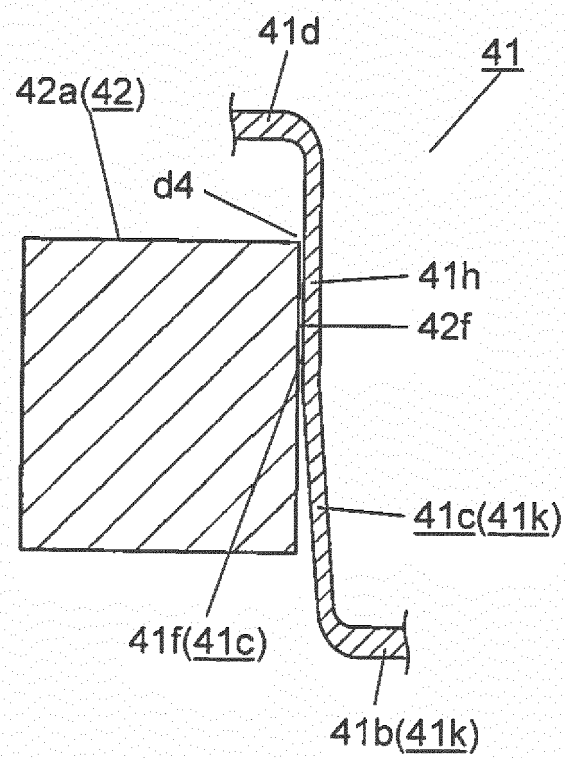
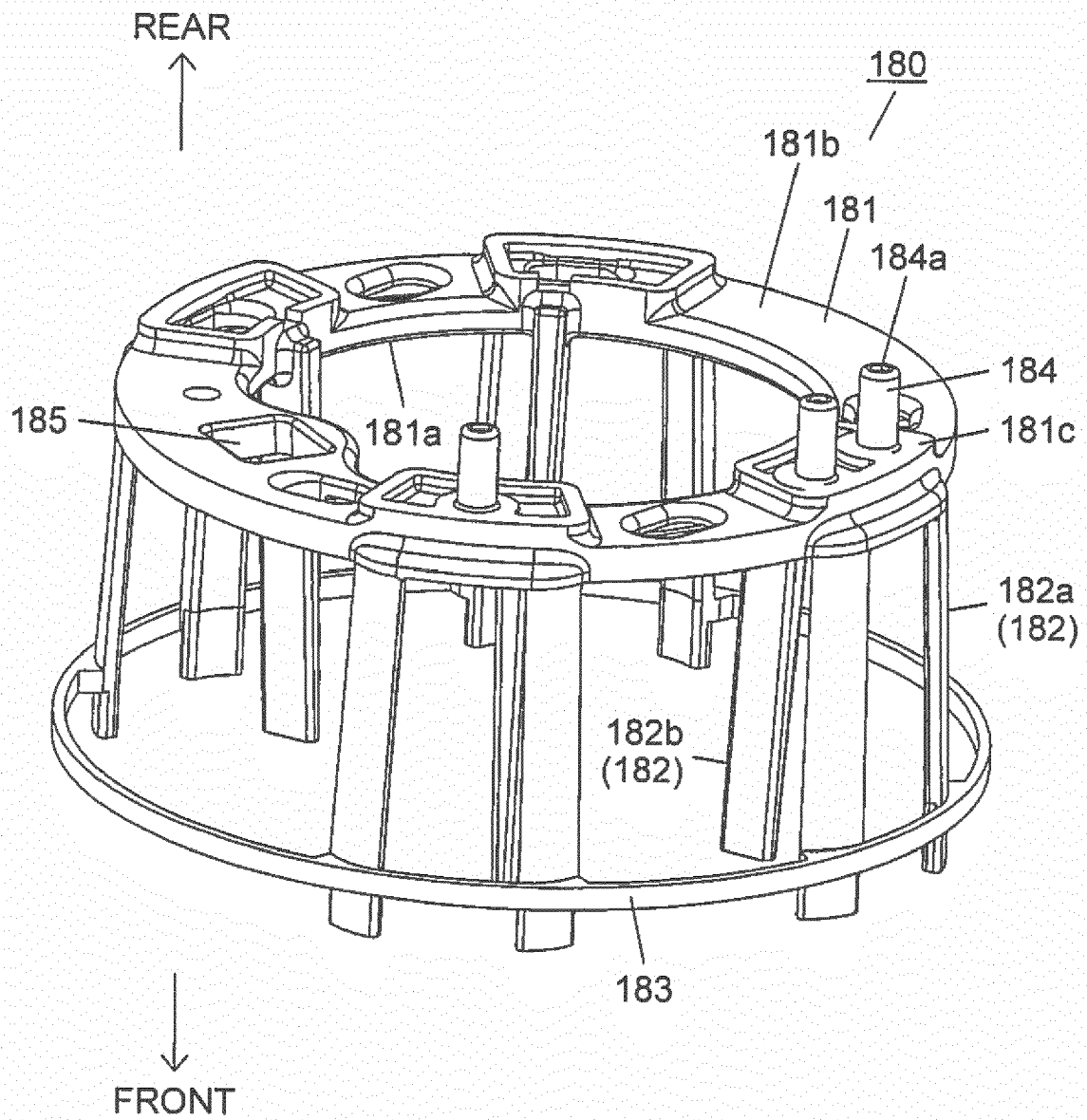


FIG. 7



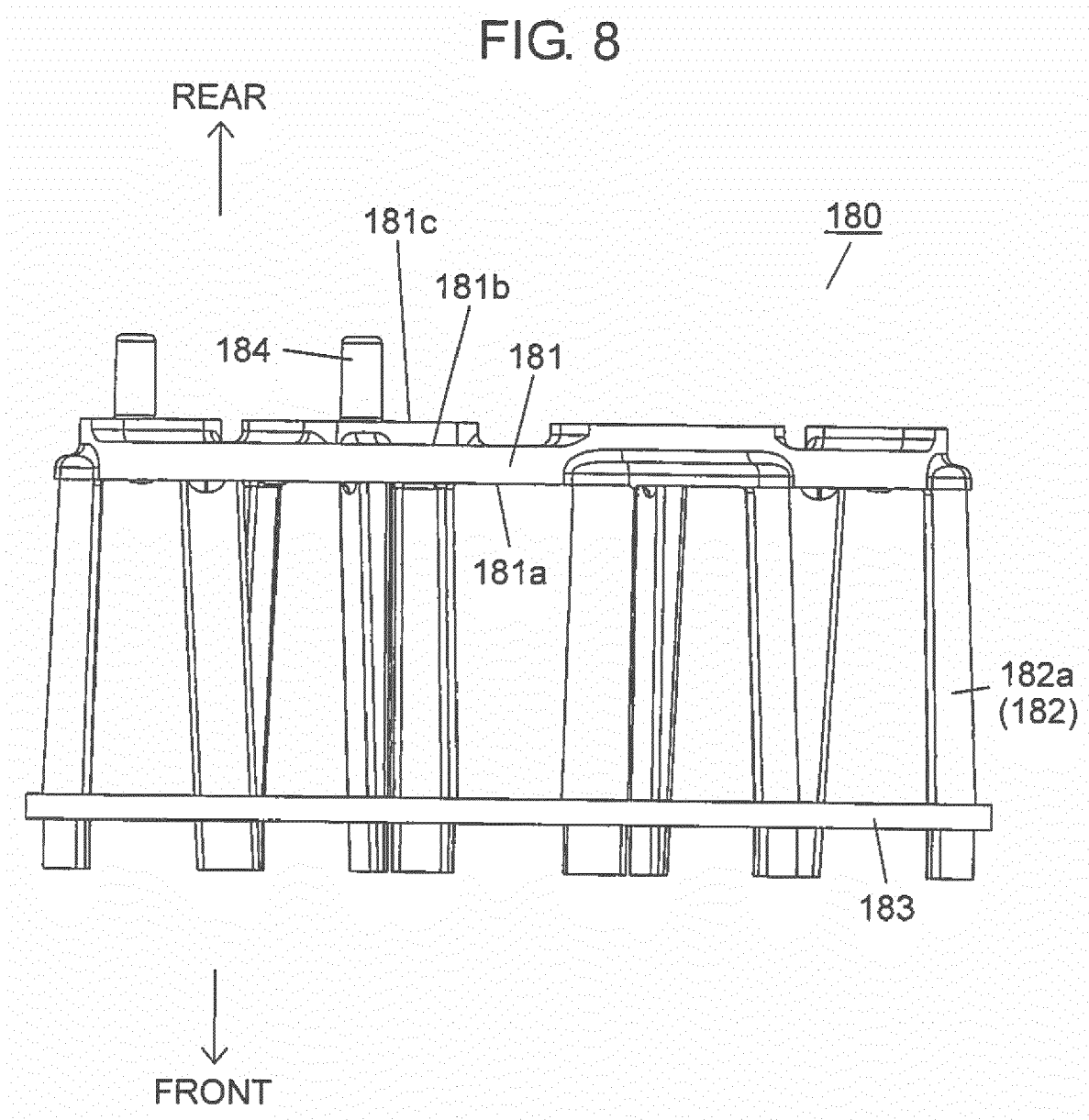


FIG. 9

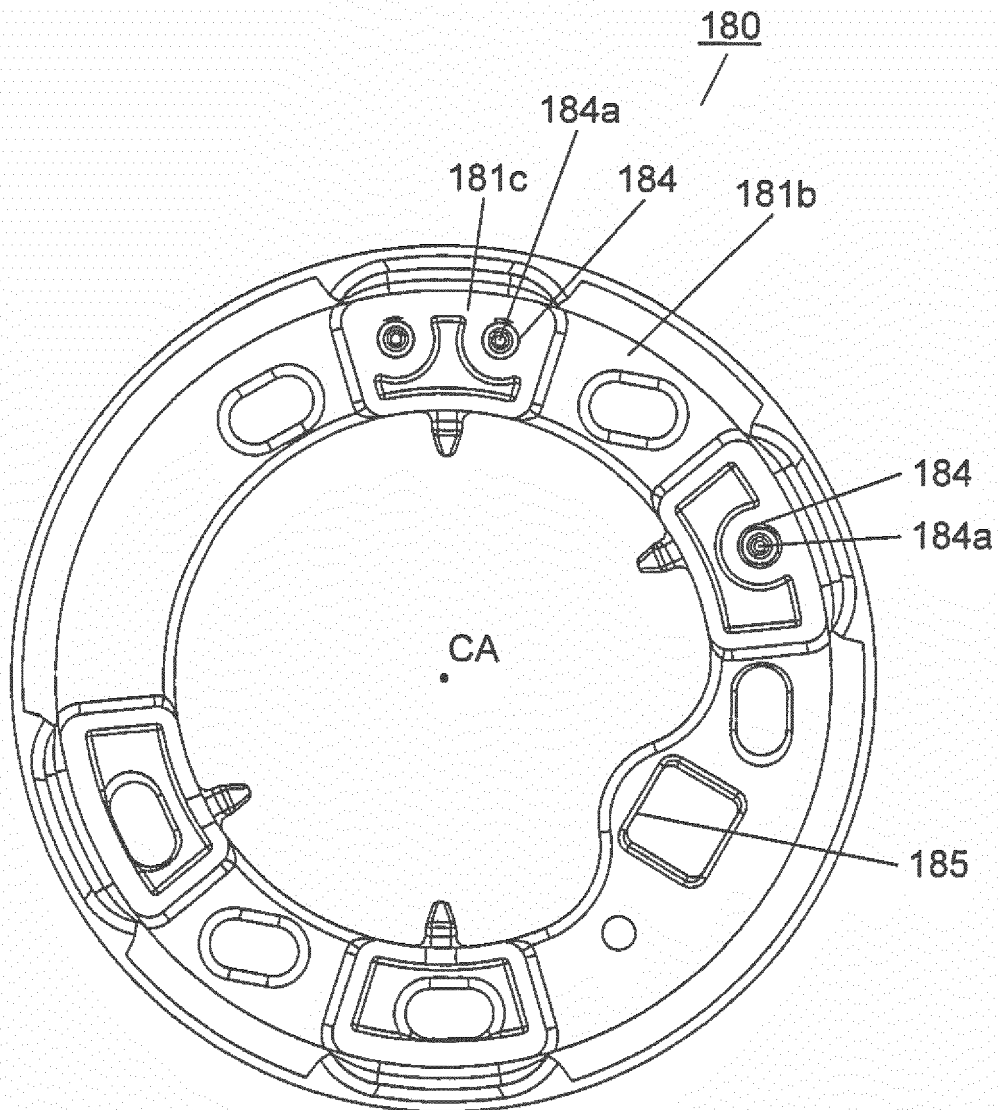
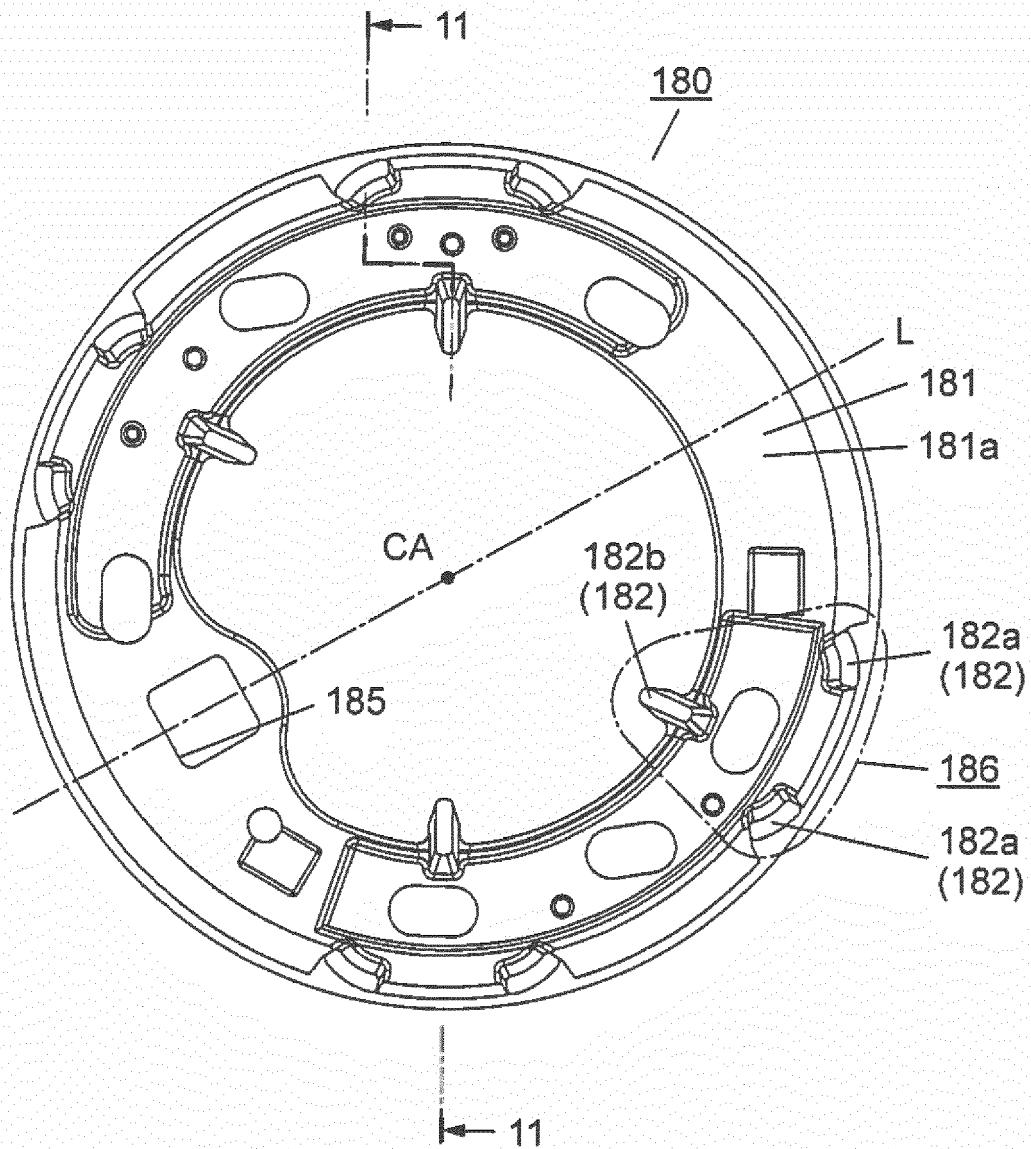


FIG. 10



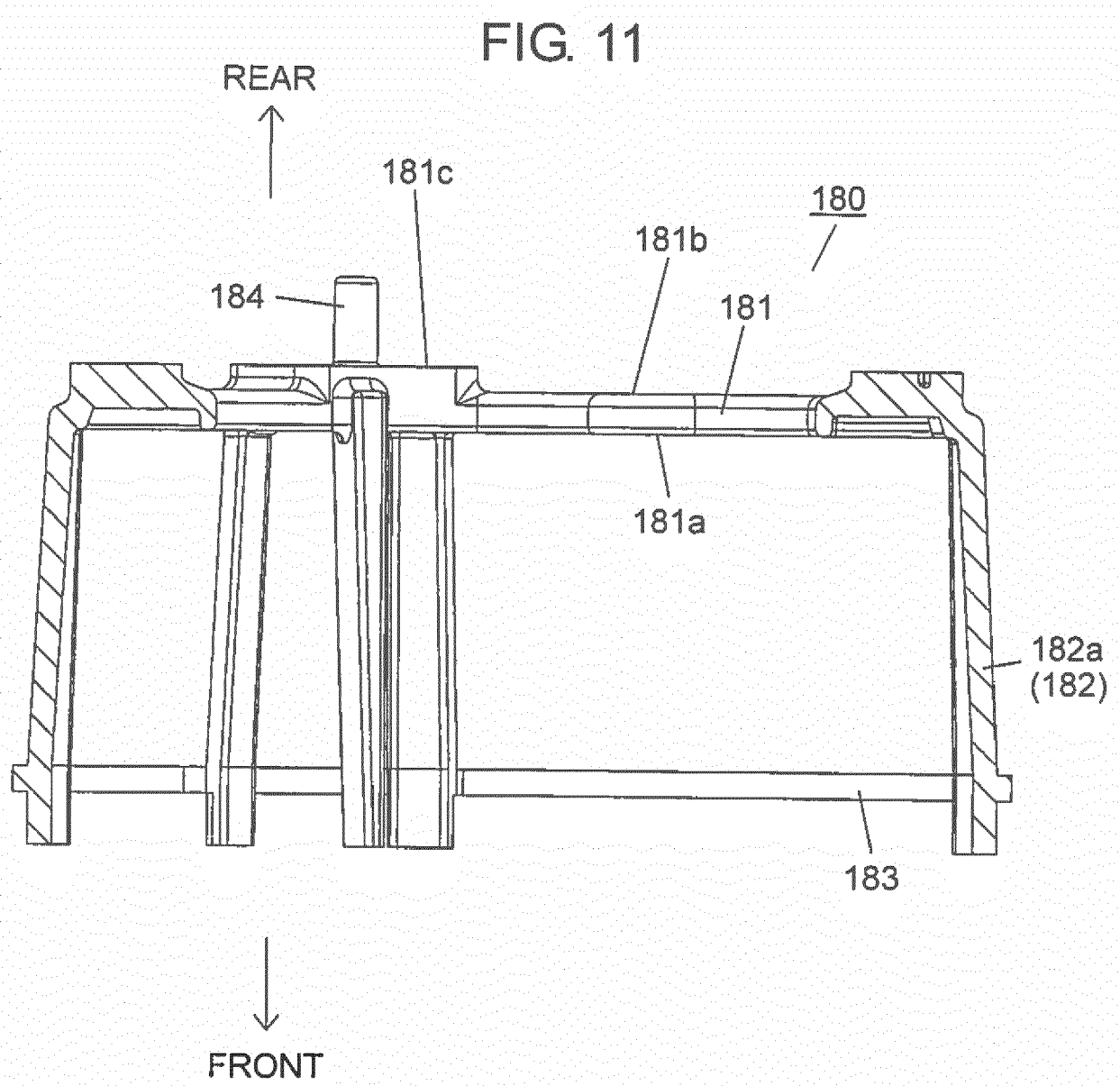


FIG. 12

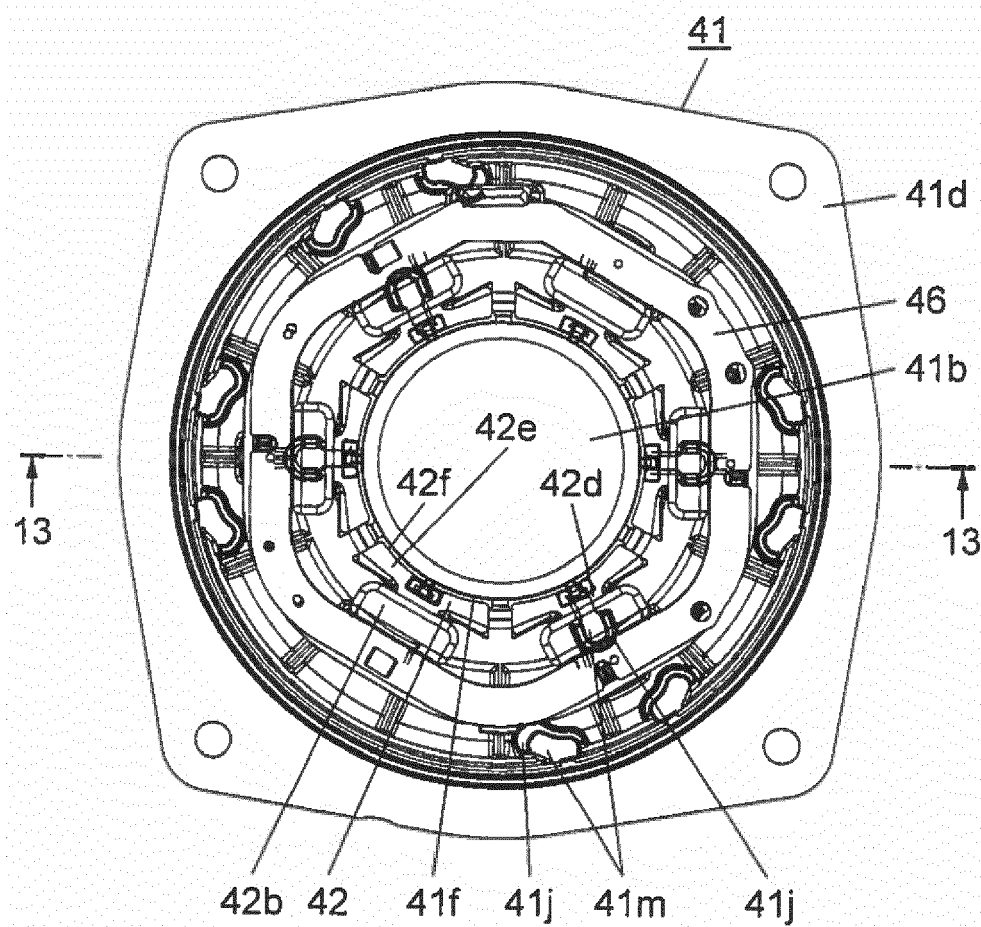


FIG. 13

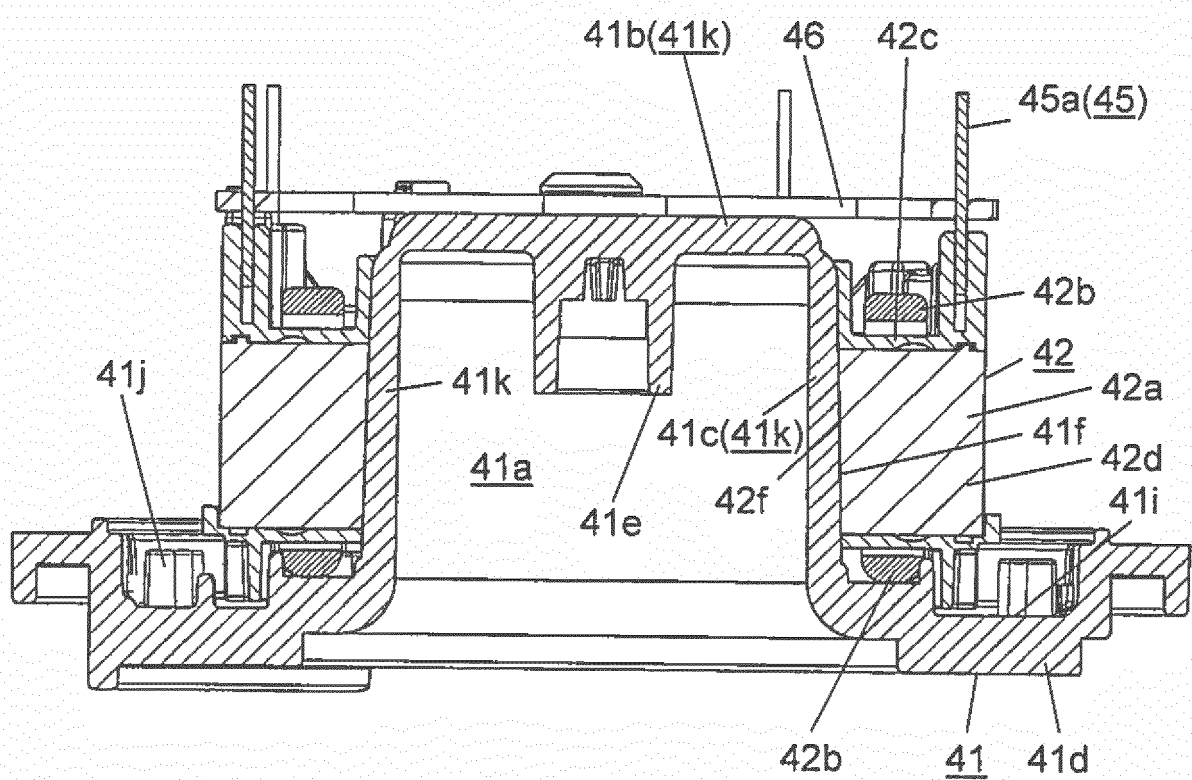


FIG. 14

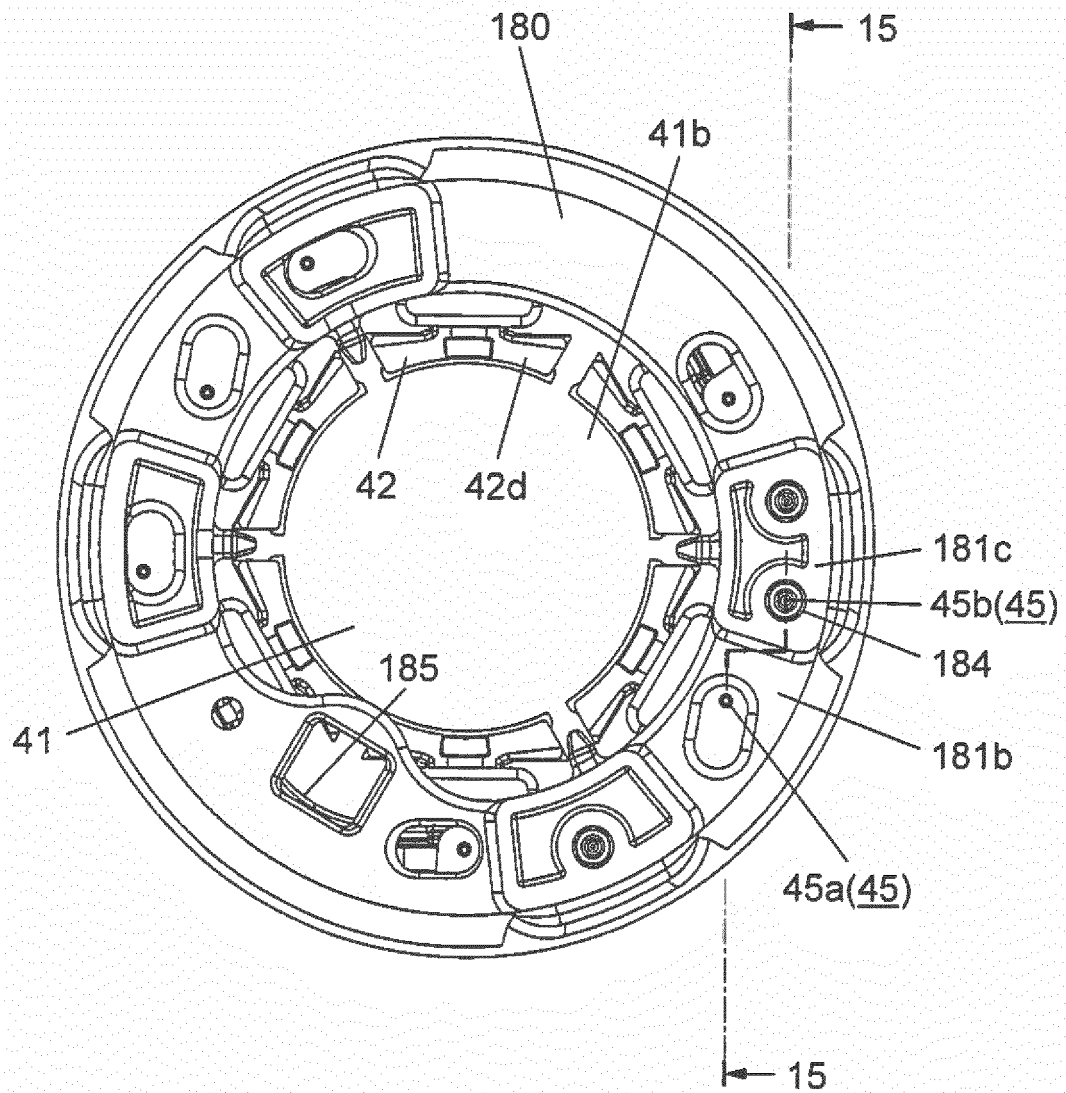


FIG. 15

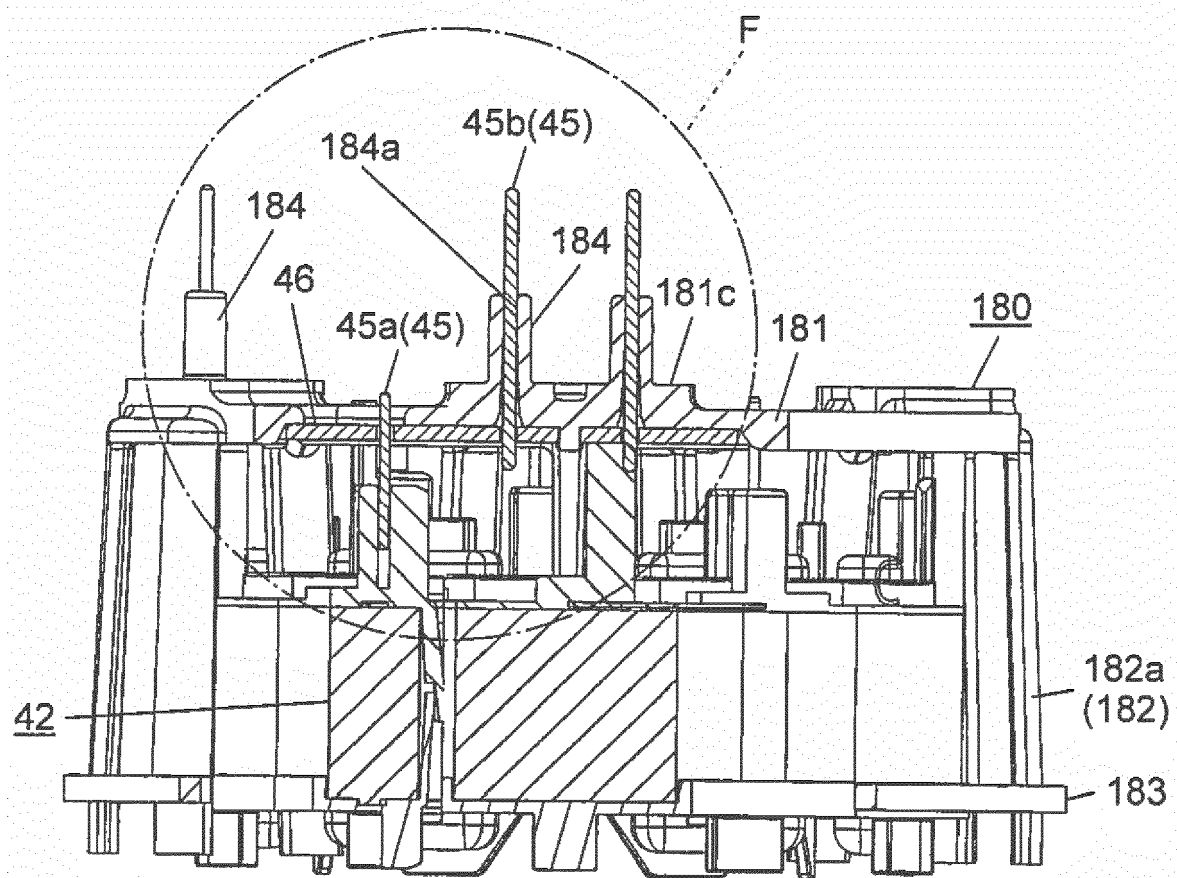


FIG. 16

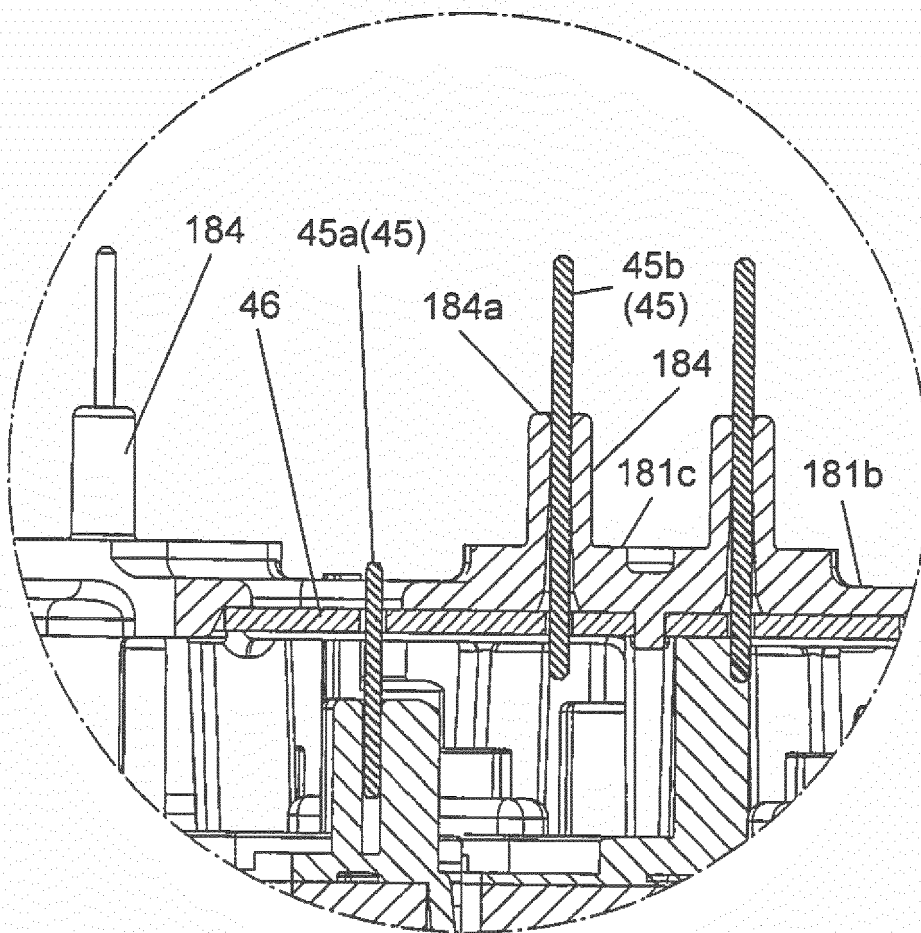


FIG. 17

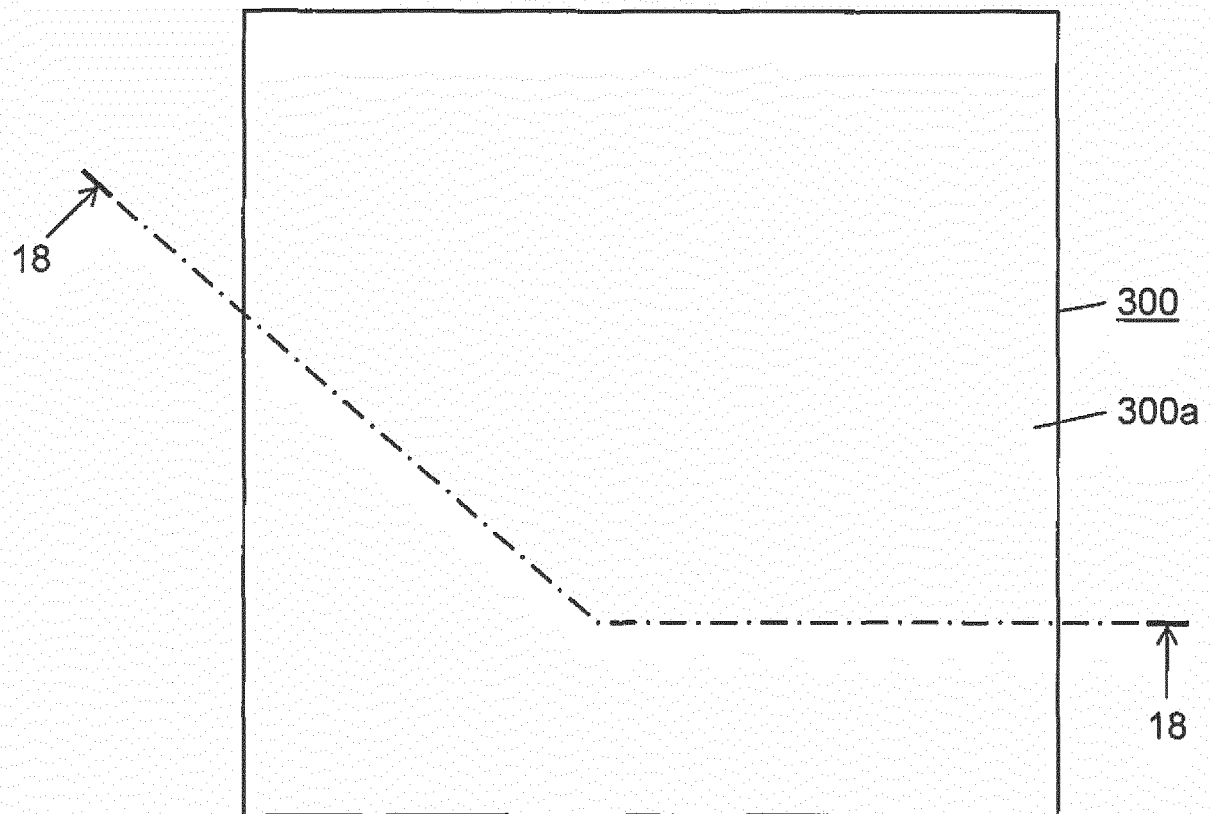


FIG. 18

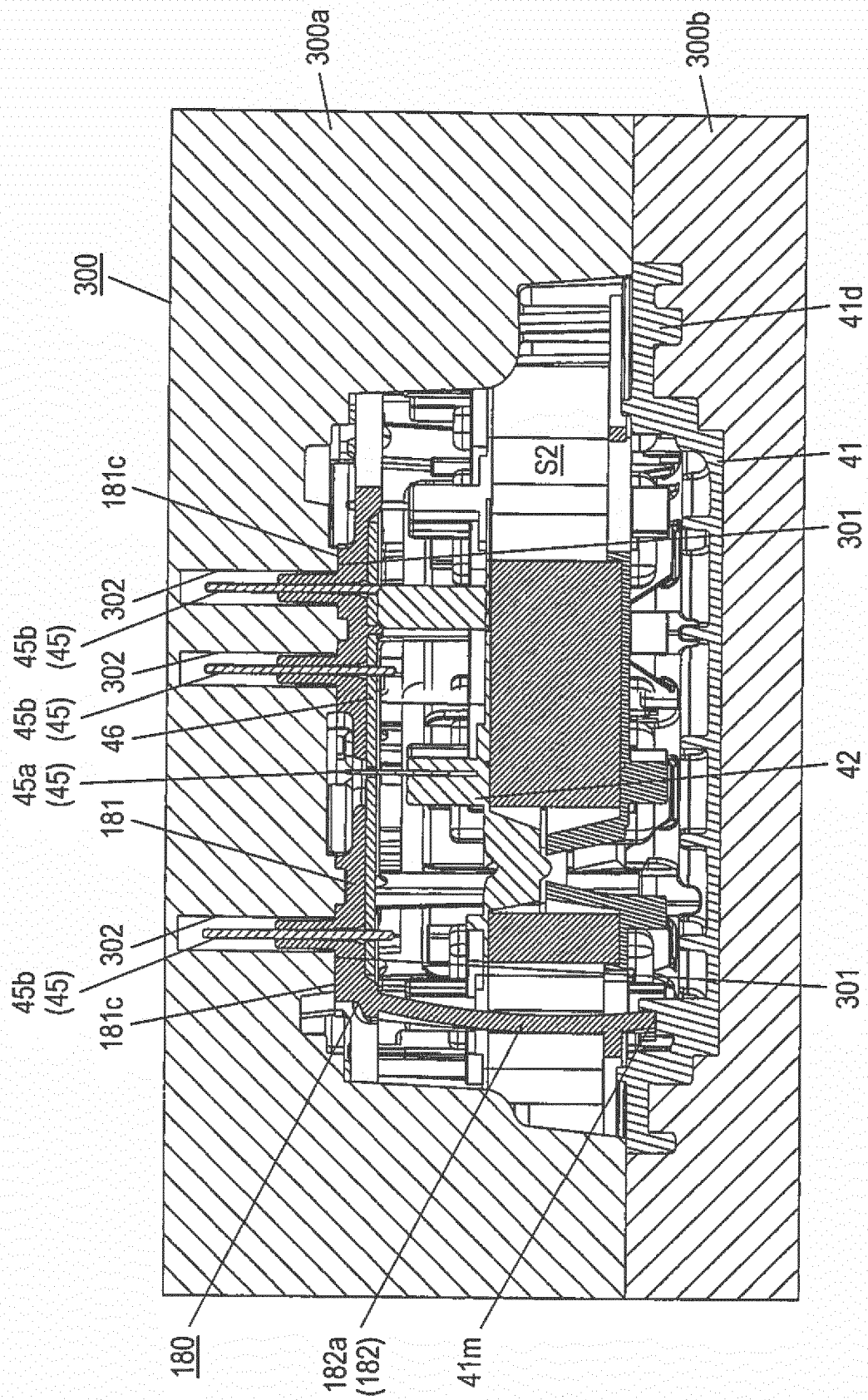


FIG. 19

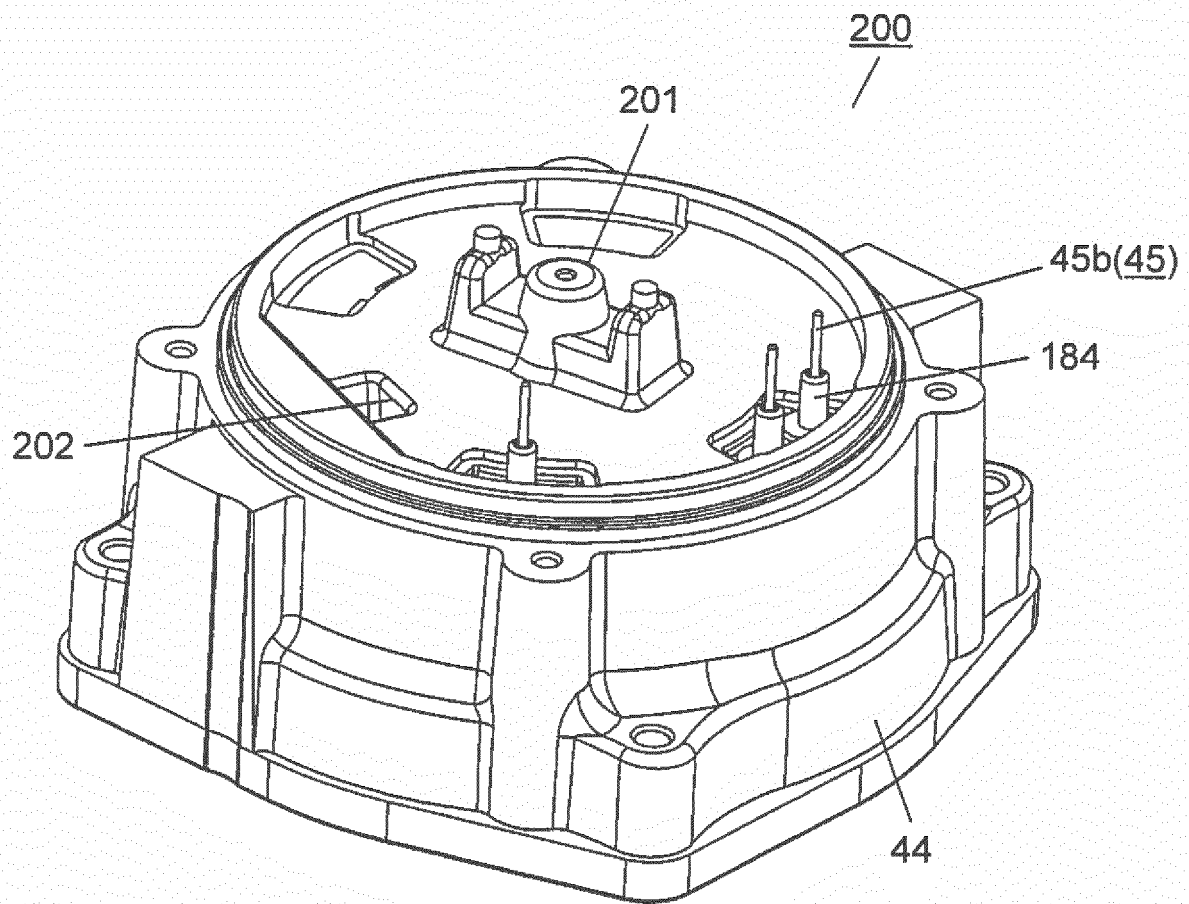
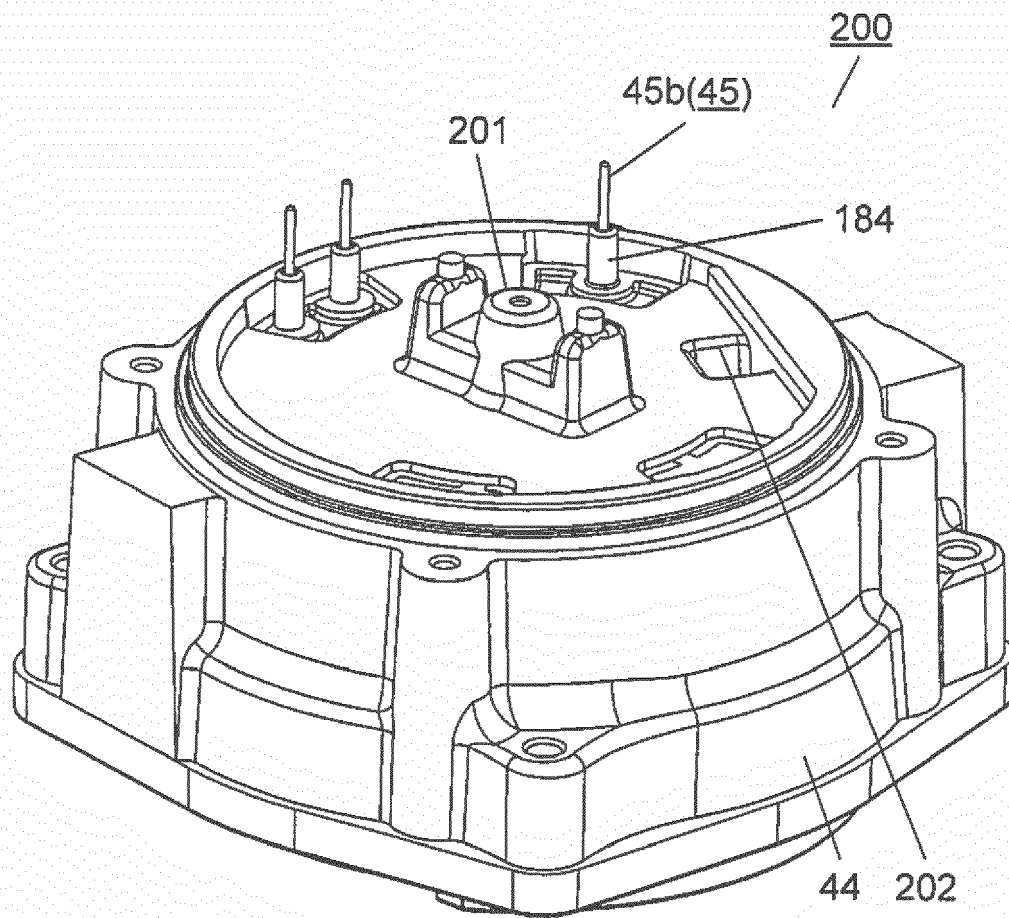


FIG. 20





EUROPEAN SEARCH REPORT

Application Number
EP 16 17 5158

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2013/213325 A1 (KIM BYOUNG SOO [KR]) 22 August 2013 (2013-08-22) * abstract * * paragraph [0051] - paragraph [0106] * * figures *	1-9	INV. F04D13/06
A	EP 2 407 670 A2 (AISIN SEIKI [JP]) 18 January 2012 (2012-01-18) * abstract * * paragraph [0023] - paragraph [0044] * * figures *	1-9	
A,D	JP 2009 284704 A (PANASONIC ELEC WORKS CO LTD) 3 December 2009 (2009-12-03) * abstract * * figures *	1-9	
			TECHNICAL FIELDS SEARCHED (IPC)
			F04D H02K
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 11 November 2016	Examiner Kolby, Lars
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/82 (P04C01)

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

EP 16 17 5158

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-11-2016

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013213325 A1	22-08-2013	KR 20120050239 A	18-05-2012
		US 2013213325 A1	22-08-2013
		WO 2012064119 A2	18-05-2012
EP 2407670 A2	18-01-2012	CN 102338098 A	01-02-2012
		EP 2407670 A2	18-01-2012
		JP 5516976 B2	11-06-2014
		JP 2012021464 A	02-02-2012
		US 2012014819 A1	19-01-2012
JP 2009284704 A	03-12-2009	JP 5065997 B2	07-11-2012
		JP 2009284704 A	03-12-2009

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 2009284704 A [0002]