(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 233 733 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
11.02.2015 Bulletin 2015/07

(51) Int Cl.:
F02N 15/06 *(2006.01)* ***H01H 50/04*** *(2006.01)*
H01H 51/06 *(2006.01)* *F02N 11/08* *(2006.01)*

(21) Application number: **10004519.4**

(22) Date of filing: **10.12.2008**

(54) **Starter with increased mounting capability**

Starter mit verbesserter Montagefähigkeit

Démarreur avec capacité d'assemblage améliorée

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR

(30) Priority: **18.01.2008 JP 2008009029**
08.02.2008 JP 2008028773

(43) Date of publication of application:
29.09.2010 Bulletin 2010/39

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
08021478.6 / 2 080 897

(73) Proprietor: **DENSO CORPORATION**
Kariya-city,
Aichi-pref. 448-8661 (JP)

(72) Inventors:
- **Niimi, Masami**
  Kariya-city
  Aichi-pref. 448-8661 (JP)
- **Usami, Shinji**
  Kariya-city
  Aichi-pref. 448-8661 (JP)

(74) Representative: **Kuhnen & Wacker**
Patent- und Rechtsanwaltsbüro
Prinz-Ludwig-Straße 40A
85354 Freising (DE)

(56) References cited:
FR-A1- 2 881 479
JP-A- 7 109 967
US-A- 4 305 002
US-A- 5 720 247
US-A- 5 731 638
US-A1- 2002 043 947
US-A1- 2003 214 766
US-A1- 2004 012 902

EP 2 233 733 B1

Description

BACKGROUND OF THE INVENTION

1. Technical Field of the Invention

[0001] The present invention relates to starters and, more particularly, to a starter having a main electromagnetic switch, operative to open or close a main contact of a motor circuit, and an auxiliary electromagnetic switch short circuiting energization limiting means provided in a motor circuit.

2. Description of the Related Art

[0002] In the related art, there has been known a starter device of a structure disclosed in Japanese Patent Application Publication No. 10-18949 (Patent Publication 1).

[0003] With such a structure, the starter device has an auxiliary electromagnetic switch, operative to supply or shut off electric current being supplied to the main electromagnetic switch, which is mounted on at least one of a plurality of mounting seats provided on a housing.

[0004] Further, the housing has a flange member through which the starter is mounted on an engine. The flange member is formed with a plurality of engine mounting bores to allow the starter to be mounted on the engine and a plurality of housing mounting bores to be mounted on the housing.

[0005] Furthermore, the housing has a plurality of flange mounting bores for mounting the flange member. This allows the flange mounting bores and the housing mounting bores to be selected in combination to enable the housing to be mounted on the flange member at a variable mounting angle.

[0006] With such a structure, of the plural switching mounting seats provided on the housing, selecting either one of the mounting seats enables the auxiliary electromagnetic switch to be mounted on a common housing at variable mounting positions. This makes it possible to avoid the auxiliary electromagnetic switch from interfering with an engine block and equipment installed on the engine at a periphery thereof.

[0007] Moreover, selecting the mounting angle of the housing with respect to the flange member enables the mounting angle of an entire structure with respect to the engine to be altered. Therefore, altering the combination between the mounting angle of the housing and the mounting angle of the auxiliary electromagnetic switch results in a further increase in a freedom of mounting the auxiliary electromagnetic switch.

[0008] However, with the related art structure disclosed in Patent Publication 1, the housing has the plurality of switch mounting seats, which are substantially limited to three areas covering an upper area and left and right side areas of the housing with a less effect of avoiding the interference with the engine block and equipment installed on the engine at the periphery thereof.

[0009] Further, Patent Publication 1 describes that it is possible to adjust the mounting angle even if the housing and the flange member and the switch mounting seats are altered in combination with the adjustment of the mounting angle enables the auxiliary electromagnetic switch to be mounted with increased freedom. However, the related art, mentioned above, takes the form of a structure in which the housing and the flange member are separate from each other with an increased limitation in available physical space. Thus, the related art can be implemented in a large-sized starter but a difficulty is encountered for the related art to be implemented in a small-sized starter.

[0010] Further, with a commonly used passenger car engine employing the small-sized starter, the starter has an extremely limited installation space. On the contrary, with the related art having the housing provided with the plurality of switch mounting seats, the switch mounting seat, except for the switch mounting seat on which the auxiliary electromagnetic switch is actually mounted, protrudes in a direction different from an orientation in which the auxiliary electromagnetic switch is mounted. This results in a difficulty of avoiding the interference with the engine block and equipment installed on the engine at the periphery thereof.

[0011] Furthermore, with the structure in which the housing and the flange member are separate from each other, it is difficult to perform a mass production of the starter accompanied by a decrease in manufacturing cost.

[0012] Meanwhile, with the large-sized starter of the related art, a switch current has an extremely large value of 100A or more. To provide such a large current, the auxiliary electromagnetic switch is provided in general to protect a starter relay which has a small contact capacity However, it is likely that the auxiliary electromagnetic switches have increasing applications even to the small-sized starters with a purpose different from that of the large-sized starter because of a reason described below.

[0013] In recent years, because motor vehicles installed with the small-sized starters are being produced in an increased volume, it has been an expanding trend to adopt an idling-stop system aimed to address a global environmental problem. With such an idling-stop system, the number of startups of the engine remarkably increases and it becomes essential for the starter to have increased durability.

[0014] Further, there has been an idea of making an attempt to suppress a drop in power supply voltage during startup of the starter to ensure operations of other electric equipments even during startup of the starter.

[0015] To this end, a method has been conceived in which a parallel circuit composed of a resistor element and an auxiliary electromagnetic switch, connected in parallel to each other, is connected to the motor circuit of the starter to allow the resistor element to supply limited current to a starter motor for energization thereof during

the startup of the starter after which the auxiliary electromagnetic switch is closed in operation to apply the starter motor with the full voltage of the battery. Such a method enables a reduction in main current flowing through the starter motor during the startup thereof. This enables a decrease in startup torque of the starter, enabling the pinion gear of the starter and the ring gear of the engine to have increased durability. In addition, decreasing the main current flowing through the starter motor during the startup thereof enables a reduction in the drop of the power supply voltage, thereby ensuring the operations of the other equipment even during the startup of the starter.

[0016] For the reason described above, when making an attempt to mount the auxiliary electromagnetic switch on the small-sized starter, it is essential to take a method to allow the auxiliary electromagnetic switch to be mounted in finely variable positions.

[0017] Further information pertaining to the prior art can be found in US 2003/214766 and US 2004/012902, both of which have been interpreted by the European Patent Office as disclosing a starter for starting up an engine having a ring gear, the starter having a housing adapted to be mounted on the engine, a motor fixedly mounted on the housing to generate a rotational force, a pinion gear operative to transfer the rotational force from the motor to the ring gear, a motor circuit having a main contact to apply electric power from a battery to the motor, a main electromagnetic switch operative to open or close the main contact and operative to actuate the pinion gear toward the ring gear, energizing current limiting means connected to the motor circuit at a high voltage potential side for limiting an electric current flowing through the motor, and an auxiliary electromagnetic switch having an auxiliary switch composed of a pair of stationary contacts, connected between low and high voltage potential sides of the energizing current limiting means, and a movable contact operative to connect or disconnect the pair of stationary contacts to short circuit the energizing current limiting means when the pair of stationary contacts are conducted with the movable contact, wherein when the main electromagnetic switch is turned on, the main contact is closed to cause the energizing current limiting means to limit the electric current flowing through the motor after which the auxiliary electromagnetic switch is energized at a given timing to short circuit the energizing current limiting means to allow a full voltage to be applied from the battery to the motor, wherein the main electromagnetic switch is fixedly mounted on the housing by means of a plurality of bolts in a first area close proximity to an outer circumferential periphery of the motor; the auxiliary electromagnetic switch is fixedly mounted on at least one of the housing or an end frame of the motor via a mounting member in a second area close proximity to the outer circumferential periphery of the motor.

[0018] JP 07-109967 has been interpreted by the European Patent Office as disclosing a starter for starting up an engine having a ring gear, the starter having a housing adapted to be mounted on the engine, a motor fixedly mounted on the housing to generate a rotational force, a pinion gear operative to transfer the rotational force from the motor to the ring gear, a motor circuit having a main contact to apply electric power from a battery to the motor, a main electromagnetic switch operative to open or close the main contact and operative to actuate the pinion gear toward the ring gear, energizing current limiting means connected to the motor circuit at a high voltage potential side for limiting an electric current flowing through the motor, and an auxiliary electromagnetic switch having an auxiliary switch composed of a pair of stationary contacts, connected between low and high voltage potential sides of the energizing current limiting means, and a movable contact operative to connect or disconnect the pair of stationary contacts to short circuit the energizing current limiting means when the pair of stationary contacts are conducted with the movable contact, wherein when the main electromagnetic switch is turned on, the main contact is closed to cause the energizing current limiting means to limit the electric current flowing through the motor after which the auxiliary electromagnetic switch is energized at a given timing to short circuit the energizing current limiting means to allow a full voltage to be applied from the battery to the motor.

SUMMARY OF THE INVENTION

[0019] The present invention has been completed with a view to addressing the above issues and has an object to provide a starter that can be easily manufactured on a mass production basis with a technology of permitting an auxiliary electromagnetic switch to be mounted at finely variable mounting angles.

[0020] The present invention provides a starter in accordance with independent claim 1. Preferred embodiments of the invention are reflected in the dependent claims.

[0021] The claimed invention can be better understood in view of the embodiments described and illustrated in the present disclosure, *viz*. in the present specification and drawings. In general, the present disclosure reflects preferred embodiments of the invention. The attentive reader will note, however, that some aspects of the disclosed embodiments extend beyond the scope of the claims. To the respect that the disclosed embodiments indeed extend beyond the scope of the claims, the disclosed embodiments are to be considered supplementary background information and do not constitute definitions of the invention *per se.*

(First Aspect)

[0022] To achieve the above object, the present disclosure provides a starter for starting up an engine having a ring gear, the starter having a housing adapted to be mounted on the engine, a motor fixedly mounted on the

housing to generate a rotational force, a pinion gear operative to transfer the rotational force from the motor to the ring gear, a motor circuit having a main contact to apply electric power from a battery to the motor, a main electromagnetic switch operative to open or close the main contact and operative to actuate the pinion gear toward the ring gear, energizing current limiting means connected to the motor circuit at a high voltage potential side for limiting an electric current flowing through the motor, and an auxiliary electromagnetic switch having an auxiliary switch composed of a pair of stationary contacts, connected between low and high voltage potential sides of the energizing current limiting means, and a movable contact operative to connect or disconnect the pair of stationary contacts to short circuit the energizing current limiting means when the pair of stationary contacts are in contact with the movable contact. The main electromagnetic switch is turned on, the main contact is closed to cause the energizing current limiting means to limit the electric current flowing through the motor after which the auxiliary electromagnetic switch is energized at a given timing to short circuit the energizing current limiting means to allow a full voltage to be applied from the battery to the motor. The main electromagnetic switch is fixedly mounted on the housing by means of a plurality of bolts in a first area close proximity to an outer circumferential periphery of the motor. The auxiliary electromagnetic switch is fixedly mounted on at least one of the housing or an end frame of the motor via a mounting member in a second area in close proximity to the outer circumferential periphery of the motor.

[0023] With the starter of the first aspect, the mounting member may preferably include a bracket with which the auxiliary electromagnetic switch is fixedly mounted on the housing. The bracket includes a first terminal member, to which the auxiliary electromagnetic switch is fixedly secured, and a second terminal member, interleaved between the housing and the main electromagnetic switch, which is fixedly attached to the housing by means of at least the plurality of bolts for fixing the main electromagnetic switch, wherein the second terminal member has bores through which the bolts are inserted and whose positions are altered to enable a circumferential angular mounting position of the auxiliary electromagnetic switch to be altered with respect to an axis of the main electromagnetic switch.

[0024] With such a structure, the bracket can be formed with bores at varying positions. This allows the auxiliary electromagnetic switch to be mounted at mounting positional angles that can be finely altered with respect to an axis of the main electromagnetic switch. Further, no need arises to provide the plurality of switch mounting seats as required in the related art (Patent Publication 1). Thus, the starter has no protruding portion protruding from a contour of the starter in an area except for an orientation in which the auxiliary electromagnetic switch is mounted. As a result, this prevents the auxiliary electromagnetic switch from conflicting with the engine block and equipment installed on the engine at the periphery thereof, thereby providing increased mounting capability.

[0025] Further, the auxiliary electromagnetic switch is fixedly secured to the housing via the bracket, the teaching of the present disclosure can be applied not only to the large-sized starter but also to the small-sized starter.

[0026] In addition, among the plurality of bolts for fixing the main electromagnetic switch to the housing, at least two bolts are employed to fix the bracket to the housing. Thus, no need arises for providing specified coupling means for fixing the bracket. In addition, this prevents the bracket from rotating. Thus, the starter can have increased vibration resistance without increasing coupling torques of the bolts to a degree more than necessary.

[0027] With the starter of such a structure set forth above, the auxiliary electromagnetic switch may be preferably fixedly mounted on the end frame of the motor via the mounting member such that at least a part of the auxiliary electromagnetic switch axially falls in an area to which the main electromagnetic switch is projected in an axial direction.

[0028] With such a structure, at least a part of the auxiliary electromagnetic switch is placed to fall in an area to which the main electromagnetic switch is projected in the axial direction. Thus, the starter can have a further minimized projection area in the axial direction than that achieved in a case where both of the main electromagnetic switch and the auxiliary electromagnetic switch are arranged in parallel to each other. Thus, no remarkable increase occurs in an installation space of the engine as compared to a starter in which no auxiliary electromagnetic switch is provided. This enables the engine to have an installation space without causing the auxiliary electromagnetic switch from conflicting the engine block and equipment installed on the engine at the periphery thereof.

[0029] With the starter of the present embodiment, the auxiliary electromagnetic switch may preferably include the energizing current limiting means.

[0030] In this case, there is no need to have a specified member to protect the energizing current limiting means from external environment with no increase occurring in a available physical space, enabling the starter to be mounted on the engine with increased mounting capability.

[0031] With the starter of the present embodiment, the main electromagnetic switch may preferably have one axial end fixedly secured to the housing and the other axial end carrying thereon two terminal bolts through which the main electromagnetic switch is electrically connected to the motor circuit. The auxiliary electromagnetic switch has one axial end fixed to the bracket and the other axial end carrying thereon two terminal bolts through which the auxiliary electromagnetic switch is electrically connected to the motor circuit. A conductive metallic plate member provides an electrical and mechanical connection between a terminal bolt, forming one

of the two bolts of the main electromagnetic switch and placed at a high voltage potential side, and a terminal bolt forming one of the two bolts of the auxiliary electromagnetic switch and placed at a low voltage potential side.

[0032] With such a structure, the auxiliary electromagnetic switch can be supported with the bracket and the metallic plate-like member on a center impeller. This allows the auxiliary electromagnetic switch to have remarkably increased vibration proof qualities, while enabling a reduction in wall thickness of the bracket and minimizing an increase in weight of the starter.

[0033] With the starter of the present embodiment, the bracket may preferably have a first terminal member, on which the auxiliary electromagnetic switch is fixedly secured, a second terminal member, dislocated from the one end portion in an axial direction, which is interleaved between the housing and the main electromagnetic switch, and a connecting portion, interconnecting the first and second terminal members to each other along the axial direction, which is curved in a circular arc configuration along an outer circumferential periphery of the main electromagnetic switch.

[0034] In such a case, the connecting portion of the bracket has further increased rigidity than that of a bracket having a connecting portion formed in a flat shape, enabling an increase in vibration resistance.

[0035] The auxiliary electromagnetic switch may be preferably placed in the area to which a whole of the main electromagnetic switch is projected in an axial direction.

[0036] In this case, no risk takes place for the projected surface area to increase in the axial direction even in making a comparison to a starter with no provision of the auxiliary electromagnetic switch. This enables the engine to have an installation space without causing the auxiliary electromagnetic switch from conflicting the engine block and equipment installed on the engine at the periphery thereof.

[0037] With the starter in accordance with the present disclosure, the main electromagnetic switch and the auxiliary electromagnetic switch may preferably have axes placed in a coaxial relationship.

[0038] With the main electromagnetic switch and the auxiliary electromagnetic switch placed in the coaxial relationship, at least a part of or a whole of the auxiliary electromagnetic switch can be structured to fall in the area to which the main electromagnetic switch is projected.

[0039] With the starter in accordance with the present disclosure, the main electromagnetic switch and the auxiliary electromagnetic switch may preferably have axes that intersect at a right angle.

[0040] The main electromagnetic switch has not only a function to open or close the main contact of the motor circuit but also a function to drive a shift lever to push the pinion gear toward the ring gear of the engine. In contrast, the auxiliary electromagnetic switch has only a switching function to short circuit the current limiting means connected to the motor circuit. This enables the auxiliary electromagnetic switch to have a shorter overall length (axial length) than that of the main electromagnetic switch. Therefore, even if the auxiliary electromagnetic switch and the main electromagnetic switch are placed in an arrangement to have axes intersecting with each other at a right angle, no risk occurs for the auxiliary electromagnetic switch to remarkably protrude from the area to which the main electromagnetic switch is projected in the axial direction.

[0041] With the starter in accordance with the present disclosure, the main electromagnetic switch may preferably have a terminal kept at a high voltage potential to which a terminal of the auxiliary electromagnetic switch remaining at a low voltage potential is electrically and mechanically connected via a metallic connecting member.

[0042] In a case where the main electromagnetic switch and the auxiliary electromagnetic switch have connection terminals connected to each other via, for instance, a wire, there is a risk of damage occurring to the wires due to vibrations exerted from an external source. In contrast, the connection terminals of the main electromagnetic switch and the auxiliary electromagnetic switch are connected to each other by means of the metallic connecting plate, thereby providing an increase in vibration proof.

[0043] With the starter in accordance with the present disclosure, the mounting member, with which the auxiliary electromagnetic switch is fixedly secured to the end frame, includes a annular band portion surrounding a radial outer circumferential periphery of the auxiliary electromagnetic switch, and a pair of let portions, formed on the band portion at both ends thereof, which are fixed to the end frame by screws.

[0044] With such a structure, the auxiliary electromagnetic switch is inserted to an inner periphery of the band portion with the leg portion, formed on the both ends of the band portion being fixedly secured to the end frame with the screws, the auxiliary electromagnetic switch can be fixed to the end frame. With such a structure, the auxiliary electromagnetic switch can be easily fixed to the end frame via the mounting member without causing a need to have a flange portion through which screws or bolts are inserted.

[0045] With the starter in accordance with the present disclosure, the mounting member is made of metallic plate material that is folded.

[0046] In this case, the metallic plate material is bent in an annular configuration to allow the band portion to have the both ends formed with the leg portions, thereby providing an ease of fabricating the mounting member. In addition, the metallic plate material takes the form of a simple configuration (such as, for instance, a band-like rectangle shape), thereby enabling an increase in yield when manufacturing a mounting member from a metallic raw material with a resultant reduction in production cost.

[0047] With the starter in accordance with the present

disclosure, the band portion of the mounting member has an inner circumferentially formed with a plurality of protrusions.

[0048] With the band portion having the inner periphery formed with the protrusions, causing the outer circumferential periphery of the auxiliary electromagnetic switch to be brought into abutting engagement with the protrusions results in an increase in surface pressures of the protrusions pressed against the outer circumferential periphery of the auxiliary electromagnetic switch. This prevents the auxiliary electromagnetic switch from slipping (in rotation) at the inner periphery of the band portion, enabling the auxiliary electromagnetic switch to be reliably fixed in place.

BRIEF DESCRIPTION OF THE DRAWINGS

[0049]

FIG. 1 is a plan view showing an overall structure of a starter of a first embodiment according to the present disclosure.

FIG. 2 is a rear view of the starter, shown in FIG. 1, as viewed from a rear side of a motor in an axial direction.

FIG. 3 is a perspective view of a mounting member in the form of a bracket used in the starter of the first embodiment shown in FIG. 1.

FIG. 4 is an electric circuit functioning as a motor circuit for the starter of the first embodiment shown in FIG. 1.

FIG. 5 is a rear view of the starter as viewed from the rear side of the motor in the axial direction.

FIG. 6 is a plan view showing an overall structure of a starter of a second embodiment according to the present disclosure.

FIG. 7 is a rear view of the starter, shown in FIG. 6, as viewed from a rear side of a motor in an axial direction.

FIG. 8A is a front view of a mounting member used in the starter of the second embodiment shown in FIG. 6.

FIG. 8B is a plan view of the mounting member with which an auxiliary electromagnetic switch is fixedly retained.

FIG. 9 is an electric circuit functioning as a motor circuit for the starter of the second embodiment shown in FIG. 6.

FIG. 10 is a plan view showing an overall structure of a starter of a third embodiment according to the present disclosure.

FIG. 11 is a plan view of a modified form of the mounting member shown in FIGS. 8A and 8B.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0050] Now, starters of various embodiments according to the present disclosure will be described below in detail with reference to the accompanying drawings. However, the present invention is construed not to be limited to such embodiments described below and technical concepts of the present invention may be implemented in combination with other known technologies or the other technology having functions equivalent to such known technologies.

(First Embodiment)

[0051] The starter 1 of the embodiment according to the present disclosure will be described below in detail with reference to FIGS. 1 and 2 and FIG. 4 of the accompanying drawings.

[0052] FIG. 1 is an overall structural view showing the starter 1 of the present embodiment. FIG. 2 is a rear view of the starter 1 as viewed from a motor along an axis thereof and FIG. 4 is an electric circuit functioning as a motor circuit for the starter 1.

[0053] As shown in FIG. 1, the starter 1 of the present embodiment includes a housing 2 adapted to be mounted on an engine (not shown), a motor 4 fixedly connected to the housing 2 by means of through-bolts 3 tightened thereto and having an armature 4a (see FIG. 4) for generating a rotational force, an output shaft 4b rotatably driven with the armature 4a and a pinion gear 6 slidably movable on the output shaft 4b on an outer periphery thereof and operatively meshing with a ring gear 5 (see FIG. 4) of the engine to transfer the rotational force of the motor 4 to the ring gear 5, a main electromagnetic switch 8 operative to open or close a main contact (described below) provided in an energization circuit (hereinafter referred to as "a motor circuit") of the motor 4 and having a function to push the pinion gear 6 toward the ring gear 5 (leftward in FIG. 1) of the engine via a shift lever 7 (see FIG. 4), a resistor element 9 (see FIG. 4) connected to the motor circuit and serving as current limiting means, and an auxiliary electromagnetic switch 10 for short-circuiting the resistor element 9.

[0054] The housing 2 has a flange portion 2a, fixedly secured to a starter mounting-wall (not shown) of the engine, and a switch mounting portion 2b on which the main electromagnetic switch 8 is fixedly secured.

[0055] The motor 4 is a well-known DC electric motor operative such that with the main contact MC being closed upon energization of the main electromagnetic switch 8, the DC electric motor is supplied with electric power from an on-vehicle battery 11 (FIG. 4) to cause the armature 4a to generate the rotational force.

[0056] As shown in FIG. 4, the main electromagnetic switch 8 incorporates therein a switch coil 12 and a plunger 13 and has a function to actuate such that when applied with electric power, the switch coil 12 forms an electromagnet to attract the plunger 13 to cause the main contact MC to be closed in conjunction with the movement of the plunger 13. As shown in FIG. 1, the main electromagnetic switch 8 is fixedly secured to the switch mount-

ing portion 2b, formed on the housing 2, by means of a plurality (with two pieces in the present embodiment) of bolts 14 which are tightened thereto.

[0057] As shown in FIG. 4, the main contact MC is formed of a B-stationary contact 15a, connected to the motor circuit at a high potential side (battery side) thereof via a B-terminal bolt 15, and an M-stationary contact 16a connected to the motor circuit at a low potential side (motor side) thereof via an M-terminal bolt 16, and a movable contact 17 integrally movable with the plunger 13 to provide a connection or disconnection between the stationary contacts 15a and 16a.

[0058] The B-terminal bolt 15 and the M-terminal bolt 16 are fixed to a contact cover 18 (see FIG. 1) of the electromagnetic switch 8. Further, a motor lead wire 20 is electrically connected to the M-terminal bolt 16 to supply electric power to a brush 19 on a positive-electrode side. The B-terminal bolt 15 has an electrical connection as will be described later.

[0059] The switch coil 12 is comprised of two coils (attraction coil 12a and holding coil 12b).

[0060] The attraction coil 12a has one terminal end, connected to the exciting terminal 21 (see FIG. 4) fixedly secured to the contact cover 18 of the main electromagnetic switch 8, and the other terminal end electrically connected to the M-terminal bolt 16. The holding coil 12b has one terminal end, connected to the exciting terminal 21 together with the one terminal end of the attraction coil 12a, and the other terminal end connected to ground (such as, for instance, a stationary core of the main electromagnetic switch 8.

[0061] As shown in FIG. 4, the exciting terminal 21 is electrically connected to the on-vehicle battery 11 through a starter relay 22, which is electrically connected to an ECU (an electronic control unit associated with an operation to start up the engine) 23. Upon receipt of a command signal from the ECU 23, the starter relay 22 is closed to allow the starter relay 22 to pass electric power, delivered from the on-vehicle battery 11, to the motor circuit.

[0062] The resistor element 9 serves as energization current limiting means in accordance with the present disclosure to limit electric current being supplied to the motor 4 on an early stage of energizing the motor 4. To this end, the resistor 9 is connected to a high voltage potential side via the main contact MC of the motor circuit and incorporated in the auxiliary electromagnetic switch 10.

[0063] The auxiliary electromagnetic switch 10 has a function to form an electromagnet to drive a movable core 27 to open or close an auxiliary contact AC provided in the motor circuit. As shown in FIG. 2, the auxiliary electromagnetic switch 10 is placed in an area radially closer to the main electromagnetic switch 8 and fixedly mounted on the housing 2 via a mounting member 24 in the form of a bracket (see FIG. 1).

[0064] As shown in FIG. 4, the auxiliary contact AC is comprised of a first stationary contact 25, connected to the resistor element 9 at a low voltage potential side thereof, a second stationary contact 26 connected to the resistor element 9 at a high voltage potential side thereof, and the movable core 27 providing a connection or disconnection between the first and second stationary contacts 25 and 26.

[0065] The first and second stationary contacts 25 and 26 are electrically connected to first and second terminal bolts 29 and 30 (see FIG. 1), fixedly mounted on a resin cover 28 of the auxiliary electromagnetic switch 10, respectively, and placed inside the resin cover 28 in face-to-face relation to the movable core 27.

[0066] As shown in FIG. 1, the first terminal bolt 29 is electrically and mechanically connected to the B-terminal bolt 15 of the main electromagnetic bolt 29 via a plate-like connecting member 31, made of electrically conductive metal, and the second terminal bolt 30 is connected to a positive electrode terminal of the on-vehicle battery 11 via a cable.

[0067] As shown in FIG. 4, the auxiliary electromagnetic switch 10 incorporates therein an excitation coil 32 operative to form an electromagnet when turned on. The excitation coil 32 has one terminal connected to an exciting terminal 33 (see FIG. 2), fixedly mounted on the resin cover 28, and the other terminal connected to ground (such as, for instance, the stationary core of the auxiliary electromagnetic switch 10).

[0068] As shown in FIG. 4, the exciting terminal 33 is connected to the ECU 23 and turned on at a given timing via the ECU 23.

[0069] As shown in FIG. 3, the bracket 24, used for fixing the auxiliary electromagnetic switch 10 in place, has a first terminal member 24a, formed in a nearly circular plate configuration, a second ring-like terminal member 24c having a central area formed with a circular hole 24b, and a connecting portion 24d standing upright from the first terminal member 24a at a rear end thereof to a front end of the second terminal member 24c for connecting these first and second members 24a and 24c in a cranked configuration. The first terminal member 24a and the connecting portion 24d are formed with a reinforcing rib 24e. The second terminal member 24c has a pair of bores 24f through which the bolts 14 extend. The connecting portion 24d is curved in a circular arc shape extending along an outer circumferential periphery of the main electromagnetic switch 8.

[0070] The auxiliary electromagnetic switch 10 is fixedly connected to one end face of the first terminal member 24a of the bracket 24 by welding or the like. The second terminal member 24c of the bracket 24 is interleaved between the switching mounting portion 2b of the housing 2 and the main electromagnetic switch 8 to be fixedly connected to the housing 2 together with the main electromagnetic switch 8 by means of the two bolts 14 extending through the bores 24f.

[0071] Next, the operation of the starter 1 will be described below.

[0072] First, upon receipt of the command signal from

the ECU 23, the starter relay 22 is turned on such that the switch coil 12 is energized. This allows the plunger 13, shown in FIG. 4, to be attracted to move leftward in the drawing figure. This allows the shift lever 7 to be actuated to push the pinion gear 6 toward the ring gear 5 (rightward in the drawing figure).

[0073] Subsequently, the main contact MC is closed such that electric power is applied from the battery 11 to the resistor element 9 through which a limited electric current is supplied to the motor 4 to rotate the same at a low speed. Upon receipt of the rotational force of the motor 4, the pinion gear 6 is brought into meshing engagement with the ring gear 5 and, thereafter, the ECU 23 energizes the excitation coil 32 of the auxiliary electromagnetic switch 10 at a given timing. When this takes place, the auxiliary contact AC is closed to form a short-circuited passage such that the resistor element 9 is short circuited. As a result, a full voltage is applied from the battery 11 to the motor 4 with high electric current flowing therethrough. When this takes place, the motor 4 rotates at a high rotation speed with a rotation of the motor 4 being transferred from the pinion gear 6 to the ring gear 5, thereby cranking the engine.

(Advantageous Effect of the First Embodiment)

[0074] With the starter 1 of the present embodiment, the motor 4 is energized with the electric current limited with the resistor element 9 at an early stage (during a period from a timing at which the main contact MC is closed to another timing at which the auxiliary contact AC is closed) of the operation of the motor 4, thereby alleviating a shock occurring during meshing engagement between the pinion gear 6 and the ring gear 5. This results in a reduction of wear occurring between the pinion gear 6 and the ring gear 5 with a resultant increase in durability.

[0075] Further, no inrush current flows into the motor 4 before it rotates and, thus, the main electromagnetic switch 8 has increased contact life while the motor 4 has increased brush life.

[0076] With the present embodiment, the starter 1 takes the form of a structure not to separate the housing 2, shown in the related art (Patent Publication 1), and the flange member but to fixedly secure the auxiliary electromagnetic switch 10 to the housing 2 via the bracket 24. In this case, the starter 1 of the present embodiment has a less limitation in available physical space than that of the related art starter. Therefore, the teaching of the present disclosure can be applied not only to a starter of a large size but also to a starter of a small size, while making it possible to easily manufacture the starter on a mass production basis.

[0077] Further, by suitably altering positions at which the two bores 24f are formed in the second terminal member 24c of the bracket 24 (in the same positional relationship, i.e., the locations of the two bores 24 are determined with positions at which the two bolts 14 are tightened to the housing 2), mounting positional angles of the auxiliary electromagnetic switch 10 can be finely altered with respect to an axis of the main electromagnetic switch 8.

[0078] Buy altering the positions of the two bores 24f, formed in the bracket 24, with respect to the mounting positional angle of the auxiliary electromagnetic switch 10 shown in FIG. 2, the mounting positional angle can be altered by an angle α as shown in FIG. 5.

[0079] Further, with the starter 1 of the present embodiment, the housing 2 has no need to have a plurality of switch mounting seats disclosed in the related art starter (see Patent Publication 1). Thus, the starter 1 has no protruding area that protrudes from a contour of the starter 1 except for the auxiliary electromagnetic switch 10 mounted on the starter 1. This prevents the starter 1 from interfering with an engine block and equipment installed on the engine at an outer circumferential periphery thereof, thereby increasing on-board mounting capability.

[0080] The bracket 24, used for the auxiliary electromagnetic switch 1 to be fixedly secured, is fixedly attached to the housing 2 by means of the two bolts 14 through which the main electromagnetic switch 8 is fixedly supported on the housing 2. Thus, no need arises for the starter 1 to have additional specified coupling means (such as, for instance, bolts) for fixing the bracket 24 and the bracket 24 can be prevented from being rotated. Thus, the starter 1 can have increased vibration resistance and reliability

[0081] Further, the connecting portion 24d, with which the first and second terminal members 24a and 24c are connected to each other, is curved in the circular arc configuration along the outer circumferential wall of the main electromagnetic switch 8. Therefore, the bracket 24 has the connecting portion 24d with further increased bending rigidity than that of the connecting portion formed in a tabular configuration, enabling an increase in vibration resistance.

[0082] With the auxiliary electromagnetic switch 10, the terminal bolt 29 is electrically and mechanically connected to the B-terminal bolt 15 of the main electromagnetic switch 8 via the metallic plate-like connecting member 31 such that the auxiliary electromagnetic switch 10 is supported on a center impeller with the bracket 24 and the plate-like connecting member 31. Thus, the starter 1 can have further remarkably increased vibration resistance than that achieved with a starter in which the auxiliary electromagnetic switch 10 is supported on a cantilever support using only the bracket 24. This also results in a reduction in a plate thickness of the bracket 24, thereby enabling the suppression of an increase in weight of the starter 1.

[0083] With the present embodiment, the resistor element 9, connected to the motor circuit, is incorporated inside the auxiliary electromagnetic switch 10 and no need arises to prepare a specified member to protect the resistor element 9 from an external environment. In this case, no physical increase occurs, thereby contributing to on-board mounting capability of the starter 1 with re-

spect to the engine.

(Second Embodiment)

[0084] A starter 1A of a second embodiment according to the present disclosure will be described below in detail with reference to FIGS. 6 and 7 and FIG. 9 of the accompanying drawings.

[0085] FIG. 6 is an overall structural view showing the starter 1A of the present embodiment. FIG. 7 is a rear view of the starter 1A as viewed from a motor along an axis thereof and FIG. 9 is an electric circuit serving as a motor circuit for the starter 1A.

[0086] As shown in FIGS. 6 and 9, the starter 1A of the present embodiment includes the housing 2 adapted to be fixedly mounted on the engine (not shown), the motor 4 fixedly mounted on the housing 2 by means of the two through-bolts 3 tightened to the housing 2 and having the armature 4a (see FIG. 9) for generating the rotational force, the output shaft 4b rotatably driven with the armature 4a and the pinion gear 6 slidably movable on the output shaft 4b on the outer periphery thereof to operatively mesh with the ring gear 5 (see FIG. 9) of the engine to transfer the rotational force of the motor 4 to the ring gear 5, the main electromagnetic switch 8 operative to open or close the main contact MC (described below) provided in the energization circuit of the motor 4 and having a function to push the pinion gear 6 toward the ring gear 5 (leftward in FIG. 9) of the engine via the shift lever 7, the resistor element 9 (see FIG. 9) serving as energization current limiting means and connected to the motor circuit, and the auxiliary electromagnetic switch 10 for short-circuiting the resistor element 9.

[0087] The housing 2 has the flange portion 2a, fixedly secured to the starter mounting-wall (not shown) of the engine, and the switch mounting portion 2b on which the main electromagnetic switch 8 is fixedly mounted.

[0088] As shown in FIG. 9, the motor 4 is a well-known DC electric motor comprised of the armature 4a having one end formed with a commutator 4c having an outer circumferential periphery with which the brushes 19 are held in abutting contact. With the main contact MC being closed upon energization of the main electromagnetic switch 8, the armature 4a is supplied with electric power from the on-vehicle battery 11 to cause the armature 4a to generate the rotational force. In addition, the motor 4 has an end frame 40 carrying thereon a pair of mounting seats 40a on which the auxiliary electromagnetic switch 10 is fixedly mounted as shown in FIG. 7.

[0089] The pinion gear 6 is integrally disposed with a clutch C on the outer circumferential periphery of the output shaft 4b driven with the motor 4 to transfer the rotational force of the output shaft 4b to the pinion gear 6 via the clutch C.

[0090] As shown in FIG. 9, the main electromagnetic switch 8 includes a solenoid comprised of the switch coil 12 and the plunger 13 with a function to actuate such that when applied with electric power, the switch coil 12 is energized to form an electromagnet to attract the plunger 13 to cause the main contact MC to be closed in conjunction with the movement of the plunger 13. In contrast, if the switch coil 12 is de-energized with the attraction force being distinguished, the plunger 13 is pushed back to its original position by a reactive force of a return spring (not shown) to thereby open the main contact MC. As shown in FIG. 6, the main electromagnetic switch 8 is fixedly mounted on the switch mounting portion 2b of the housing 2 by means of the two bolts 14.

[0091] As shown in FIG. 9, the main contact MC is formed of the B-stationary contact 15a, connected to the high potential side (battery side) of the motor circuit via the B-terminal bolt 15, and the M-stationary contact 16a connected to the low potential side (motor side) of the motor circuit via the M-terminal bolt 16, and the movable contact 17 integrally movable with the plunger 13 to provide the connection or disconnection between the stationary contacts 15a and 16a.

[0092] The B-terminal bolt 15 and the M-terminal bolt 16 are fixed to the contact cover 18 (see FIG. 6) of the electromagnetic switch 8, in which the main contact MC is internally provided. Also, the M-terminal bolt 16 is electrically connected to the positive-side electrode brush 19 via the motor lead wire 20 (see FIGS. 6 and 9) to supply electric power thereto. The B-terminal bolt 15 has an electrical connection as will be described later.

[0093] The switch coil 12 is comprised of two coils (attraction coil 12a and holding coil 12b).

[0094] The attraction coil 12a has one terminal end, connected to the exciting terminal 21 (see FIG. 9) fixedly attached to the contact cover 18 of the main electromagnetic switch 8, and the other terminal end electrically connected to the M-terminal bolt 16. The holding coil 12b has one terminal end, connected to the exciting terminal 21 together with the one terminal end of the attraction coil 12a, and the other terminal end connected to ground (such as, for instance, the stationary core of the main electromagnetic switch 8). As shown in FIG. 9, the exciting terminal 21 is electrically connected to the on-vehicle battery 11 through the starter relay 22, which is electrically connected to the ECU (the electronic control unit associated with the operation to start up the engine). Upon receipt of the command signal from the ECU 23, the starter relay 22 is turned on to allow the starter relay 22 to pass electric power, delivered from the on-vehicle battery 11, to the motor circuit.

[0095] The resistor element 9 serves as the energization current limiting means to limit electric current being supplied to the motor 4 on the early stage in which the motor 4 is energized. To this end, the resistor 9 is connected to the high voltage potential side via the main contact MC of the motor circuit and incorporated in the auxiliary electromagnetic switch 10.

[0096] As shown in FIG. 9, the auxiliary electromagnetic switch 10 is comprised of the auxiliary contact AC, connected to the motor circuit in parallel to the resistor element 9. The auxiliary contact AC includes the pair of

stationary contacts 25 and 26, the movable core 27 serving as the movable contact operative to close or open the stationary contacts 25 and 26, and the excitation coil 32. With the excitation coil 32 turned on to form the electromagnet, the movable core 27 is pushed back to open the stationary contacts 25 and 26 of the auxiliary contact AC. The auxiliary electromagnetic switch 10 is mounted on the end frame 40 of the motor 4 via a mounting member 50.

[0097] As shown in FIG. 8A, the mounting member 50, having a annular band portion 50a and a pair of leg portions 50b formed on the annular band portion 50a at both ends thereof, is formed of a metallic plate member that is folded. As shown in FIG. 8B, the auxiliary electromagnetic switch 10 is inserted to an inner circumferential periphery of the mounting member 50. Then, the leg portions 50b of the mounting member 50 are placed on top surfaces of the mounting seats 40a, after which the screws S 1 are inserted to elongated holes 50c formed on the leg portions 50b (see FIG. 7). Thereafter, the screws S 1 are screwed into threaded bores (not shown) formed in the mounting seats 40a of the end frame 40 to be tightened to tightly fix the band portion 50a in place. Thus, the auxiliary electromagnetic switch 10 is fixedly mounted on the end frame 40 as shown in FIGS. 6 and 7.

[0098] As shown in FIG. 6, the auxiliary electromagnetic switch 10 is fixedly mounted on the end frame 40 by means of the mounting member 30. With such a mounting state, the auxiliary electromagnetic switch 10 is placed such that the movable core 27 axially moves in the same direction (as viewed in a lateral direction in FIG. 6) as that in which the plunger 13 of the main electromagnetic switch 8 axially moves and a whole of the auxiliary electromagnetic switch 10 falls in an area to which the main electromagnetic switch 8 is projected in an axial direction. That is, the electromagnetic switches 8 and 10 have axes placed on a coaxial relationship with respect to each other with the auxiliary electromagnetic switch 10 having a diameter determined to be slightly less than that of the main electromagnetic switch 8.

[0099] Further, the auxiliary electromagnetic switch 10 has two terminal bolts 29 and 30 connected to the stationary contacts 25 and 26 of the auxiliary contact AC. In addition, the two terminal bolts 29 and 30 are placed in areas axially close to the two terminal bolts (B-terminal bolt 15 and M-terminal bolt 16) extending through the main electromagnetic switch 8. Moreover, the two terminal bolts 29 and 30 include the first terminal bolt 29, connected to the positive-electrode side terminal of the battery 11 via the battery cable, and the second terminal bolt 30 electrically and mechanically connected to the B-terminal bolt 15 of the main electromagnetic switch 8 via a metallic connecting plate 34A.

[0100] As shown in FIG. 7, the two terminal bolts 15 and 16 of the main electromagnetic switch 8 and the two terminal bolts 29 and 30 of the auxiliary electromagnetic switch 10 are located to be opposite to each other in a radial direction and circumferentially dislocated from each other by an angle of 90 degrees.

[0101] Next, the operation of the starter 1A will be described below.

[0102] First, upon receipt of the command signal delivered from the ECU 23, the starter relay 22 is turned on such that the switch coil 12 is energized. Thus, the plunger 13, shown in FIG. 9, is attracted to move leftward in the drawing figure. This allows the shift lever 7 to be actuated to push the pinion gear 6 toward the ring gear 5 (rightward in the drawing figure).

[0103] Subsequently, the main contact MC is closed to cause the battery 11 to apply electric power to the resistor element 9 through which the limited electric current is supplied to the motor 4 to rotate the same at a low speed. Upon receipt of the rotational force of the motor 4, the pinion gear 6 is brought into meshing engagement with the ring gear 5 and, thereafter, the ECU 23 energizes the excitation coil 32 of the auxiliary electromagnetic switch 10 at a given timing. When this takes place, the movable core 27 is attracted to close the stationary contacts 25 and 26, thereby forming a short-circuited passage to short-circuit the resistor element 9. As a result, a full voltage is applied from the battery 11 to the motor 4 to allow a high electric current to flow through the motor 4. When this takes place, the motor 4 rotates at a high speed with a high-speed rotation of the motor 4 being transferred from the pinion gear 6 to the ring gear 5, thereby cranking the engine.

(Advantageous Effect of Second Embodiment)

[0104] With the starter 1A of the present embodiment, the motor 4 is energized with the electric current limited with the resistor element 9 at an early stage (during a period from a timing at which the main contact MC is closed to another timing at which the auxiliary contact AC is closed) of the operation of the motor 4, thereby alleviating a shock occurring during meshing engagement between the pinion gear 6 and the ring gear 5. This results in a reduction of wear occurring between the pinion gear 6 and the ring gear 5 with a resultant increase in durability.

[0105] Further, no inrush current flows into the motor 4 before it rotates, thereby increasing a contact life of the main electromagnetic switch 8 while increasing brush life of the motor 4.

[0106] With the present embodiment, the starter 1A takes the form of a structure in which the housing and the flange member, shown in the related art (Patent Publication 1), are not separate from each other and the auxiliary electromagnetic switch 10 is fixedly mounted on the end frame 40 of the motor 4 via the mounting member 50. With such a structure, the starter 1A of the present embodiment has a less limitation in available physical space than that of the related art starter. Therefore, the teachings of the present disclosure can be applied not only to a starter of a large size but also to a starter of a small size, while making it possible to easily manufacture

the starter on a mass production basis.

[0107] Further, the auxiliary electromagnetic switch 10 can be placed in a position such that a whole of the auxiliary electromagnetic switch 10 falls in the area to which the main electromagnetic switch 8 is projected in the axial direction. Thus, the main electromagnetic switch 8 and the auxiliary electromagnetic switch 10 can have a smaller projected area on a plane perpendicular to an axis of the motor 4 than that of the main electromagnetic switch 8 and the auxiliary electromagnetic switch 10 that are placed in parallel to each other in areas above the motor 4 at circumferentially spaced positions thereof. As a result, no likelihood occurs for the starter 1A to have a remarkably larger installation space than that achieved with a starter having no auxiliary electromagnetic switch 10. This prevents the starter 1A from interfering with an engine block and equipment installed on the engine at an outer circumferential periphery thereof, thereby ensuring an adequate installation space for the starter 1A with respect to the engine.

[0108] Further, the B-terminal bolt 15 of the electromagnetic switch 8 and the second terminal bolt 30 of the electromagnetic switch 10 are electrically and mechanically connected to one another via the metallic connecting member 34A. Thus, the starter 1A of the present embodiment has a further increased vibration proof than that achieved in a case where wires connect both of the bolts 15 and 30 to each other.

[0109] Furthermore, the auxiliary electromagnetic switch 10 is fixedly mounted on the end frame 40 of the motor 4 via the mounting member 50. Thus, the auxiliary electromagnetic switch 10 can be easily fixed to the end frame 40 via the mounting member 50 with no need required for the auxiliary electromagnetic switch 10 to have, for instance, a flange portion or the like to pass screws or bolts.

[0110] The mounting member 50 is comprised of the band portion 50a, made of a metallic plate material bent in a annular configuration, and the leg portions 50b formed at the both terminal ends of the band portion 50a and, hence it is easy to manufacture the mounting member 50. In addition, the mounting member 50 is made of the metallic plate material formed in a simple configuration (such as, for instance, a band-like rectangle shape). This enables the mounting member 50 to be made of metallic raw material with a resultant increase in yield, enabling a reduction in production cost.

(Modified Form of Second Embodiment)

[0111] A starter 1B of a modified form of the second embodiment will be described below with reference to FIG. 10.

[0112] The starter 1B of the present modification differs from the starter 1A of the second embodiment in that the starter 1B of the present embodiment includes an auxiliary electromagnetic switch 10B having an axis placed in a position perpendicular to the axis of the main electromagnetic switch 8.

[0113] With such a structure, the starter 1B can be structured with the main electromagnetic switch 8 having not only a function to open or close the main contact provided in the motor circuit but also a function to drive the shift lever 7 to push the pinion gear 6 to the ring gear 5 and the auxiliary electromagnetic switch 10B merely having a function to short circuit the resistor element 9 of the motor circuit. Thus, the auxiliary electromagnetic switch 10B can have an overall length (a length in an axial direction) that is less than that of the main electromagnetic switch 8. As shown in FIG. 10, therefore, even if the axis of the auxiliary electromagnetic switch 10B and the axis of the main electromagnetic switch 8 are placed so as to intersect with each other on a plane perpendicular to each other, the auxiliary electromagnetic switch 10B does not protrude in a large extent from an area to which the main electromagnetic switch 8 is projected in an axial direction. This prevents the auxiliary electromagnetic switch 10B from interfering with an engine block or equipment disposed on the engine around a circumferential periphery thereof.

(Modified Form of Mounting Member)

[0114] FIG. 11 shows a front view of a mounting member of a modified form of the mounting member shown in FIG. 10.

[0115] With the modified form shown in FIG. 11, the mounting member 50B includes a annular band portion 50Ba, with which the auxiliary electromagnetic switch 10B is fixedly secured to the end frame 40 of the motor 4, and leg portions 50Bb formed at both ends of the band portion 50Ba. As shown in FIG. 11, the band portion 50Ba has an inner circumferential periphery formed with circumferentially spaced protrusions 50Bd.

[0116] With the band portion 50Ba having the inner circumferential periphery formed with the circumferentially spaced protrusions 50Bd, the protrusions 50Bd are brought into abutting engagement with an outer circumferential periphery of the auxiliary electromagnetic switch 10B. This enables the protrusions 50Bd to be held in pressured contact with the outer circumferential periphery of the auxiliary electromagnetic switch 10B with increased surface pressures. This prevents the auxiliary electromagnetic switch 10B from slipping (in rotation) at the inner periphery of the band portion 50Ba, enabling the auxiliary electromagnetic switch 10B to be reliably fixed in place.

[0117] While the specific embodiments of the present invention have been described in detail, it will be appreciated by those skilled in the art that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangements disclosed are meant to be illustrative only and not limited to the scope of the present invention, which is to be given the full breadth of the following claims and.

Claims

1. A starter (1) for starting up an engine having a ring gear (48),
the starter (1, 1A, 1B) having a housing (2) adapted to be mounted on the engine,
a motor (2) fixedly mounted on the housing to generate a rotational force,
a pinion gear (5) operative to transfer the rotational force from the motor to the ring gear,
a motor circuit having a main contact (MC) to apply electric power from a battery (11) to the motor (4),
a main electromagnetic switch (8) operative to open or close the main contact (MC) and operative to actuate the pinion gear toward the ring gear,
energizing current limiting means (9) connected to the motor circuit at a high voltage potential side for limiting an electric current flowing through the motor, and
an auxiliary electromagnetic switch (10) having an auxiliary switch (AC) composed of a pair of stationary contacts (25, 26), connected between low and high voltage potential sides of the energizing current limiting means (9), and
a movable contact (27) operative to connect or disconnect the pair of stationary contacts (25, 26) to short circuit the energizing current limiting means (9) when the pair of stationary contacts are conducted with the movable contact (27),
wherein when the main electromagnetic switch (8) is turned on, the main contact (MC) is closed to cause the energizing current limiting means (9) to limit the electric current flowing through the motor (4) after which the auxiliary electromagnetic switch (10) is energized at a given timing to short circuit the energizing current limiting means (9) to allow a full voltage to be applied from the battery to the motor
the main electromagnetic switch (8) is fixedly mounted on the housing (2) by means of a plurality of bolts (14) in a first area close proximity to an outer circumferential periphery of the motor (4),
the auxiliary electromagnetic switch (10) is fixedly mounted on at least one of the housing (2) or an end frame (40) of the motor (4) via a mounting member (24, 50) in a second area close proximity to the outer circumferential periphery of the motor (4) and
the auxiliary electromagnetic switch (10) is fixedly mounted on the end frame (40) of the motor (4) via the mounting member (24, 50) such that at least a part of the auxiliary electromagnetic switch (10) axially falls in an area to which the main electromagnetic switch (8) is projected in an axial direction,
characterized in that:

the mounting member (50), with which the auxiliary electromagnetic switch (10) is fixedly secured to the end frame (40), includes a annular band portion (50a) surrounding a radial outer circumferential periphery of the auxiliary electromagnetic switch (10), and a pair of leg portions (50b), formed on the band portion (50a) at both ends thereof, which are fixed to the end frame (40) by screws (S1), and
the band portion (50a) of the mounting member (50) has an inner eircurnferentially formed with a plurality of protrusions.

2. The starter according to claim 1, **characterized in that**:

the auxiliary electromagnetic switch (10) is placed in the area to which a whole of the main electromagnetic switch (8) is projected in an axial direction.

3. The starter according to claims 1 or 2, **characterized in that**:

the main electromagnetic switch (8) and the auxiliary electromagnetic switch (10) have axes placed in a coaxial relationship.

4. The starter according to any one of claims 1 to 3, **characterized in that**:

the main electromagnetic switch (8) and the auxiliary electromagnetic switch (10) have axes that intersect at a right angle.

5. The starter according to any one of claims 1 to 4, **characterized in that**:

the main electromagnetic switch (8) has a terminal remained at a high voltage potential to which a terminal of the auxiliary electromagnetic switch (10) remaining at a low voltage potential is electrically and mechanically connected via a metallic connecting member.

6. The starter according to claim 1, **characterized in that**:

the mounting member (50) is made of metallic plate material that is folded.

Patentansprüche

1. Starter (1) zum Starten einer Maschine mit einem Hohlrad (48),
wobei der Starter (1, 1A, 1B) ein Gehäuse (2), das so ausgebildet ist, dass es an der Maschine befestigt wird,
einen Motor (2), der fest auf dem Gehäuse angebracht ist, um eine Rotationskraft zu erzeugen,
ein Ritzel (5), das dazu dient, die Rotationskraft von

dem Motor zu dem Hohlrad zu übertragen,
einen Motorstromkreis mit einem Hauptkontakt (MC), um dem Motor (4) elektrische Energie von einer Batterie (11) zuzuführen,
einen elektromagnetischen Hauptschalter (8), der dazu dient, den Hauptkontakt (MC) zu öffnen oder zu schließen und das Ritzel in Richtung des Hohlrads anzutreiben,
ein Erregungstrom-Begrenzungsmittel (9), das an den Motorstromkreis an einer Hochspannungspotentialseite angeschlossen ist, um einen elektrischen Strom, der durch den Motor fließt, zu begrenzen, und
einen elektromagnetischen Hilfsschalter (10) mit einem Hilfsschalter (AC), der aus einem Paar feststehender Kontakte (25, 26) besteht, die zwischen der Niedrigspannungs- und Hochspannungspotentialseite des Erregungstrom-Begrenzungsmittels (9) verbunden sind, und
einen beweglichen Kontakt (27) aufweist, der dazu dient, das Paar feststehender Kontakte (25, 26) zu verbinden oder zu trennen, um das Erregungstrom-Begrenzungsmittel (9) kurzzuschließen, wenn das Paar feststehender Kontakte mit dem beweglichen Kontakt (27) betrieben werden,
wobei, wenn der elektromagnetische Hauptschalter (8) eingeschaltet ist, der Hauptkontakt (MC) geschlossen wird, um das Erregungsstrom-Begrenzungsmittel (9) zu veranlassen, den durch den Motor (4) fließenden elektrischen Strom zu begrenzen, wonach der elektromagnetische Hilfsschalter (10) zu einem vorgegebenen Zeitpunkt erregt wird, um das Erregungsstrom-Begrenzungsmittel (9) kurzzuschließen, damit eine volle Spannung von der Batterie an den Motor angelegt werden kann, wobei
der elektromagnetische Hauptschalter (8) mittels einer Mehrzahl von Schraubbolzen (14) in einem ersten Bereich, der sich in großer Nähe zu einem äußeren Umfang des Motors (4) befindet, fest auf dem Gehäuse (2) angebracht ist; der elektromagnetische Hilfsschalter (10) mittels eines Befestigungselements (24, 50) in einem zweiten Bereich, der sich in großer Nähe zu dem äußeren Umfang des Motors (4) befindet, fest auf zumindest einem von dem Gehäuse (2) oder einem Endgehäuse (40) des Motors (4) angebracht ist, und
der elektromagnetische Hilfsschalter (10) mittels des Befestigungselements (24, 50) auf dem Endgehäuse (40) des Motors (4) derart fest angebracht ist, dass zumindest ein Teil des elektromagnetischen Hilfsschalters (10) axial in einen Bereich fällt, in den der elektromagnetische Hauptschalter (8) in einer axialen Richtung axial vorsteht,
dadurch gekennzeichnet, dass
das Befestigungselement (50), mit dem der elektromagnetische Hilfsschalter (10) fest an dem Endgehäuse (40) angebracht ist, einen ringförmigen Bandbereich (50a), der einen radial äußeren Umfang des elektromagnetischen Hilfsschalters (10) umgibt, und ein Paar von Schenkelbereichen (50b), die auf dem Bandbereich (50a) an beiden Enden desselben ausgebildet sind, die an dem Endgehäuse (40) mittels Schrauben (S1) befestigt sind, aufweist, und
der Bandbereich (50a) des Befestigungselements (50) einen inneren Umfang aufweist, der mit einer Mehrzahl von Vorsprüngen ausgebildet ist.

2. Starter nach Anspruch 1, **dadurch gekennzeichnet, dass**
der elektromagnetische Hilfsschalter (10) in dem Bereich angeordnet ist, in den eine Gesamtheit des elektromagnetischen Hauptschalters (8) in einer axialen Richtung vorsteht.

3. Starter nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass**
der elektromagnetische Hauptschalter (8) und der elektromagnetische Hilfsschalter (10) Achsen aufweisen, die in einer koaxialen Beziehung angeordnet sind.

4. Starter nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass**
der elektromagnetische Hauptschalter (8) und der elektromagnetische Hilfsschalter (10) Achsen aufweisen, die sich in einem rechten Winkel schneiden.

5. Starter nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass**
der elektromagnetische Hauptschalter (8) einen Anschluss aufweist, der auf einem Hochspannungspotential verbleibt, mit dem ein Anschluss des elektromagnetischen Hilfsschalters (10), der auf einem Niedrigspannungspotential verbleibt, über ein metallisches Verbindungselement elektrisch und mechanisch verbunden ist.

6. Starter nach Anspruch 1, **dadurch gekennzeichnet, dass**
das Befestigungselement (50) aus einem gefalteten metallischen Plattenmaterial besteht.

Revendications

1. Démarreur (1) pour démarrer un moteur à combustion interne comportant une couronne (48),
le démarreur (1, 1A, 1B) comportant un logement (2) conçu pour être monté sur le moteur à combustion interne,
un moteur (2) monté fixement sur le logement pour générer une force de rotation,
un pignon (5) pouvant être utilisé pour transférer la force de rotation du moteur à la couronne,
un circuit de moteur comportant un contact principal (MC) pour appliquer une alimentation électrique

d'une batterie (11) au moteur (4),
un commutateur électromagnétique principal (8) pouvant être utilisé pour ouvrir ou fermer le contact principal (MC) et pouvant être utilisé pour actionner le pignon vers la couronne,
des moyens de limitation de courant d'alimentation (9) connectés au circuit de moteur d'un côté de potentiel haute tension pour limiter un courant électrique circulant à travers le moteur, et
un commutateur électromagnétique auxiliaire (10) comportant un commutateur auxiliaire (AC) composé d'une paire de contacts fixes (25, 26), connecté entre les côtés de potentiels basse tension et haute tension des moyens de limitation de courant d'alimentation (9), et
un contact mobile (27) pouvant être utilisé pour connecter ou déconnecter la paire de contacts fixes (25, 26) pour mettre en court-circuit les moyens de limitation de courant d'alimentation (9) lorsque la paire de contacts fixes sont en conduction avec le contact mobile (27),
dans lequel, lorsque le commutateur électromagnétique principal (8) est mis en marche, le contact principal (MC) est fermé pour amener les moyens de limitation de courant d'alimentation (9) à limiter le courant électrique circulant à travers le moteur (4) après que le commutateur électromagnétique auxiliaire (10) a été alimenté selon une synchronisation donnée pour mettre en court-circuit les moyens de limitation de courant d'alimentation (9) pour permettre l'application d'une tension totale de la batterie au moteur,
le commutateur électromagnétique principal (8) est monté fixement sur le logement (2) au moyen d'une pluralité de boulons (14) dans une première zone à proximité étroite d'une périphérie circonférentielle extérieure du moteur (4),
le commutateur électromagnétique auxiliaire (10) est monté fixement sur au moins l'un du logement (2) ou d'un cadre d'extrémité (40) du moteur (4) par l'intermédiaire d'un élément de montage (24, 50) dans une deuxième zone à proximité étroite de la périphérie circonférentielle extérieure du moteur (4), et
le commutateur électromagnétique auxiliaire (10) est monté fixement sur le cadre d'extrémité (40) du moteur (4) via l'élément de montage (24, 50) de sorte qu'au moins une partie du commutateur électromagnétique auxiliaire (10) tombe axialement dans une zone de laquelle le commutateur électromagnétique principal (8) fait saillie dans une direction axiale,
caractérisé en ce que :

l'élément de montage (50) avec lequel le commutateur électromagnétique auxiliaire (10) est fixement fixé au cadre d'extrémité (40), comprend une partie de bande annulaire (50a) entourant une périphérie circonférentielle extérieure radiale du commutateur électromagnétique auxiliaire (10), et une paire de parties de patte (50b), formées sur la partie de bande (50a) au niveau de ses deux extrémités, qui sont fixées au cadre d'extrémité (40) par des vis (S1), et
la partie de bande (50a) de l'élément de montage (50) a une circonférence interne formée avec une pluralité de saillies.

2. Démarreur selon la revendication 1, **caractérisé en ce que** :

le commutateur électromagnétique auxiliaire (10) est placé dans la zone de laquelle la totalité du commutateur électromagnétique principal (8) fait saillie dans une direction axiale.

3. Démarreur selon les revendications 1 ou 2, **caractérisé en ce que** :

le commutateur électromagnétique principal (8) et le commutateur électromagnétique auxiliaire (10) ont des axes placés en relation coaxiale.

4. Démarreur selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** :

le commutateur électromagnétique principal (8) et le commutateur électromagnétique auxiliaire (10) ont des axes qui se coupent en angle droit.

5. Démarreur selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** :

le commutateur électromagnétique principal (8) a une borne qui reste au potentiel haute tension à laquelle une borne du commutateur électromagnétique auxiliaire (10) restant à un potentiel basse tension est électriquement et mécaniquement connectée via un élément de raccordement métallique.

6. Démarreur selon la revendication 1, **caractérisé en ce que** :

l'élément de montage (50) est réalisé avec un matériau de plaque métallique qui est plié.

FIG. 1

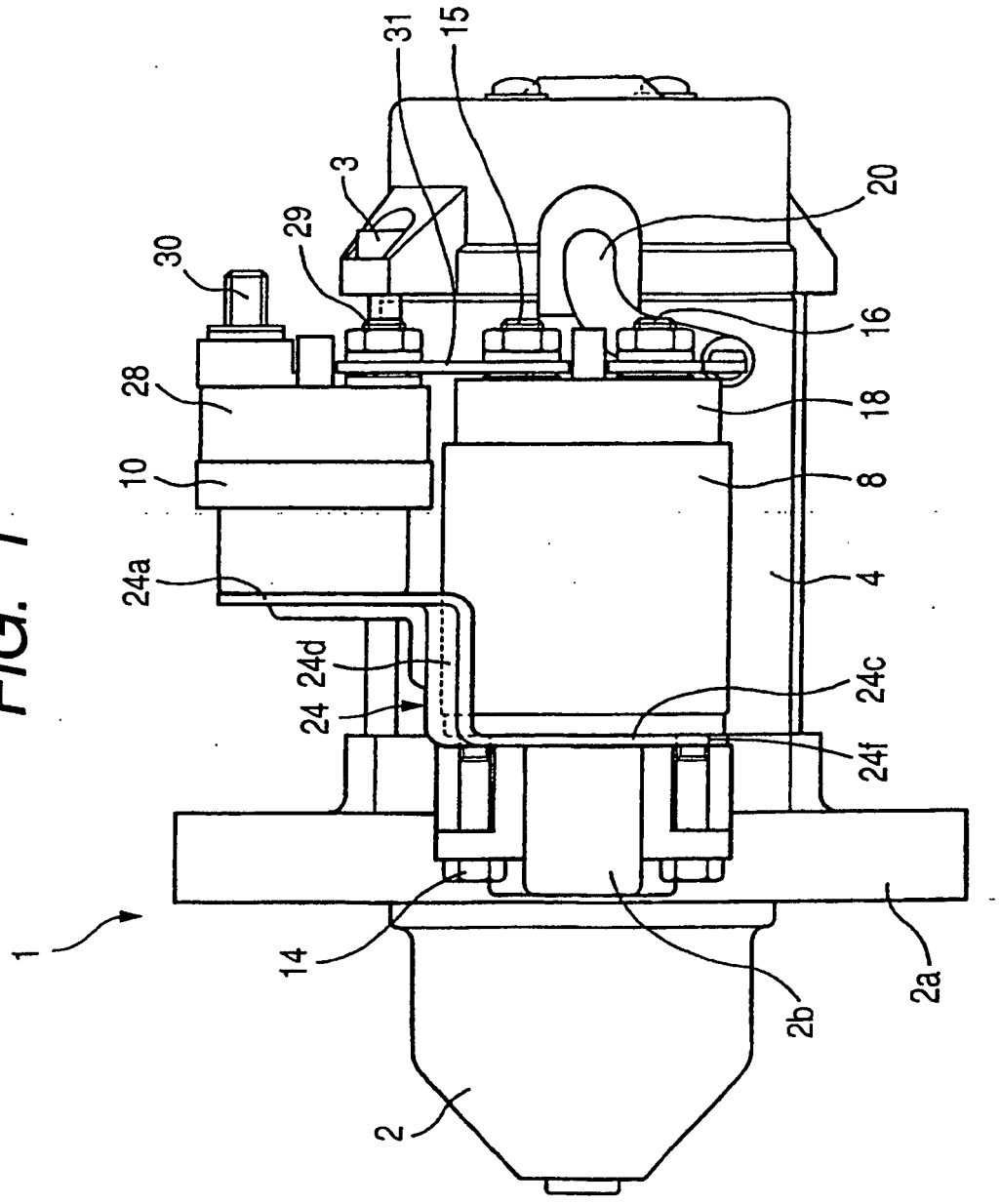


FIG. 2

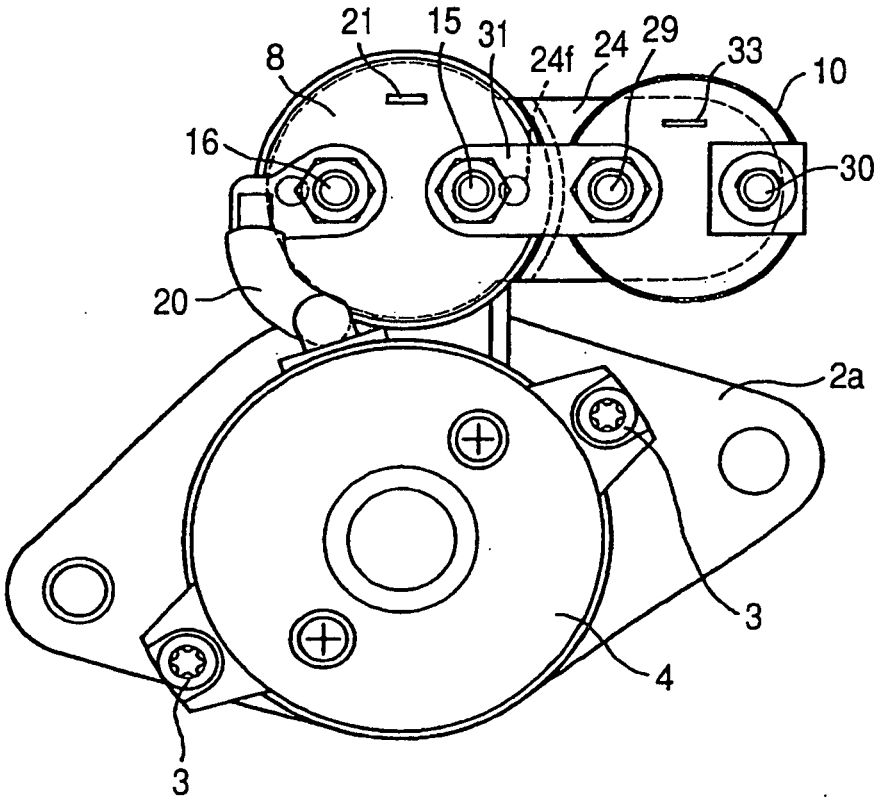


FIG. 3

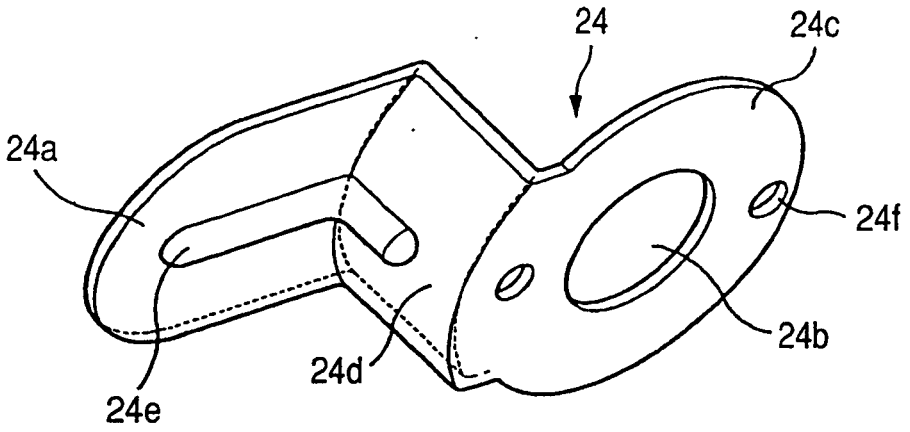

24
24c
24a
24f
24b
24d
24e

FIG. 4

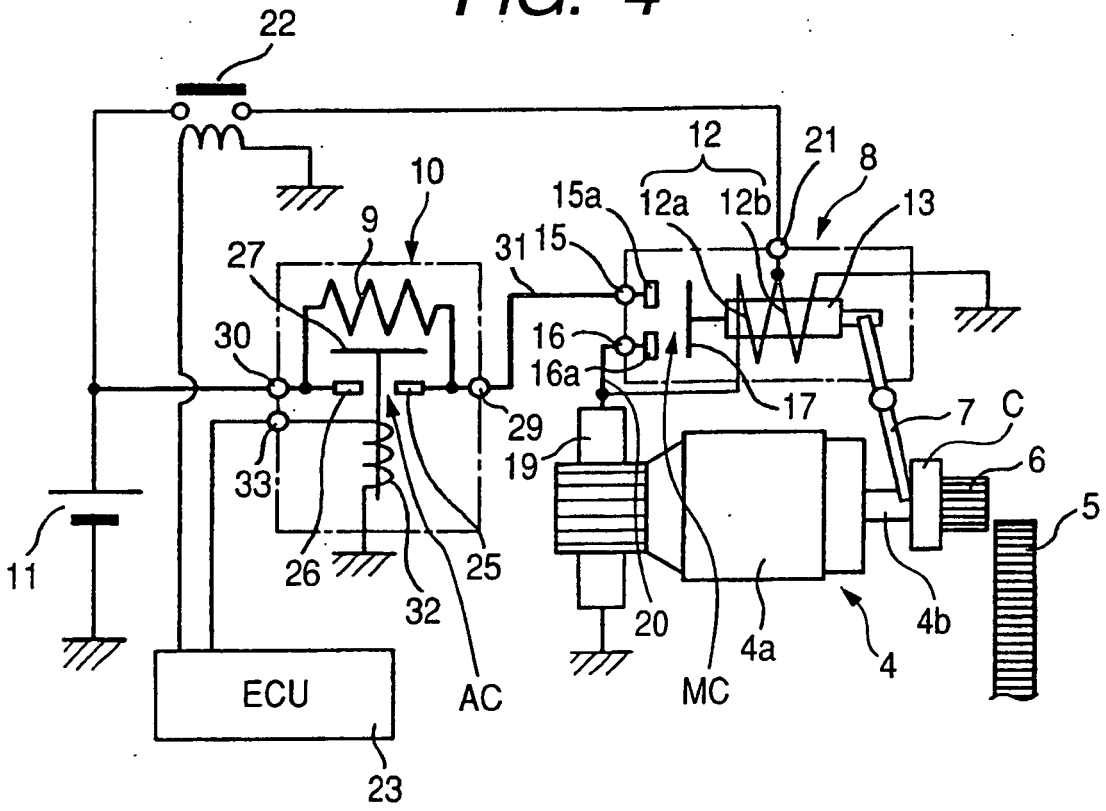

22
12
21
8
10
15a
12a
12b
13
9
31
15
27
30
16
16a
17
7
C
29
19
6
33
5
11
26
25
32
20
4a
4b
4
ECU
AC
MC
23

FIG. 5

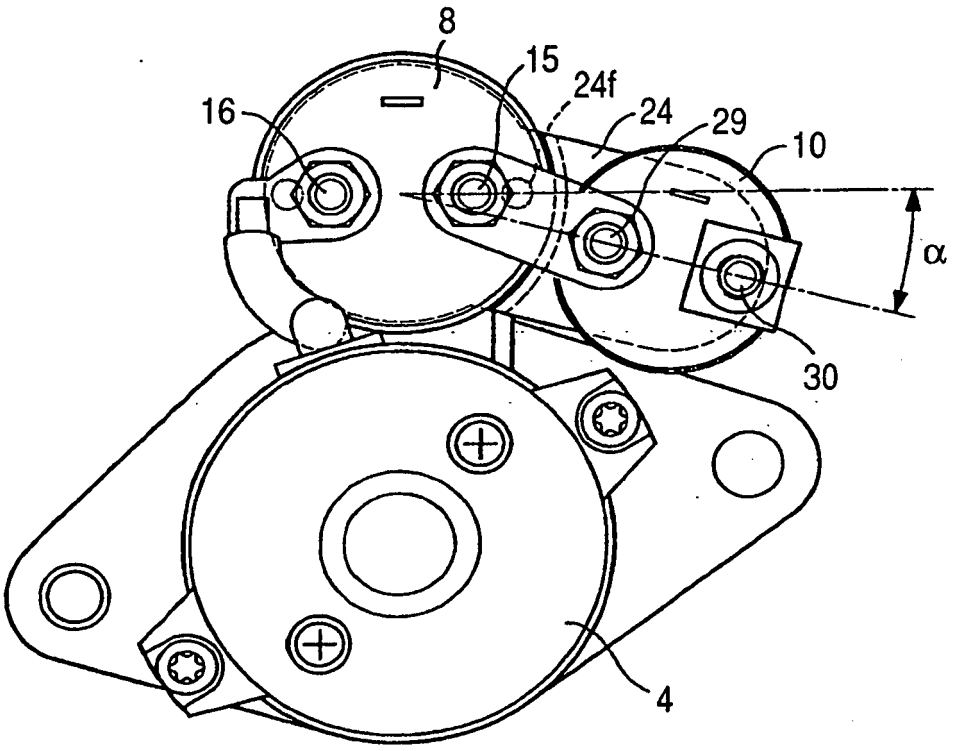


FIG. 6

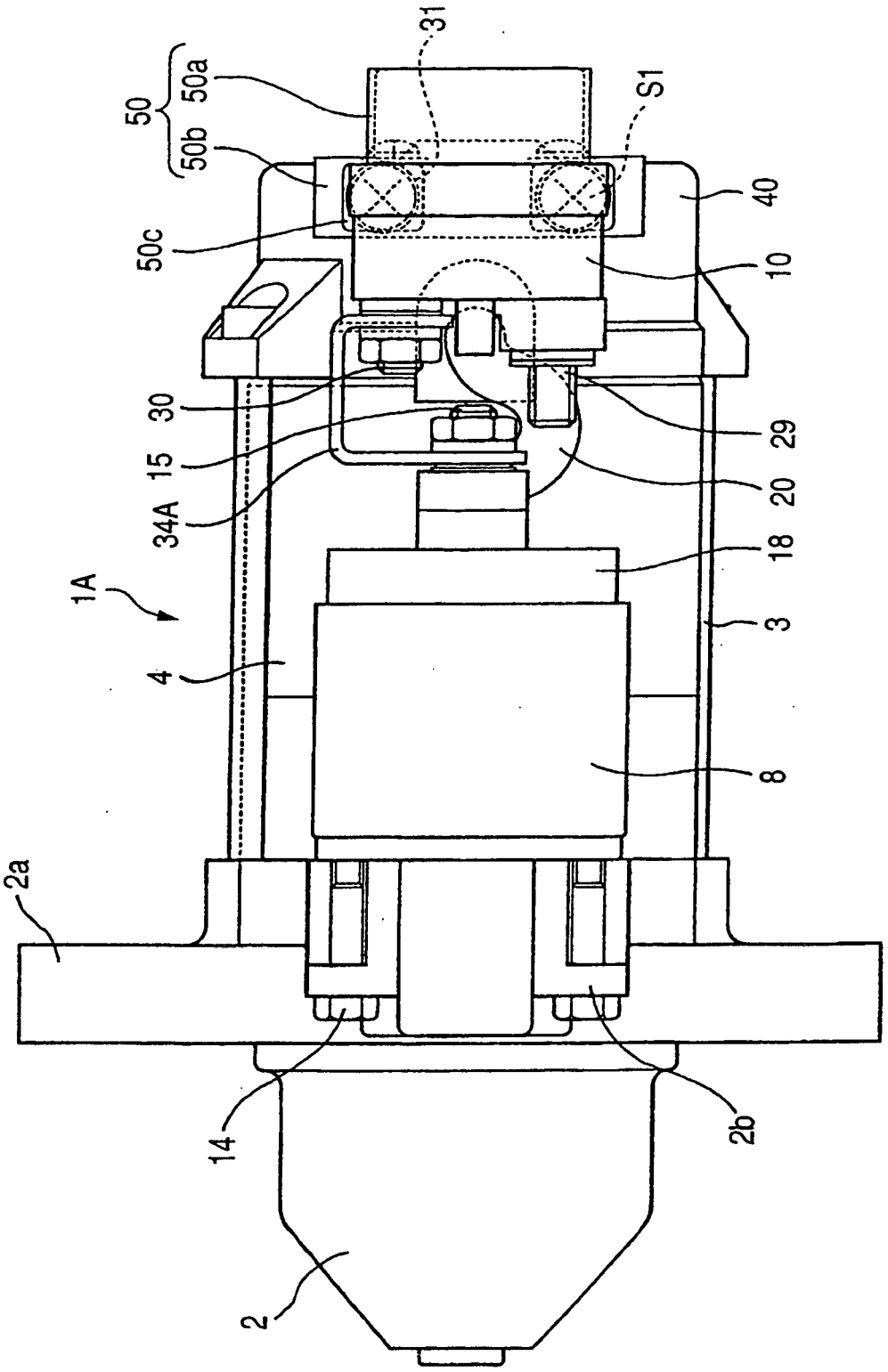


FIG. 7

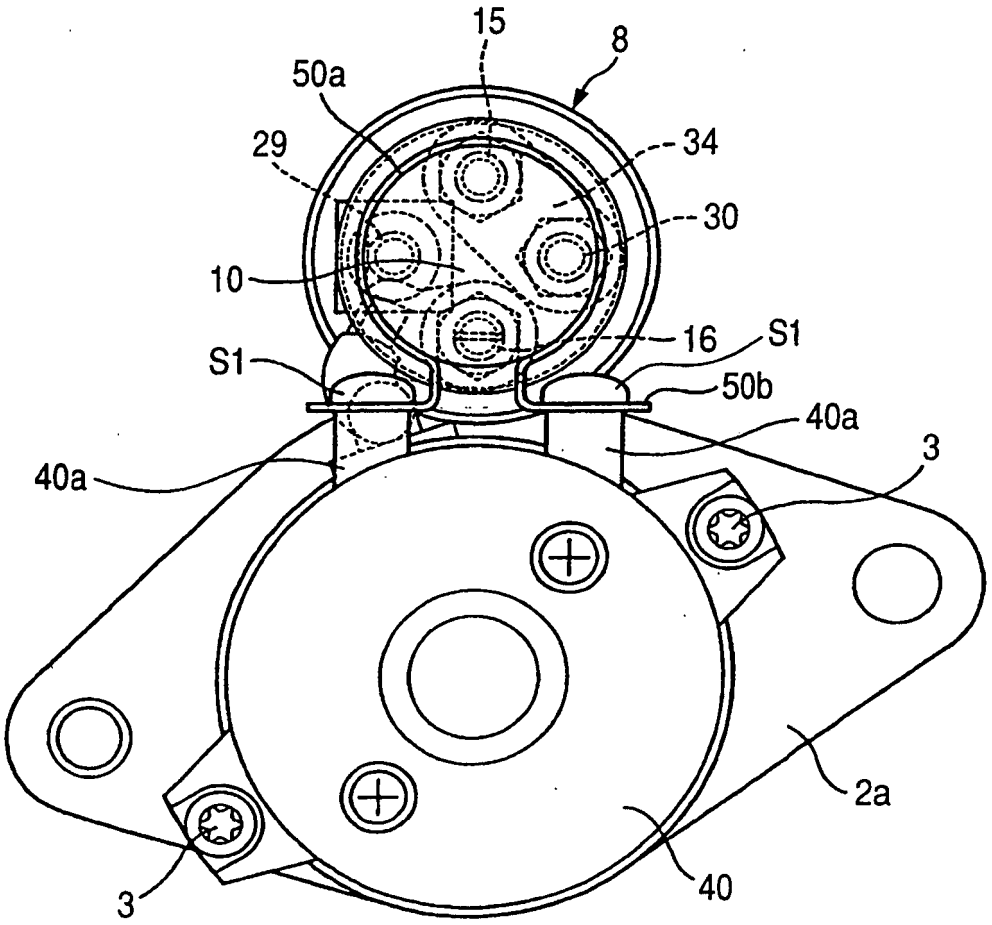


FIG. 8A

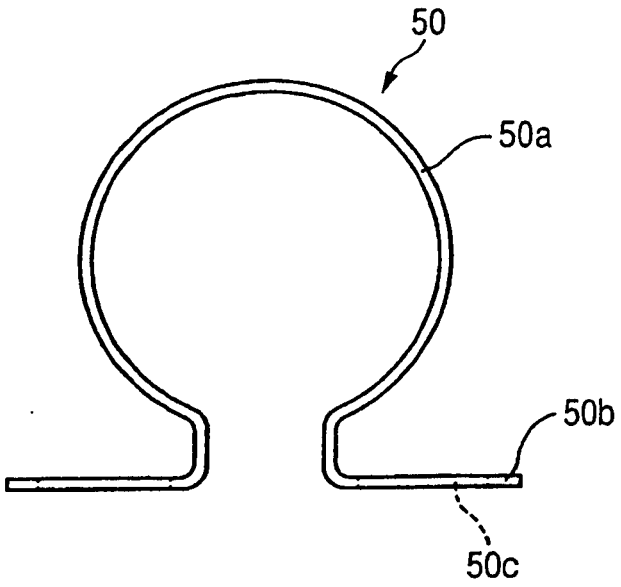


FIG. 8B

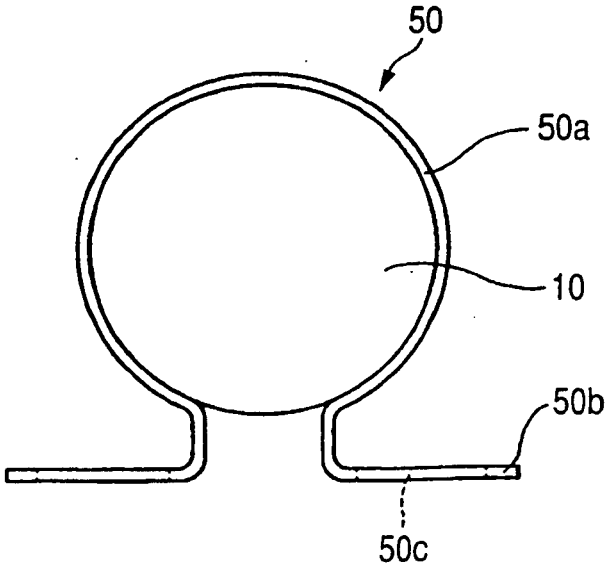


FIG. 9

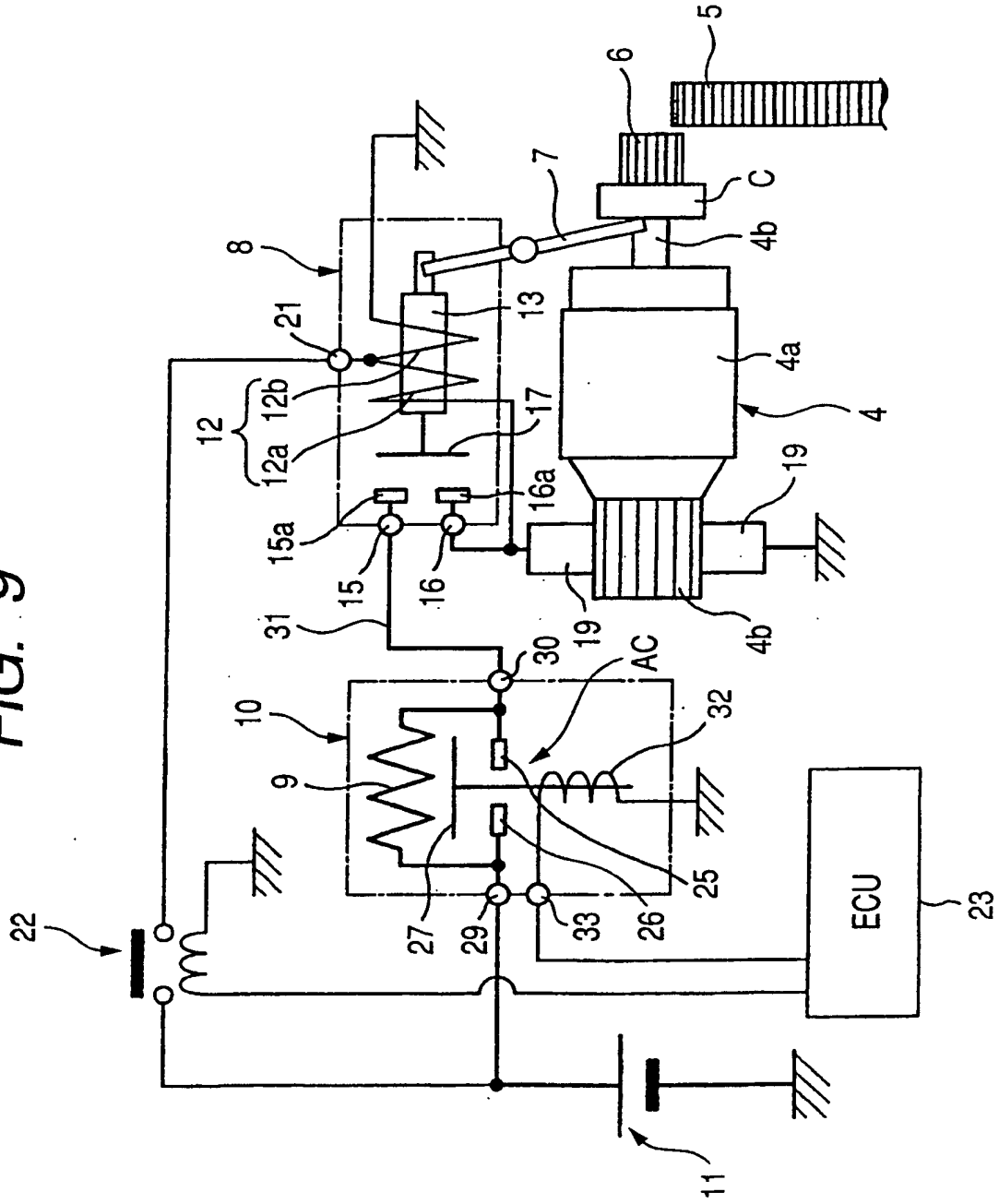

5
6
7
C
4b
8
13
21
4a
12b
12
12a
17
4
16a
19
15a
15
16
31
30
AC
32
10
9
25
22
27
29
33
26
ECU
23
11

FIG. 10

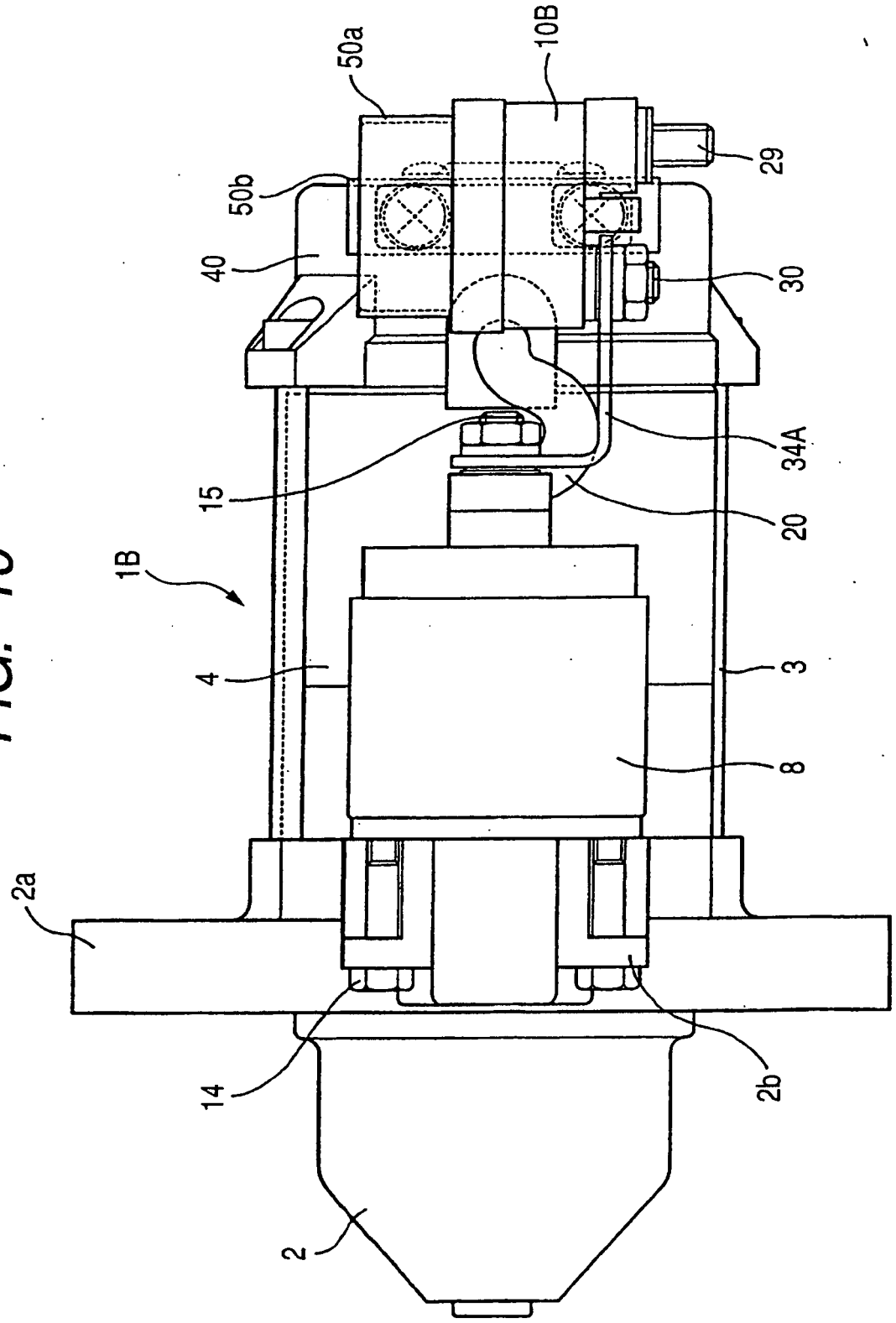
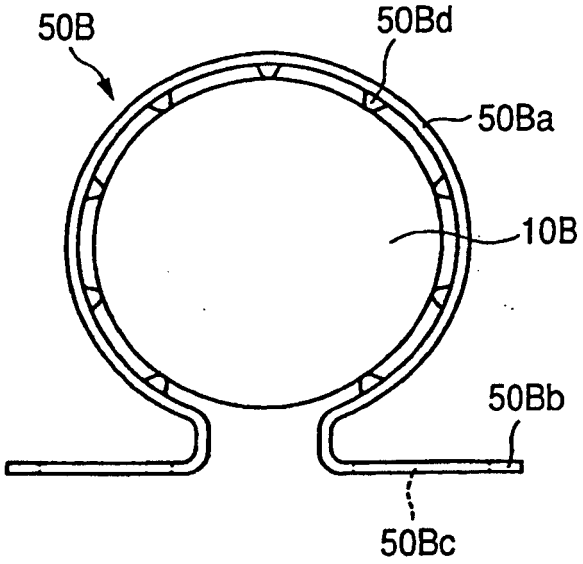


FIG. 11



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 10018949 A **[0002]**
- US 2003214766 A **[0017]**
- US 2004012902 A **[0017]**
- JP 7109967 A **[0018]**