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

(11) **EP 3 471 087 A1**

# (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**17.04.2019 Bulletin 2019/16**

(51) Int Cl.:
***G10K 9/13*** *(2006.01)* ***G10K 9/22*** *(2006.01)*

(21) Application number: **18198613.4**

(22) Date of filing: **04.10.2018**

(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:
**KH MA MD TN**

(30) Priority: **10.10.2017 JP 2017196521**
**10.10.2017 JP 2017196522**

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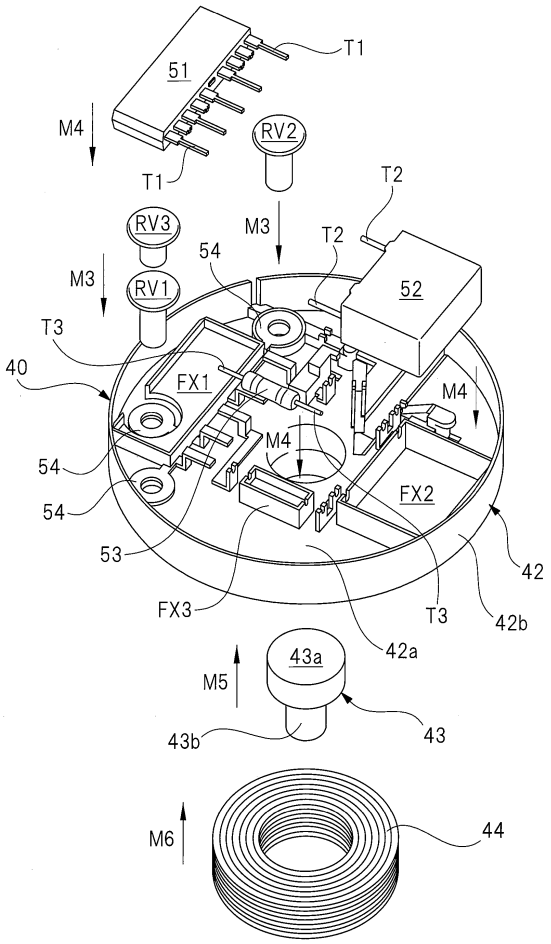
## (54) HORN DEVICE

(57) A horn device (10) includes a third rivet (RV3) whose one end side is connected to a conductive member (54), whose other end side is exposed outside a case (21), and which fixes a coil bobbin (40) to the case, and this third rivet is used for communication with an IC chip (51) and an adjuster (AD). Consequently, an increase in the number of components is suppressed and a structure of the device is made uncomplicated, so that the hom device can communicate with the internal IC chip from outside without resolving the hom device. Therefore, even when the hom device does not sound for any reasons, whether the IC chip operates normally can be confirmed quickly and easily from outside. Thus, the horn device excellent in maintainability can be realized.

FIG. 9

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## Description

### TECHNICAL FIELD OF THE INVENTION

**[0001]** The present invention relates to a horn device that generates sound by vibrations of a movable iron core attached to a diaphragm.

### BACKGROUND OF THE INVENTION

**[0002]** Mounted on a forward side of a vehicle such as an automobile is an electromagnetic type horn device. The electromagnetic type horn device includes a horn device that generates sound by vibrations of a movable iron core attached to a diaphragm and in which the generated sound is resonated by a resonator. Such a horn device having the resonator is disclosed in, for example, Patent Document 1 (Japanese Patent Application Laid-open No. 2003-122369).

**[0003]** A horn device (electromagnetic type alarm) disclosed in Patent Document 1 includes: a case (body) housing a coil(s) at its center; a diaphragm (vibration plate) blocking an opening portion of the case; and a movable iron core (armature) attached to a center of the diaphragm. Also, housed in the case are a contact point (interrupter) opened/closed (turned on/off) by an up-and-down motion of the movable iron core and a control circuit substrate that controls a current flowing in a coil by opening/closing the contact point.

**[0004]** Mounted on the control circuit substrate are a transistor(s) and a power MOS type FET(s). The transistor uses a weak current to control the power MOS type FET, and the power MOS type FET supplies a high current (drive current) to the coil. That is, the control circuit substrate is controlled by the weak current, so that only the weak current used for driving the control circuit substrate flows at the contact point. Therefore, suppressed is abrasion of the contact point due to the flowing of the high current (due to occurrence of spark).

**[0005]** Further, like a horn device disclosed in Patent Document 2 (ES 2376690 A1), there is also a method in which the control circuit substrate provided outside the case causes the horn device to be sounded without having any contact points inside the case.

### SUMMARY OF THE INVENTION

**[0006]** In the horn device disclosed in Patent Document 1 as mentioned above, however, when the horn device does not sound due to any reasons, whether the control circuit substrate (controller) normally operates has not been confirmed from outside. That is, in order to confirm good or bad quality of the control circuit substrate, the horn device is firstly resolved (taken apart) and the control circuit substrate exposed outside then needs to be connected to an inspection device (exterior device), so that the above resolving and connecting have brought troublesome work.

**[0007]** Further, the horn device disclosed in Patent Document 1 has the contact point, and regulation for a sounding frequency of the horn device has needed to regulate a regulation screw(s) etc. provided near the contact point. For this reason, a mechanism for mechanically regulating the sounding frequency becomes necessary and, for example, parts such as the regulation screw etc. have been required. Therefore, this brings an increase in the number of parts and, additionally thereto, there are also some fears in which the sounding frequency having been regulated with effort varies due to external loads such as vibration etc. Moreover, getting used to regulation work is required, and causing the regulation work to have permissible variations in some degrees becomes necessary for adjusting the regulation work to production tact. Doing so also causes variations etc. in sound pressure.

**[0008]** Additionally, the horn device disclosed in Patent Document 2 does not have the contact point as described in Patent Document 1, and includes the control circuit substrate provided outside, but does not premise the structure of regulating the sounding frequency, so that some parts for regulating the sounding frequency become necessary separately. Therefore, this brings an increase of the number of parts and, additionally thereto, it has been required to fundamentally review the structure of the horn device.

**[0009]** An object of the present invention is to provide a horn device communicable with an internal (interior) controller from outside without making a structure of the horn device complicated by suppressing an increase of the number of parts and without resolving the horn device.

**[0010]** In one aspect of the present invention, a horn device includes: a case, its one side being closed and its other side being opened; a diaphragm closing an opening portion of the case; a movable iron core attached to the diaphragm; a bobbin housed in the case, a coil being wound radially outside the bobbin; a fixed iron core provided radially inside the bobbin and generating a magnetic force for attracting the movable iron core; a controller provided to the bobbin and controlling a current flowing in the coil; a conductive member provided to the bobbin and connected to the controller; and a fixing metal fixture, its one end side being connected to the conductive member, its other end side being exposed outside the case, and the fixing metal fixture fixing the bobbin to the case, wherein the fixing metal fixture is used for communication between the controller and an exterior device.

**[0011]** In another aspect of the present invention, when the bobbin is viewed from its axial direction, the controller and the fixing metal fixture are overlapped.

**[0012]** In yet another aspect of the present invention, a connector connection portion to be connected to an exterior connector is provided outside the case, an end portion of a power supply conductive member supplying a drive current to the controller, and an end portion of a communication conductive member used for communi-

cation with the controller are exposed inside the connector connection portion, and the end portion of the communication conductive member is arranged on a deeper side of the connector connection portion than the end portion of the power supply conductive member.

**[0013]** According to the present invention, the horn device has a fixing metal fixture whose one end side is connected to a conductive member, whose other end side is exposed outside the case, and which fixes a coil bobbin to the case, and this fixing metal fixture is used for communication with the internal controller from outside.

**[0014]** Consequently, an increase in the number of components is suppressed and a structure of the device is made uncomplicated, so that the horn device can communicate with the internal controller from outside without resolving the horn device. Therefore, even when the horn device does not sound for any reasons, whether the controller operates normally can be confirmed quickly and easily from outside. Thus, the horn device excellent in maintainability can be realized.

## BRIEF DESCRIPTIONS OF THE DRAWINGS

**[0015]**

FIG. 1 is a perspective view showing a horn device according to the present invention;
FIG 2 is a sectional view showing an internal structure of the horn device of FIG 1;
FIG 3 is a perspective view showing an IC chip side (front side) of a coil bobbin housed in a case;
FIG 4 is a perspective view showing a coil side (back side) of the coil bobbin housed in the case;
FIG 5 is an electric circuit diagram for driving the horn device of FIG 1;
FIG 6 is a sectional view for explaining a transfer path of heat generated by coils;
FIG 7A is a perspective view for explaining a connection portion between an electronic component and a conductive member;
FIG 7B is a perspective view for explaining a connection portion between an electronic component and a conductive member;
FIG 7C is a perspective view for explaining a connection portion between an electronic component and a conductive member;
FIG. 8A is a perspective view for explaining an [Insert Molding Step];
FIG 8B is a perspective view for explaining an [Insert Molding Step];
FIG. 9 is a perspective view for explaining a [Component Attaching Step];
FIG. 10 is a perspective view for explaining a [Laser Depositing Step];
FIG. 11 is a perspective view for explaining an [Assembling Step];
FIG 12 is a perspective view for explaining a [Frequency Adjusting Step]; and
FIG. 13 is a perspective view showing a portion of a horn device according to the present invention.

## DESCRIPTIONS OF THE PREFERRED EMBODIMENTS

**[0016]** Hereinafter, Embodiment 1 according to the present invention will be detailed with reference to the drawings.

**[0017]** FIG. 1 is a perspective view showing a horn device according to the present invention; FIG. 2 is a sectional view showing an internal structure of the horn device of FIG 1; FIG 3 is a perspective view showing an IC chip side (front side) of a coil bobbin housed in a case; FIG 4 is a perspective view showing a coil side (back side) of the coil bobbin housed in the case; FIG. 5 is an electric circuit diagram for driving the horn device of FIG 1; FIG. 6 is a sectional view for explaining a transfer path of heat generated by coils; FIGS. 7A to 7C are perspective views for explaining a connection portion between an electronic component and a conductive member; FIGS. 8A and 8B are perspective views for explaining an [Insert Molding Step]; FIG 9 is a perspective view for explaining a [Component Attaching Step]; FIG 10 is a perspective view for explaining a [Laser Depositing Step]; FIG 11 is a perspective view for explaining an [Assembling Step]; and FIG. 12 is a perspective view for explaining a [Frequency Adjusting Step].

**[0018]** As shown by FIG 1, a horn device 10 is mounted on a forward side of a vehicle such as automobile, and generates alarm sound. A base end side of an attachment stay 11 is fixed to the horn device 10, and a tip side of the attachment stay 11 is fixed, by a fixing bolt(s), to a cross member etc. forming a vehicle body. Here, the horn device 10 is an electromagnetic type spiral-shaped horn, and is actuated by an operation of a horn switch provided to a steering etc., thereby generating an alarm sound.

**[0019]** The horn device 10 comprises a horn body 20 and a resonator 30. The resonator 30 is attached to the horn body 20, and resonates a sound generated by the horn body 20, thereby emitting the resonated sound outside. Incidentally, in generating sounds different in frequency, a plurality of horn bodies 20 and resonators 30 respectively different in specifications are prepared, and each of both may be arbitrarily combined in number. For example, a common automobile has a combination of two horn devices 10, one of them being for a High sound of 490 Hz, the other being for a Low sound of 410 Hz.

**[0020]** As shown in FIG 2, the horn body 20 has a case 21. The case 21 is formed into a stepped, bottomed cylindrical shape by press-working etc. a metal plate (conductive material), one side (downside in the drawing) of the cylindrical shape being blocked and the other side (upside in the drawing) being opened. One side of the case 21 is provided with a small-diameter containing portion 21b that has a disk bottom portion 21a. Further, the other side of the case 21 is provided with a large-diameter containing portion 21d that has an annular bottom portion

21c.

**[0021]** Here, the large-diameter containing portion 21d is made larger in diameter than the small-diameter containing portion 21b, and its diameter size is made about twice larger than that of the small-diameter containing portion 21b. Additionally, housed in the small-diameter and large-diameter containing portions 21b and 21 d is a coil bobbin 40 made of a resin material (insulating material) such as plastic.

**[0022]** Formed opposite a disk bottom portion 21a side with respect to an axial direction of the case 21 is an opening portion 21e. The opening portion 21e is blocked by a diaphragm 22 formed into a substantially disk shape from a thin metal plate. A movable iron core 23 is attached to a center portion of the diaphragm 22, and is made of a magnetic material and formed into a stepped, substantially columnar shape.

**[0023]** The movable iron core 23 includes: a body portion 23a attracted to a pole 43 by carrying a current into coils 44; and a fixation portion 23b fixed to a center portion of the diaphragm 22. Additionally, a step difference surface 23c is formed between the fixation portion 23b and the body portion 23a, and the center portion of the diaphragm 22 is placed on the step difference surface 23c.

**[0024]** Attached to the fixation portion 23b are a large-diameter washer 24a and a small-diameter washer 24b for fixing the diaphragm 22 onto the body portion 23a. The large-diameter washer 24a is arranged on a base end side of the fixation portion 23b, and the small-diameter washer 24b is arranged on a tip side of the fixation portion 23b. Additionally, the diaphragm 22 and the pair of washers 24a and 24b are attached to the fixation portion 23b and, under such a state, the tip side of the fixation portion 23b is caulked, so that the diaphragm 22 is tightly fixed to the body portion 23a.

**[0025]** Here, by overlapping the small-diameter washer 24b on the large-diameter washer 24a, the movable iron core 23 is set to have a tapered shape on its resonator 30 side (upside in the drawing). This brings such a structure that a flow channel area of an air flow channel 26 between an air vibration chamber 27 and a sounding chamber 31 is made lager. For this reason, a flow of air flowing in the air flow channel 26 is smoothened, and an acoustic characteristic(s) of the horn device 10 is consequently stabilized.

**[0026]** Further, an axis of the movable iron core 23 and an axis of the pole 43 attracting the movable iron core 23 each coincide with an axis C, and the movable iron core 23 and the pole 43 are arranged concentrically with each other. Additionally, a pole 43 side of the body portion 23a along the axial direction is inserted, until its predetermined amount (length), radially inside a coil winding portion 41 of the coil bobbin 40 via a predetermined gap.

**[0027]** Incidentally, the diaphragm 22 has a function as a leaf spring for placing the movable iron core 23 at a "reference position" shown by FIG. 2. Namely, under a state of applying no force to the diaphragm 22, the diaphragm 22 is set to retain a state of separating the movable iron core 23 from the pole 43.

**[0028]** As shown by FIG 2, provided opposite (upside in the drawing) the case 21 side of the diaphragm 22 is a cover 25 formed into a substantially disk shape by press-working etc. a steel plate. An annular caulking fixation portion 25a is formed on an outer periphery portion of the cover 25. Additionally, the caulking fixation portion 25a nips and holds an outer periphery portion of the case 21 and an outer periphery portion of the diaphragm 22. This brings tight fixation of both of the diaphragm 22 and the cover 25 onto the case 21.

**[0029]** The cover 25 is placed between the diaphragm 22 and the resonator 30. A sound output port 25b concentric with the movable iron core 23 is provide to the center portion of the cover 25, and an annular air flow channel 26 is formed between the sound output port 25b and each of the pair of washers 24a and 24b. Additionally, the air flow channel 26 has such a structure that air is ventilated by vibrations of the diaphragm 22.

**[0030]** Here, the vibrations of the diaphragm 22 bring an increase in a volume of an air vibration chamber 27 formed between the cover 25 and the diaphragm 22. This leads to generating a flow of air in the air flow channel 26. The diaphragm 22 is vibrated with a high frequency (e.g., 490 Hz or 410 Hz), and this vibration is converted to some sounds so that the converted sounds are emitted from the sound output port 25b.

**[0031]** As shown by FIG 2, the resonator 30 is attached on the cover 25 side of the horn body 20. The resonator 30 is provided so as to cover the cover 25 side of the horn body 20. The resonator 30 is formed into a predetermined shape by a resin material such as plastic, and the sounding chamber 31 placed on the axis C of the movable iron core 23 is provided on the cover 25 side and at the center portion of the resonator. This brings ventilation (circulation) of the air between the air vibration chamber 27 and the sounding chamber 31 via the sound output port 25b by the vibrations of the diaphragm 22.

**[0032]** Provided inside the resonator 30 are sound passages 32 (not detailed in the drawing) each formed into a spiral shape. Each of the sound passages 32 forms a passage which the sound generated by the vibrations of the diaphragm 22 passes. Additionally, arranged on an inlet side of each sound passage 32, that is, at a center portion of the spiral shape is the sounding chamber 31 which the sound generated by the vibrations of the diaphragm 22 reaches first. Contrarily, an outlet side of each sound passage 32, that is, a portion closer to an outer periphery of the spiral shape is provided with an outlet opening portion 33 so that the above sound can be emitted outside from the outlet opening portion 33.

**[0033]** Here, each sound passage 32 is formed so as to gradually increase its opening area from a sounding chamber 31 side toward an outlet opening portion 33 side. This brings amplification of a sound pressure level of the sound generated by the vibration of the diaphragm 22 so that a predetermined quantity of loud sound can be emitted.

**[0034]** As shown in FIGS. 2 to 4, housed in the case 21 is a coil bobbin (bobbin) 40 which vibrates the diaphragm 22 by vibrating the movable iron core 23. More specifically, the coil bobbin 40 functions as a vibration generating mechanism (sounding mechanism), and is placed in a space surrounding the case 21 and the diaphragm 22.

**[0035]** The coil bobbin 40 is formed into a predetermined shape by a resin material (insulating material) such as plastic, and includes a small-diameter coil winding portion 41, and a controller mounting portion 42 larger in diameter than the coil winding portion 41. The coil winding portion 41 is housed in the small-diameter containing portion 21b of the case 21, and the controller mounting portion 42 is housed in the large-diameter containing portion 21d of the case 21. That is, the coil winding portion 41 and the controller mounting portion 42 are each provided alongside in an axial direction of the horn body 20 (in an axial direction of the axis C).

**[0036]** Provided radially inside the coil winding portion 41 is the pole 43 serving as a fixed iron core. The pole 43 is formed by cut-working etc. a round bar made of a magnetic material, and has a large-diameter body portion 43a and a male screw portion 43b smaller in diameter than the body portion 43a. The body portion 43a is tightly fixed radially inside the coil winding portion 41 by serration fitting (engagement) etc. (not shown), and the male screw portion 43b penetrates the plate bottom portion 21a and is arranged outside the case 21. Additionally, a base end side of the attachment stay 11 is fixed by a fixation nut 12 (see FIG. 1) onto the male screw portion 43b placed outside the case 21.

**[0037]** Wound around a radial outside of the coil winding portion 41 are the coils 44 each made of a conductive material (conductive wire) and having the predetermined number of windings. That is, the coils 44 are arranged round the pole 43. For those reasons, by supplying a drive current (high current) to the coils 44, the pole 43 provided at a center of the coils 44 becomes an electromagnet, thereby generating a magnetic force (attractive force).

**[0038]** The controller mounting portion 42a includes: an annular body portion 42a formed into a substantially disk shape; and an annular wall portion 42b provided integrally with its circumference and rising in an axial direction (an axial direction of the axis C) of the annular body portion 42a (coil bobbin 40). More specifically, the annular wall portion 42b rises opposite a coil winding portion 41 side of the annular body portion 42a.

**[0039]** Mounted on a annular wall portion 42b side of the annular body portion 42a is a control circuit 50 that supplies a drive current of a predetermined magnitude to the coils 44 at predetermined timing, namely, drives the horn device 10. Additionally, as shown in FIGS. 3 and 4, the annular body portion 42a is fixed to the annular bottom portion 21c (see FIG 2) of the case 21 by caulking a first rivet RV1, a second rivet RV2, and a third rivet RV3 (three in total).

**[0040]** The control circuit 50 includes: an IC (Integrated Circuit) chip 51 formed by a single package component in which a plurality of electronic parts (not shown) are sealed by a sealing material (e.g., epoxy resin); a film capacitor 52 functioning as a surge protection component for protecting the IC chip 52 from a unexpected high current(s); and a resistive element 53 set at a predetermined resistive value. Additionally, those IC chip 51, film capacitor 52, resistive element 53, and coils 44 are electrically connected to one another via each of a plurality of conductive members 54. Incidentally, the IC chip 51 controls a current(s) flowing into the coils 44, and forms a controller (integrated circuit) in the present invention.

**[0041]** The conductive members 54 provided in the bobbin are seven in total as shown in FIG. 8, and are each formed into a predetermined shape by brass etc. excellent in conductivity. Additionally, those conductive members 54 are each provided on the annular body portion 42a by insert molding. Further, each of the three rivets RV1 to RV3 is also formed by brass etc. excellent in conductivity, and has not only a function of fixing the coil bobbin 44 to the case 21 (see FIG 2) but also a function as an electronic component that supplies a drive current(s) etc. to the control circuit 50 from outside the case 21.

**[0042]** Further, the film capacitor 52 and the resistive element 53 form a so-called snubber circuit. Such a "snubber circuit" is incorporated in the control circuit 50, so that transient high voltages (high currents) generated in tuning on/offthe horn switch (not shown) are absorbed to protect the IC chip 51.

**[0043]** Incidentally, in the present embodiment, used as the snubber circuit is a film capacitor 52 whose dielectric is a plastic film and which has a small capacitance change due to temperature and a stable characteristic with high accuracy. Therefore, the IC chip 51 can be protected more certainly. Depending on its specifications, however, some capacitors that, for example, have other forms and are cheaper can be also used.

**[0044]** Additionally, portions of the three rivets KV1 to RV3 each having a function as an electronic component and exposed (arranged) outside the case 21, that is, the other end sides of the three rivets RV1 to RV3 are fixed, as shown in FIG 12, to a connector member 60 provided outside the case 21. Namely, the connector member 60 is fixed to the annular bottom portion 21c of the case 21 by the three rivets RV1 to RV3.

**[0045]** The connector member 60 is made of a resin material such as plastic, and has a connector body 61 formed into a substantially arc shape. The connector body 61 is placed along the annular bottom portion 21c of the case 21. Additionally, the connector body 61 is integrally provided with a connector connection portion 62 to which an external connector (not shown) on a vehicle side is connected. The connector connection portion 62 is opened toward a radial outside of the case 21, thereby making it easy to insert the external connector therein.

**[0046]** A plus (+)-side conductive member and a minus (-)-side conductive member (both are not shown) are buried in the connector member 60 by insert molding. One end (one end portion) of each conductive member is exposed inside the connector connection portion 62, and the other end (the other end portion) of each conductive member is electrically connected to each of the first and second rivets RV1 and RV2 via the connector body 61. More specifically, the plus-side conductive member is connected to the first rivet RV1, and the minus-side conductive member is connected to the second rivet RV2.

**[0047]** Here, the conductor portion is not connected to the third rivet RV3 unlike the first and second rivets RV1 and RV2. Instead of this, as shown in FIG 12, an adjuster wiring L3 of an adjuster AD (a check terminal of the adjuster AD) may be electrically connected directly to the third rivet RV3. That is, the third rivet RV3 is used for communication between the IC chip 51 and the adjuster AD serving as an external device. Incidentally, the adjuster AD is a device for correcting variations in a sounding frequency per production of the horn device 10 due to manufacturing error etc. A concrete method of adjusting the sounding frequency by using the adjuster AD will be described later.

**[0048]** As shown in FIG. 5, the IC chip 51 forming a control circuit 50 supplies a drive current with a predetermined frequency to the coils 44. This brings generation of a magnetic force around the coils 44 (pole 43) at a predetermined frequency, which causes the movable iron core 23 to be vibrated at a predetermined frequency. Therefore, the diaphragm 22 is also vibrated at a predetermined frequency, and a volume of the air vibration chamber 27 (see FIG. 2) formed between the cover 25 and the diaphragm 22 is increased or decreased, so that a flow of air is generated in the air flow chamber 26. Thus, since the diaphragm 22 vibrates at the predetermined frequency, the vibration becomes (is changed into) sound, so that the sound is emitted toward the sounding chamber 31 through (from) the air flow chamber 26.

**[0049]** Provided in the IC chip 51 are a control unit 51 a, a drive unit 51b, a temperature measurement unit 51c, a current measurement unit 51d, and a storage unit 51e. Additionally, as shown in FIGS. 3 and 5, a power supply device BT is electrically connected, via the conductive members 54 and the first and second rivets RV1 and RV2, to each of two or three of a plurality of terminals T1 provided to the IC chip 51.

**[0050]** Additionally, as shown in FIG. 3, the coils 44 are electrically connected to other terminal T1 of the plural terminal T1 via the conductive member 54, film capacitor 52, and resistive element 53. Further, as shown in FIGS. 3 and 5, the adjuster AD is electrically connected to yet another terminal T1 of the plural terminals T1 via the conductive member 54 and the third rivet RV3.

**[0051]** Incidentally, the IC chip 51 of the present embodiment becomes a package component having a so-called SIP (Single Inline Package) structure in which the plural terminals T1 are provided alongside in a line on one side of a package.

**[0052]** As shown in FIG. 5, the control unit 51a outputs a PWM (Pulse Width Modulation) signal SP to the drive unit 51b, so that the drive unit 51b supplies a predetermined-frequency drive current to the coils 44. Therefore, the diaphragm 22 is vibrated at a predetermined frequency. Here, the control unit 51a is configured to adjust (correct) a duty cycle (ratio) of the PWM signal PS depending on atmosphere temperature of the IC chip 51 and/or magnitude of a current flowing in the coils 44.

**[0053]** Incidentally, the drive unit 51b converts, to an alternating current, a direct current from the power supply device BT based on the PWM signal from the control unit 51a so as to output the converted AC current (drive current) to the coils 44.

**[0054]** The temperature measurement unit 51c is a unit for measuring ambient temperature (atmosphere temperature) of the horn device 10, and is formed by an NTC (Negative Temperature Coefficient) thermistor etc., for example, whose resistive value decreases depending on a rise in the atmosphere temperature. Additionally, the temperature measurement unit 51c outputs data T on the measured temperatures to the control unit 51a. Thereafter, the control unit 51a refers to a temperature correction map (not shown) previously stored in the storage unit 51e based on the temperature data T from the temperature measurement unit 51c. Next, the control unit 51a obtains, from the temperature correction map, a duty cycle corresponding to the inputted temperature data T, and outputs, to the drive unit 51b, the PWM signal PS having the duty cycle.

**[0055]** Thus, the IC chip 51 corrects the PWM signal PS depending on the atmosphere temperature, and such correction is made for preventing a frequency of sound from being changed, the sound being emitted from the horn device 10 by variation in the atmosphere temperature. That is, the horn device 10 according to the present invention can emit constant-frequency sound regardless of high or low atmosphere temperature.

**[0056]** The current measurement unit 51d measures a current value I flowing in the coils 44, and outputs the measured current value I to the control unit 51a. The current measurement unit 51d has shunt resistance (not shown) provided in a channel of the current flowing in the coils 44, and is formed by a current measurement circuit for measuring the current value I from a voltage difference between both ends of the shunt resistance.

**[0057]** Additionally, the control unit 51a refers to a current correction map (not shown) previously stored in the storage unit 51e based on the current value I from the current measurement unit 51d. Then, the control unit 51a obtains, from the current correction map, a duty cycle corresponding to the inputted current value I, and outputs, to the drive unit 51b, the PWM signal PS having the duty cycle.

**[0058]** Thus, the IC chip 51 corrects the PWM signal PS depending on the current value I flowing in the coils 44, and such correction is made for suppressing an in-

crease in the current value I flowing in the coils 44 as the atmosphere temperature becomes low. This brings, even when the atmosphere temperature is low, suppression of the increase in the current value I flowing in the coils 44, and prevention of collision with the movable iron core 23 and the pole 43, so that the generation of collision noise (abnormal noise) can be effectively suppressed.

**[0059]** Incidentally, the power supply device BT is a vehicle mounted battery (12 V), and supplies not only a drive current (low current) to the IC chip 51 but also a drive current (high current) to the coils 44. Here, used in the power supply device BT can be a secondary battery such as a nickel hydride battery or lithium-ion battery. Further, an electric double layer capacitor (capacitor) etc. can be also used instead of the secondary battery.

**[0060]** Next, a mounting structure of the control circuit 50 onto the controller mounting portion 42 will be detailed with reference to the drawings.

**[0061]** As shown in FIGS. 3, 6, and 7, the control circuit 50 is mounted on the controller mounting portion 42 of the coil bobbin 40. More specifically, the IC chip 51, film capacitor 52, and resistive element 53 forming the control circuit 50 are respectively fixed to the a first fixation portion FX1, second fixation portion FX2, and third fixation portion FX3 each provided integrally with the annular body portion 42a.

**[0062]** Those first to third fixation portions FX1 to FX3 are each formed into a substantially box shape, and the IC chip 51, film capacitor 52, and resistive element 53 are respectively housed in the first to third fixation portions FX1 to FX3 without any play. Incidentally, in order to certainly prevent the IC chip 51, film capacitor 52, and resistive element 53 from playing in the first to third fixation portions FX1 to FX3, application of adhesive thereto is desirable.

**[0063]** Additionally, as shown in FIG. 3, the IC chip 51 (first fixation portion FX1) and the film capacitor 52 (second fixation portion FX2) are centered about the axis C and arranged opposite each other. That is, the IC chip 51 and the film capacitor 52 are arranged opposite each other so as to center the movable iron core 23 and the pole 43 (see FIG. 2), so that the IC chip 51 and the film capacitor 52 are provided on the annular body portion 42a with good balance. More specifically, by regarding the axis C as a center, weight balance of the coil bobbin 40 is made good.

**[0064]** Additionally, as shown in FIG 6, when the coil bobbin 40 is viewed from a direction (arrow A direction) intersecting its axial direction under a state of fixing the IC chip 51 to the first fixation portion FX1, the IC chip 51 is overlapped on (over) the annular wall portion 42b. That is, when the coil bobbin 40 is viewed from the arrow A direction in the drawing, the IC chip 51 is hidden (covered) by the annular wall portion 42b. Incidentally, FIG 6 shows a state of detaching the resonator 30 from the horn body 20.

**[0065]** Consequently, even if the temperature of the coils 44 becomes high by driving the horn device 10 for a long time, heat HT generated by the coils 44 at this time is transmitted to the case 21 as shown by thick-line arrows in the drawing. Then, the heat is radiated outside from the caulking fixation portion 25a of the cover 25. At this time, the IC chip 51 is blocked by the annular wall portion 42b with respect to the case 21, so that it is difficult to transmit, as shown by a thick-broken-line arrow, the heat HT transmitted into the case 21. Therefore, it becomes difficult for the heat HT to reach the IC chip 51, and it is suppressed that the IC chip 51 is heated by the heat HT generated from the coils 44. Therefore, damages and/or malfunction etc. of the IC chip 51 due to the heat are certainly prevented.

**[0066]** Here, the IC chip 51 and the coils 44 inside the case 21 are arranged closer to one another. However, the annular body portion 42a is interposed between the IC chip 51a and each of the coils 44. Since the annular body portion 42a is formed by a resin material such as plastic, it is lower in thermal conductivity than the metal case 21. Therefore, it is suppressed that the heat HT of the coils 44 is transmitted to the IC chip 51 via the annular body portion 42a.

**[0067]** As shown in FIGS. 7A to 7C, end portions of the plural conductive members 54 are exposed from near the first to third fixation portions FX1 to FX3 on the annular body portion 42a. Additionally, respectively electrically connected to those end portions of the conductive members 54 are: terminals T1 provided to the IC chip 51; leg portions (terminals) T2 provided to the film capacitor 52; and lead lines T3 provided to the resistive element 53.

**[0068]** As shown in FIG. 7A, placement portions (extension portions) 54a bent and extended in a radial direction of the annular body portion 42a are integrally provided to the conductive members 54 exposed from near the first fixation portion FX1, respectively. More specifically, each tip side of the plural placement portions 54a is directed toward a central side of the coil bobbin 40. In other words, each bending direction of the plural placement portions 54a is directed toward the axis C (see FIG 3).

**[0069]** The terminals T1 of the IC chip 51 are placed on the plural placement portions 54a. More specifically, by housing the IC chip 51 in the first fixation portion FX1, each terminal T1 of the IC chip 51 is placed on each of the plural placement portions 54a. Consequently, the terminals T1 and the conductive members 54 are mutually positioned so as to be able to facilitate electrical connection (laser weld described later) between both (assembility improvement).

**[0070]** Incidentally, an amount of adhesive to be applied between the IC chip 51 and the first fixation portion FX1 is regulated to such a degree that no gap is formed between each terminal T1 and each placement portion 54a when the IC chip 51 is housed in the first fixation portion FX1.

**[0071]** Additionally, as shown in FIG 7A, a height dimension of a weld portion (deposition portion) to the annular body portion 42a is set at a reference symbol "h1"

regarding all of the terminals T1 and placement portions 54a to be paired. Here, the weld portion is a portion in which each terminal T1 and each placement portion 54a are melted and integrated with each other and, in the present embodiment, becomes a focus of a laser beam LS (see FIG. 10) of a laser welder (not shown).

**[0072]** As shown in FIG. 7B, the opening portions 54b opened in an axial direction (in an extension direction of the axis C) of the annular body portion 42a are integrally provided in the conductive members 54 exposed from near the second fixation portion FX2. Additionally, the leg portions T2 of the film capacitor 52 are inserted into those opening portions 54b in the extension direction (upside in the drawing) of the axis C.

**[0073]** More specifically, by housing the film capacitor 52 in the second fixation portion FX2, each of the leg portions T2 of the film capacitor 52 is configured to enter each of the opening portions 54b. Consequently, the leg portions T2 and the conductive members 54 are mutually positioned so as to be able to facilitate electrical connection between both.

**[0074]** Incidentally, an amount of adhesive to be applied between the film capacitor 52 and the second fixation portion FX2 is also regulated to such a degree that each leg portion T2 and each opening portion 5 can contact with each other without any gap when the film capacitor 52 is housed in the second fixation portion FX2.

**[0075]** Additionally, as shown in FIG 7B, a height dimension of the weld portion to the annular body portion 42a is set at a reference symbol "h2" regarding all of the leg portions T2 and opening portions 54b to be paired. Here, the weld portion is, similarly to the above, a portion in which each leg portion T2 and each opening portion 54b are melted and integrated with each other and, in the present embodiment, becomes a focus of the laser beam LS (see FIG. 10) of the laser welder.

**[0076]** As shown in FIG. 7C, the opening portions 54c opened in the axial direction (in the extension direction of the axis C) of the annular body portion 42a are integrally provided in the conductive members 54 exposed from near the third fixation portion FX3, respectively. Additionally, the lead lines T3 of the resistive element 53 are respectively inserted into those opening portions 54c from the extension direction (upside in the drawing) of the axis C.

**[0077]** More specifically, by housing the resistive element 53 in the third fixation portion FX3, each of the lead lines T3 of the resistive element 53 enter each of the opening portions 54c. Consequently, each lead line T3 and each conductive member 54 are mutually positioned so as to be able to facilitate electrical connection between both.

**[0078]** Incidentally, an amount of adhesive to be applied between the resistive element 53 and the third fixation portion FX3 is also regulated to such a degree that each lead line T3 and each opening portion 54c can contact with each other without any gap when the resistive element 53 is housed in the third fixation portion FX3.

**[0079]** Additionally, as shown in FIG 7C, a height dimension of the weld portion to the annular body portion 42a is set at a reference symbol "h3" regarding all of the lead lines T3 and opening portions 54c to be paired. Here, the weld portion is, similarly to the above, a portion in which each lead line T3 and each opening portion 54c are melted and integrated with each other and, in the present embodiment, becomes a focus of the laser beam LS (see FIG. 10) of the laser welder.

**[0080]** Here, all of the height dimensions h1 to h3 of the respective weld portions from the annular body portion 42a are set to have the same height dimension (h1 = h2 = h3). That is, the terminals T1 of the IC chip 51, the leg portions T2 of the film capacitor 52, and the lead lines T3 of the resistive element 53 are respectively provided at positions having the same height along the axial direction of the coil bobbin 40.

**[0081]** Consequently, when each weld portion is laser-welded, a base (not shown) of the laser welder can be controlled (X-Y controlled) only in a two-dimensional plane without controlling the focus of the laser beam LS, so that simplicity of control logic about the laser welder can be achieved.

**[0082]** Additionally, since all of the height dimensions h1 to h3 of the respective weld portions from the annular body portion 42a are set at the same height dimension, connection strength of the respective weld portions can be everywhere made the same value. Therefore, variations in the connection strength of the respective weld portions are suppressed, and improvement of reliability becomes possible.

**[0083]** Further, as shown in FIGS. 3, 7A, and 7B, a connection portion between each terminal T1 of the IC chip 51 and each placement portion 54a, and a connection portion between each leg portion T2 of the film capacitor 52 and each opening portion 54b are arranged closer to a center of the annular body portion 42a (coil bobbin 40). This makes an operating range of the base of the laser welder narrow. Therefore, it can be achieved to make an assembly time short.

**[0084]** Next, an assembly procedure (manufacturing method) of the horn device 10 (see FIG. 2) that has been formed as mentioned above will be detailed with reference to the drawings.

[Insert Molding Step]

**[0085]** Firstly, as shown in FIG 8A, prepared are the plural conductive members 54 (seven in total) previously manufactured by other manufacturing step(s). Next, as shown by an arrow M1, the plural conductive members 54 are each arranged (fixed) at (to) a predetermined place of a concave portion 71 (not shown in detail) in a lower mold 70 forming an injection molding apparatus (not shown).

**[0086]** Then, the injection molding apparatus is driven, and an upper mold 72 is descended onto the lower mold 70. Consequently, as shown in FIG. 8B, the lower mold

70 and the upper mold 72 are confronted with each other. The upper mold 72 is then cohered onto the lower mold 70, and a cavity (not shown), which forms the coil bobbin 40 (see FIGS. 3 and 4), is formed in the cohered molds.

**[0087]** Next, a melted resin (not shown) is supplied, as shown by an arrow M2, to a supply passage(s) (not shown) formed in the upper mold 72 and communicating with the cavity. At this time, the melted resin is supplied, with predetermined pressure, from a dispenser 73 of the injection molding apparatus. Thus, by pressure-feeding the melted resin to the cavity, the melted resin evenly spreads everywhere over an inside of the cavity. Therefore, no bubbles etc. are generated in the coil bobbin 40, and the coil bobbin 40 can be formed with high accuracy.

**[0088]** Consequently, the coil bobbin 40 in which the plural conductive members 54 are inserted (buried) is completed, and an insert molding step ends. Incidentally, detaching work (demolding work) of the completed coil bobbin 40 from the lower mold 70 and the upper mold 72 is done after the coil bobbin 40 is sufficiently cooled and hardened.

[Component Attaching Step]

**[0089]** Next, as shown in FIG 9, the coil bobbin 40 obtained by completing the insert molding step is prepared, and the IC chip 51, film capacitor 52, resistive element 53, and first to third rivets RV1 to RV3 to be mounted on the controller mounting portion 41 are prepared. Further, the pole 43 and coils 44 to be attached to the coil winding portion 41 are prepared.

**[0090]** Additionally, firstly, as shown by an arrow M3, the first and third rivets RV1 to RV3 are attached to predetermined places from a side (upside in the drawing) opposite to the coil winding portion 41 side along the axial direction of the coil bobbin 40. Consequently, one end side of each of the first to third rivets RV1 to RV3 is electrically connected to each of the conductive members 54.

**[0091]** Here, the third rivet RV3 configures a fixing metal fixture of the present invention, and is attached inside the first fixation portion FX1. For this reason, when the coil bobbin 40 is viewed from its axial direction (in an arrow B direction) as shown in FIG 10, the third rivet RV3 is overlapped on the IC chip 51. Thus, by attaching the third rivet RV3 into the first fixation portion FX1 having a relatively large space, downsizing of the horn device 10 is realized.

**[0092]** Additionally, since the IC chip 51 can be arranged closer to the third rivet RV3 than to the other first and second rivets RV1 and RV2, shortening of the conductive member 54 (for the adjuster AD as shown in FIG 12) between the third rivet RV3 and the IC chip 51 can be realized.

**[0093]** Next, as shown in an arrow M4, the IC chip 51, film capacitor 52, and resistive element 53 are housed in the first to third fixation portions FX1 to FX3, respectively. At this time, adhesive is previously applied thinly to the first to third fixation portions FX1 to FX3.

**[0094]** By doing so, as shown in FIGS. 7A to 7C, positioning of the IC chip 51, film capacitor 52, and resistive element 53 to controller mounting portion 42 (annular body portion 42a) is completed. Additionally, as shown in FIGS. 7A to 7C, the terminals T1 of the IC chip 51 are respectively arranged at the placement portions 54a; the leg portions T2 of the film capacitor 52 respectively enter the opening portions 54b; and the lead lines T3 of the resistive element 53 respectively enter the opening portions 54c.

**[0095]** Further, as shown by an arrow M5, the body portion 43a of the pole 43 is fixed radially inside the coil winding portion 41 (see FIGS. 2 and 4) by serration fitting. Moreover, as shown by an arrow M6, the coils 44 are wound radially outside the coil winding portion 41.

**[0096]** Thus, the IC chip 51, film capacitor 52, resistive element 53, and the first to third rivets RV1 to RV3 are attached onto controller mounting portion 42, and the pole 43 and coils 44 are attached onto the coil winding portion 41, as a result of which a component attaching step ends.

[Laser Depositing Step]

**[0097]** Next, as shown in FIG 10, the coil bobbin 40 obtained by ending the electronic component attaching step is prepared, and the prepared coil bobbin 40 is set on the base (not shown) of the laser welder. At this time, the electronic components such as the IC chip 51 etc. mounted on the controller mounting portion 42 are directed toward a laser nozzle LN side of the laser welder.

**[0098]** Here, the laser welder includes: a base (X-Y table) on which the coil bobbin 40 as a workpiece is set and that is moved in directions of arrows M7 and M8; a laser nozzle LN placed above the base; and a control panel (not shown) controlling them.

**[0099]** Additionally, by driving the laser welder through predetermined control logic, the base on which the coil bobbin 40 is set is moved in the directions of the arrows M7 and M8, and a laser beam LS is radiated from the laser nozzle LN toward the plural weld portions in sequence with predetermined timing.

**[0100]** After the irradiation, the terminals T1 of the IC chip 51 and the placement portions 54a (see FIG 7A) of the conductive member 54 are melted and integrated; the leg portions T2 of the film capacitor 52 and the opening portions 54b of the conductive member 54 are melted and integrated (deposited); and the lead lines T3 of the resistive element 53 and the opening portions 54c (see FIG 7) of the conductive member 54 are melted and integrated (deposited).

**[0101]** Thus, the electronic components such as the IC chip 51 etc. mounted on the controller mounting portion 42 are electrically connected to one another, and the control circuit 50 is formed on the controller mounting portion 42, as a result of which a laser depositing step ends.

[Assembling Step]

**[0102]** Next, as shown in FIG. 11, the coil bobbin 40 obtained by completing the laser depositing step, and the case 21 manufactured by other manufacturing process are prepared, and the coil bobbin 40 is housed in the case 21 as shown by an arrow M9. At this time, the coil winding portion 41 (see FIG. 4) are housed in the small-diameter containing portion 21b, and the controller mounting portion 42 is housed in the large-diameter containing portion 21d.

**[0103]** Next, each end portion (see FIG 4) of the first to third rivets RV1 to RV3 each protruding outside the case 21 from the annular bottom portion 21c of the case 21 is caulked by using a caulking jig (not shown). Consequently, the coil bobbin 40 is fixed to the case 21 and, as shown in FIG. 12, the first to third rivets RV1 to RV3 are electrically connected to the connector member 60.

**[0104]** Then, as shown in FIG 2, the diaphragm 22 and cover 25 are attached to the case 21 so as to block (cover) its opening portion 21e, and an outer peripheral portion of the cover 25 is caulked by using a caulking jig (not shown). Consequently, the annular caulking fixation portion 25a is formed, and assembling of the horn body 20 is completed.

**[0105]** Next, the resonator 30 manufactured by another manufacturing process is prepared and, as shown in FIG 2, the prepared resonator 30 is assembled to the horn body 20. Consequently, assembling of the horn device is completed, and an assembling step ends.

[Frequency Adjusting Step]

**[0106]** Next, as shown in FIG 12, the completed horn device 10 is prepared, and the adjuster AD is connected to the prepared horn device 10. More specifically, a pair of power supply lines L1 and L2 of the adjuster AD are connected to the connecter connection portion 62, and an adjuster wiring L3 of the adjuster AD is connected to the third rivet RV3 exposed outside the case 21. Further, a microphone MC of the adjuster AD is set at the front of the horn device 10.

**[0107]** Additionally, the adjuster AD is actuated to sound the horn device 10. After the sounding, the adjuster AD picks up a sounding frequency of the then horn device 10 with the microphone MC, thereby grasping a state of the before-adjusted horn device 10.

**[0108]** Next, if there is any difference ($A \neq B$) between a sounding frequency (AHz) to be targeted and the actual sounding frequency (BHz) picked up by the microphone MC, the adjuster AD outputs a correction signal(s) to the IC chip 51 (see FIG. 5) via the adjuster wiring L3. After the output of the signal, the IC chip 51 varies a vibration frequency of the diaphragm 22 so as to generate the targeted sounding frequency (AHz) based on the correction signal from the adjuster AD.

**[0109]** Then, if judging that the targeted sounding frequency (AHz) and the actual sounding frequency (BHz) picked up by the microphone MC become the same frequency ($A \approx B$), the adjuster AD causes a correction signal (target drive signal) sounding the varied vibration frequency to be stored in the storage unit 51e (see FIG. 5) of the IC chip 51.

**[0110]** Consequently, the sounding frequency of the horn device 10 is adjusted, and a frequency adjusting step (final finish step) ends. Additionally, the horn device 10 whose sounding frequency has been adjusted is driven at a target drive signal by the IC chip 51 under a state of being mounted onto the vehicle, and sounds with substantially the same sounding frequency as the targeted sounding frequency. Therefore, improvement of reliability becomes possible by eliminating manufacturing error etc. of the components configuring the horn device 10, for example, eliminating variations in the sounding frequency per product due to a difference etc. between caulking degrees of the caulking fixation portion 25a.

**[0111]** As detailed by the above, the horn device 10 according to embodiment 1 includes the third rivet RV3 whose one end side is connected to the conductive member 54, whose other end side is exposed outside the case 21, and which fixes the coil bobbin 40 to the case 21, and this third rivet RV3 is used for communication between the IC chip 51 and the adjuster AD. Consequently, since an increase in the number of components is suppressed and a structure of the horn device is made uncomplicated, it becomes possible to communicate with the IC chip 51 in the horn device from outside without taking apart the horn device 10.

**[0112]** Therefore, even when the horn device 10 does not sound for any reasons, it becomes possible to quickly and easily confirm from outside whether the IC chip 51 operates normally. Thus, the horn device 10 excellent in maintainability can be realized.

**[0113]** Additionally, the horn device 10 according to embodiment 1 makes it possible to shorten the conductive member 54 connecting the IC chip 51 and the third rivet RV3 since the IC chip 51 and the third rivet RV3 overlap with each other at a time of viewing the coil bobbin 40 from its axial direction. Therefore, reduction in size and weight of the horn device 10 can be realized. In other words, by providing the third rivet RV3, the horn device 10 can avoid being enlarged.

**[0114]** Next, embodiment 2 according to the present invention will be detailed with reference to the drawings. Incidentally, the same reference numerals are given to portions having similar functions to those described in embodiment 1, and their detailed explanation will be omitted.

**[0115]** FIG 13 shows a perspective view illustrating one portion of a horn device according to embodiment 2.

**[0116]** As shown in FIG 13, a horn device 80 according to embodiment 2 is different from the horn device (see FIG 12) according to embodiment 1 in a shape of a connector member 81 provided outside the case 21. More specifically, inside a connector body 82 of the connector member 81 forming the horn device 80, an adjustment

conductive member (communication conductive member) 85 is also buried (embedded) by insert molding in addition to a plus-side conductive member (power supply conductive member) 83 and a minus-side conductive member (power supply conductive member) 84.

**[0117]** Here, the plus-side conductive member 83 and the minus-side conductive member 84 are members for supplying a drive current(s) to the IC chip 51. Further, the adjustment conductive member 85 is a member used for communication with the IC chip 51.

**[0118]** Additionally, one end (one end portion) of each of the three conductive members 83 to 85 is exposed inside the connector connection portion 86, and a vehicle-side exterior connector (not shown) is connected also to this connector connection portion 86. Further, the other ends (other end portions) of the three conductive members 83 to 85 are electrically connected to the first to third rivets RV1 to RV3, respectively. That is, in embodiment 2, the conductive member (adjustment conductive member 85) is provided between the third rivet RV3 and the connector connection portion 86 outside the case 21.

**[0119]** Incidentally, the conductive members 54 are provided between each of the first to third rivets RV1 to RV3 and each of the terminals T1 (see FIG 3) of the IC chip 51 similarly to the horn device 10 according to embodiment 1.

**[0120]** Although the one end of each of the three conductive members 83 to 85 is exposed inside the connector connection portion 86, tip portions (one ends) of the plus-side conductive member 83 and the minus-side conductive member 84 and a tip portion (end portion) of the adjustment conductive member 85 are spaced a predetermined distance S apart with respect to an insertion direction of the connector connection portion 86.

**[0121]** Incidentally, depth of insertion of the vehicle-side exterior connector (not shown) into the connector connection portion 86 is made equal to a dimension D in the insertion direction of the connector connection portion 86. Additionally, the tip portions of the plus-side conductive member 83 and the minus-side conductive member 84 are each arranged, as shown in FIG. 13, within a range of the dimension D. In contrast, the tip portion of the adjustment conductive member 85 is arranged outside the range of the dimension D.

**[0122]** That is, the tip portion of the adjustment conductive member 85 is arranged at a further deep place (position) from a bottom portion of the connector connection portion 86. In other words, the tip portion of the adjustment conductive member 85 is arranged at a further deeper place in the connector connection portion 86 than the tip portions of the plus-side conductive member 83 and the minus-side conductive member 84.

**[0123]** Consequently, the vehicle-side exterior connector does not contact with the tip portion of the adjustment conductive member 85, and contacts only with the tip portions of the plus-side conductive member 83 and the minus-side conductive member 84 so as to be electrically connected to them.

**[0124]** Meanwhile, the adjuster AD (see FIG. 12) is provided with a dedicated connector (not shown) that can be electrically connected to all (three in total) of the tip portions of the plus-side conductive member 83 and minus-side conductive member 84 and the tip portion of the adjustment conductive member 85. More specifically, collected in a connector of the adjuster AD are the respective end portions of the pair of power supply lines L1 and L2 and the adjuster wiring L3 (see FIG 12).

**[0125]** Additionally, by simply inserting the connector of the adjuster AD into the connector connection portion 86, the preparation for the above frequency adjusting step is completed. Namely, embodiment 1 needs such two preparation operations that the paired power supply lines L1 and L2 of the adjuster AD are connected to the connector connection portion 62 and then the adjuster wiring L3 of the adjuster AD is connected to the third rivet RV3 exposed outside the case 21. In contrast, embodiment 2 does with only an insertion operation (one preparation operation) of the connector of the adjuster AD into the connector connection portion 86.

**[0126]** The horn device 80 according to embodiment 2, which has been formed as mentioned above, can also obtain the similar operations and effects to those of the horn device 10 according to embodiment 1 as described above.

**[0127]** In addition to those, embodiment 2 has a structure in which: the connector connection portion 86 to be connected to the exterior connector is provided outside the case 21; the end portions of the plus-side and minus-side conductive members 83 and 84 supplying a drive current(s) to the IC chip 85 and the adjustment conductive member 85 used for communication with the IC chip 51 are exposed inside the connector connection portion 86; and the end portion of the adjustment conductive member 85 is placed on a deeper side of the connecter connection portion 86 than the end portions of the plus-side and minus-side conductive members 83 and 84.

**[0128]** Therefore, while the normal vehicle-side exterior connector can be inserted, the dedicated connector provided to the adjuster AD can be also inserted, as a result of which the frequency adjusting step for adjusting the sounding frequency can be made more simplified.

**[0129]** The present invention is not limited to the above embodiments and, needless to say, can be variously altered and modified within a range not departing from the gist thereof. For example, each of the above embodiments indicates the horn device to be mounted on a vehicle such as an automobile. However, the present invention is not limited to this, and can be applied also to horn devices of railroad vehicles, vessels, and construction machines, etc.

**[0130]** Additionally, each of the above embodiments indicates the horn device having the resonator 30 with a spiral type horn. However, the present invention is not limited to this, and has no resonator and is applicable also to a flat type horn that causes a movable iron core and a fixed iron core to collide with each other at a pre-

determined frequency to generate collision sound.

**[0131]** Besides, a material (quality of material), a shape, a dimension, the number, and a setting place, etc. of each component configuring each of the above embodiments can be set arbitrarily as long as being capable of achieving the present invention, and are not limited to the above embodiments.

## Claims

**1.** A horn device comprising:

a case, its one side being closed and its other side being opened;
a diaphragm closing an opening portion of the case;
a movable iron core attached to the diaphragm;
a bobbin housed in the case, a coil being wound radially outside the bobbin;
a fixed iron core provided radially inside the bobbin and generating a magnetic force for attracting the movable iron core;
a controller provided to the bobbin and controlling a current flowing in the coil;
a conductive member provided to the bobbin and connected to the controller; and
a fixing metal fixture, its one end side being connected to the conductive member, its other end side being exposed outside the case, and the fixing metal fixture fixing the bobbin to the case,
wherein the fixing metal fixture is used for communication between the controller and an exterior device.

**2.** The horn device according to claim 1,
wherein when the bobbin is viewed from its axial direction, the controller and the fixing metal fixture are overlapped.

**3.** The horn device according to claim 1 or 2,
wherein a connector connection portion to be connected to an exterior connector is provided outside the case,
an end portion of a power supply conductive member supplying a drive current to the controller, and an end portion of a communication conductive member used for communication with the controller are exposed inside the connector connection portion, and
the end portion of the communication conductive member is arranged on a deeper side of the connector connection portion than the end portion of the power supply conductive member.

FIG. 1

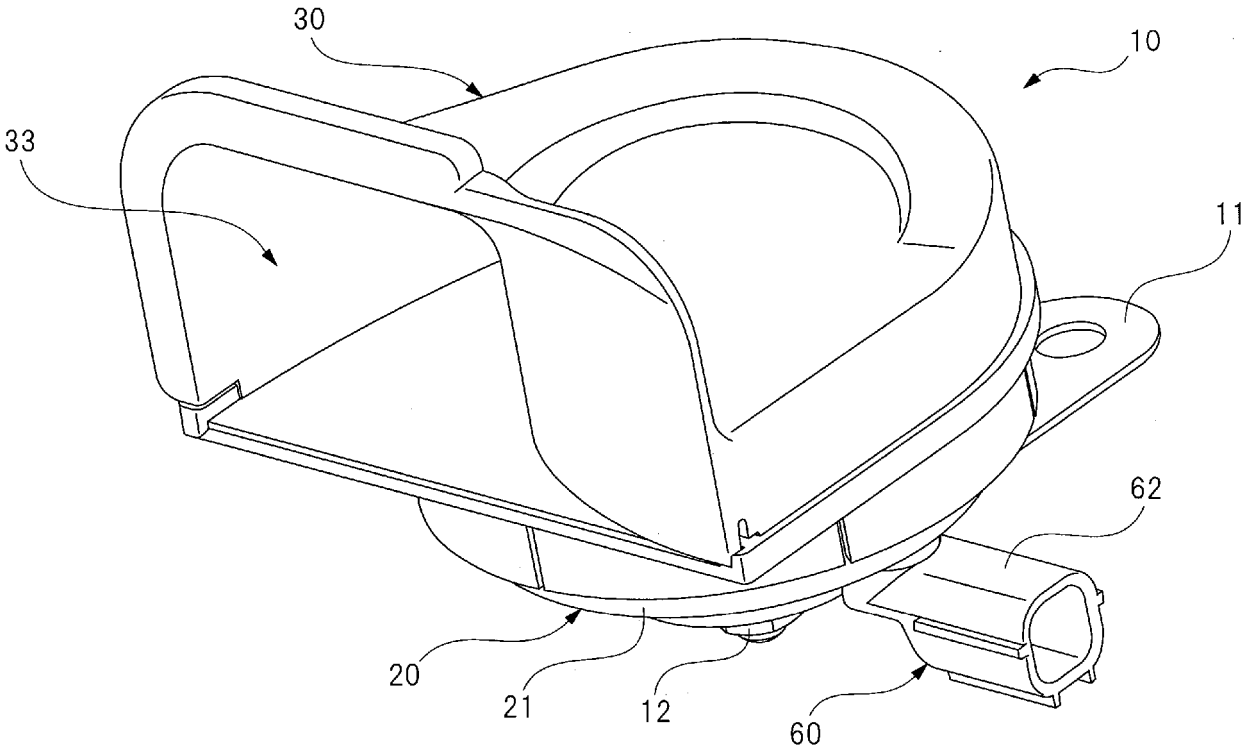
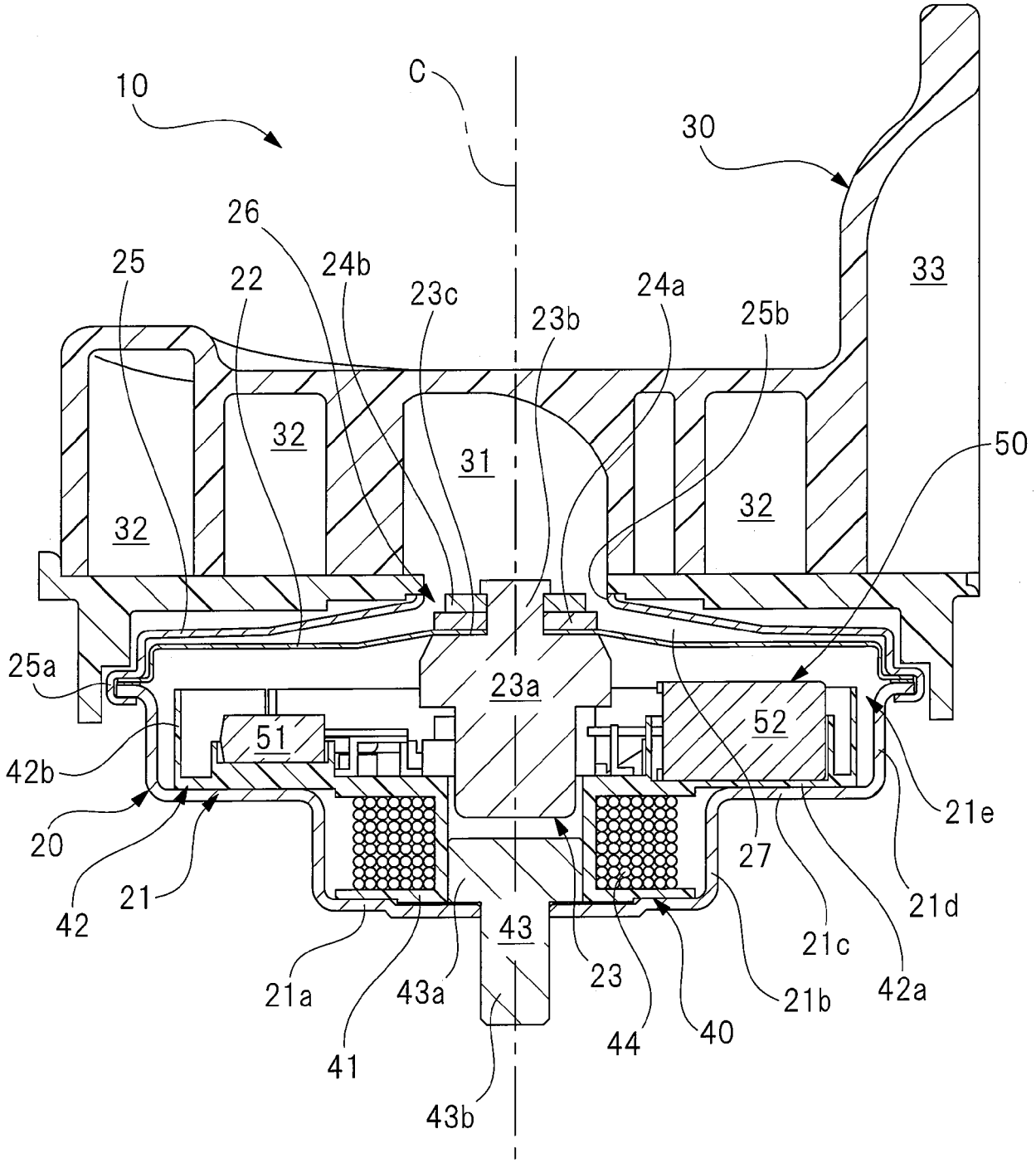


FIG. 2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42b
20
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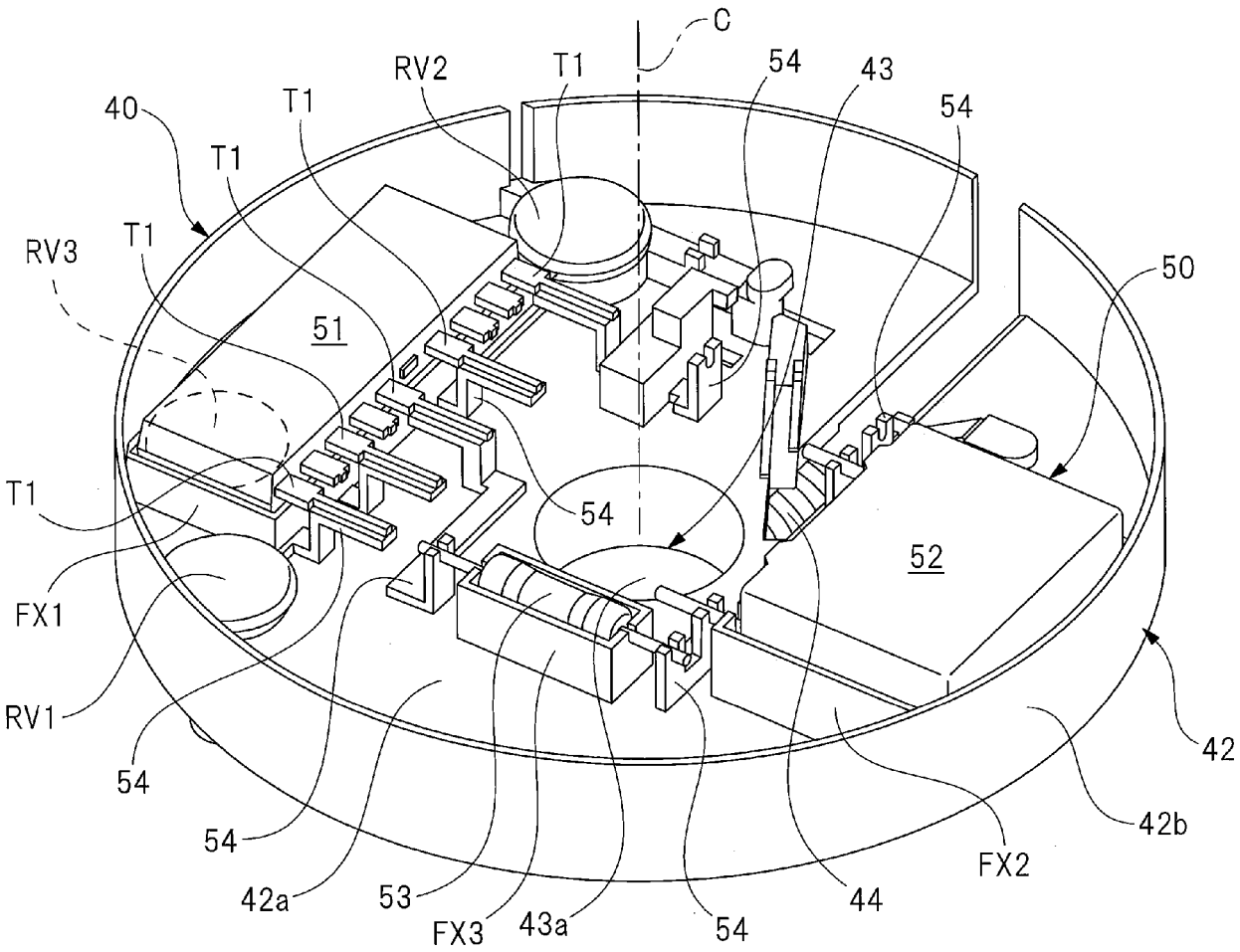
21c
21d
21e
42a

FIG. 3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54
40
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RV3
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50
T1
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FX3
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54
44
FX2
42b
42

FIG. 4

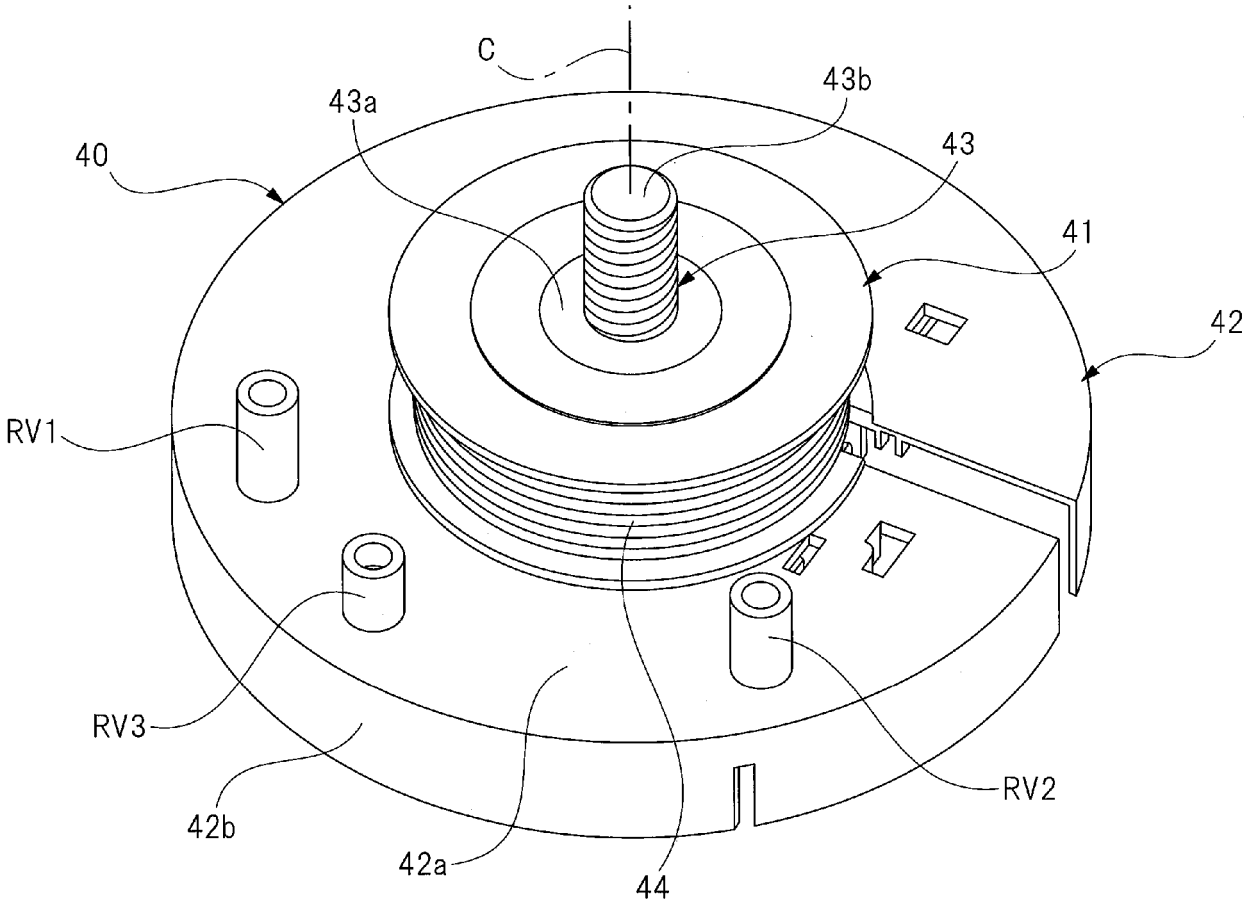
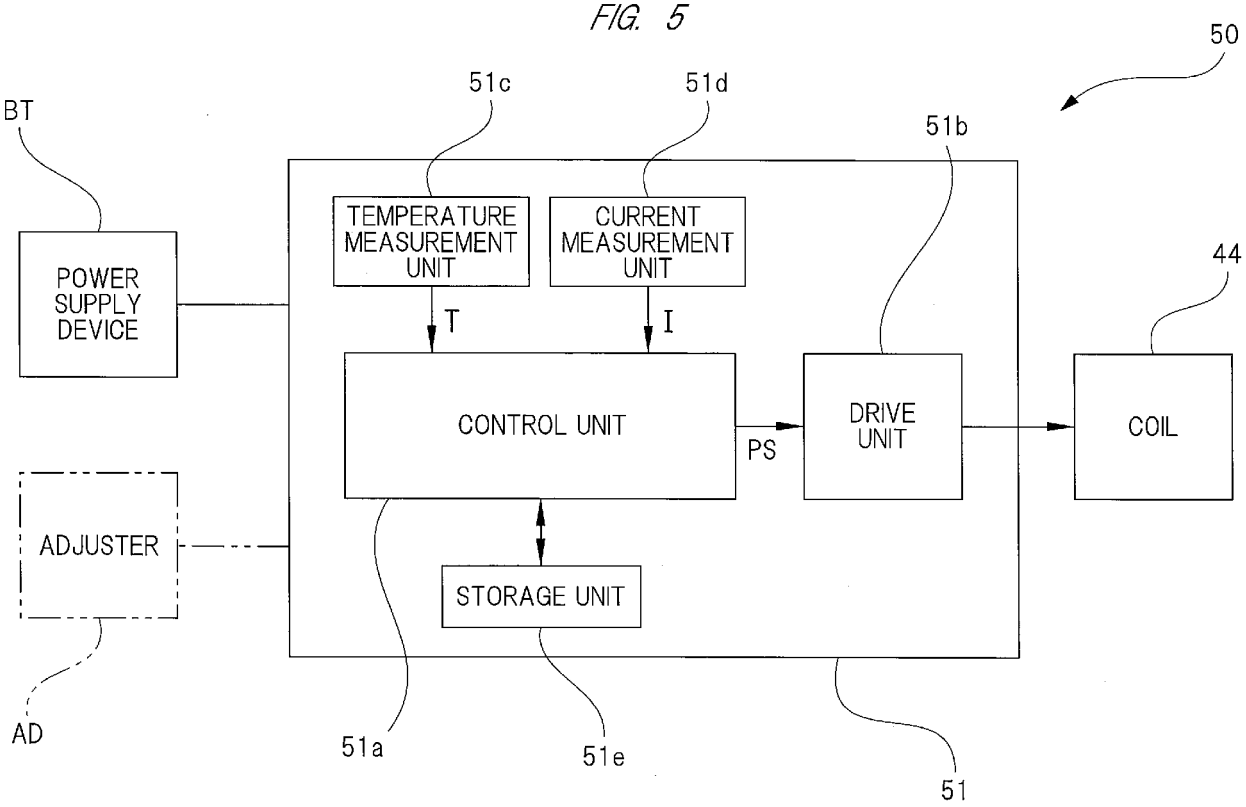


FIG. 5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51c
51d
51b
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CURRENT MEASUREMENT UNIT
44
POWER SUPPLY DEVICE
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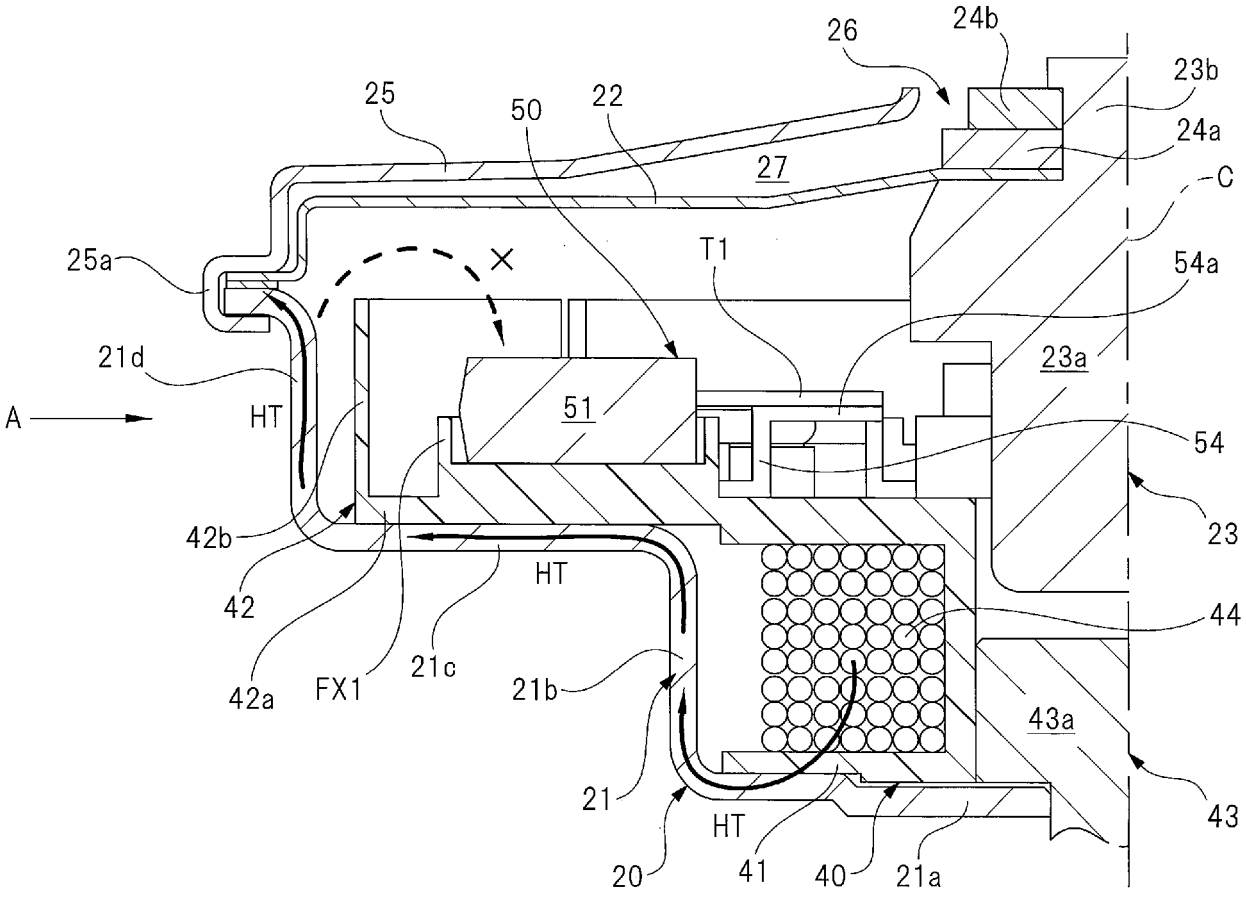
CONTROL UNIT
DRIVE UNIT
COIL
PS
ADJUSTER
STORAGE UNIT
AD
51a
51e
51

FIG. 6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FX1
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HT
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20
41
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21a

FIG. 7A

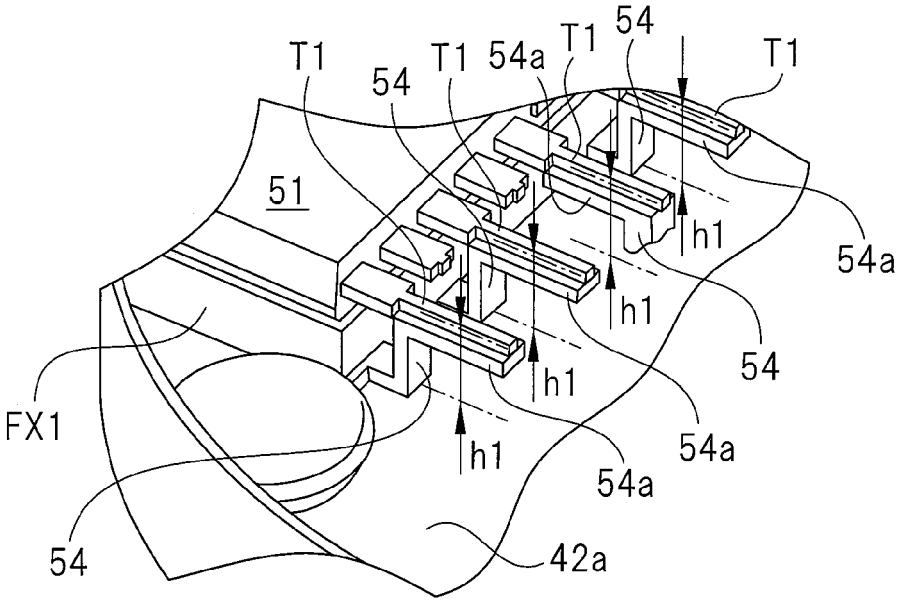



FIG. 7B

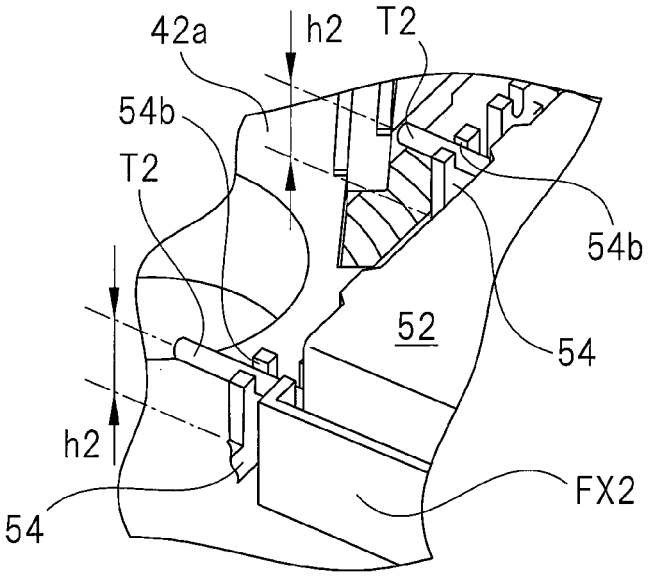



FIG. 7C

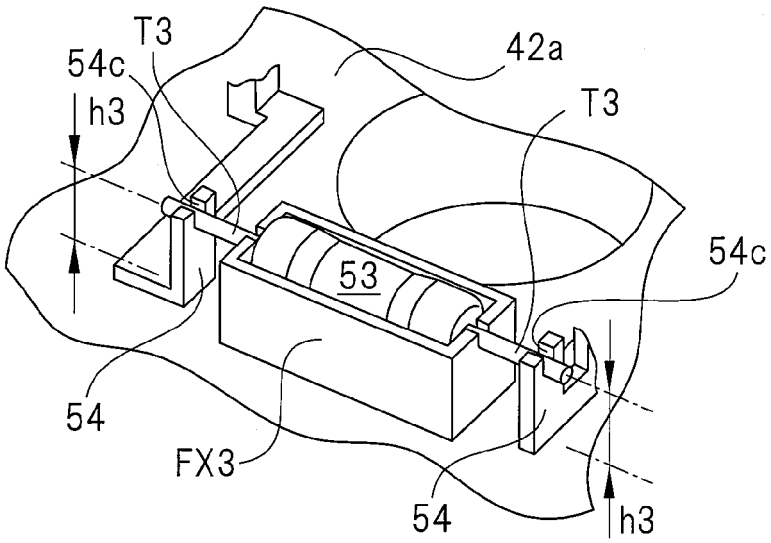


FIG. 8A

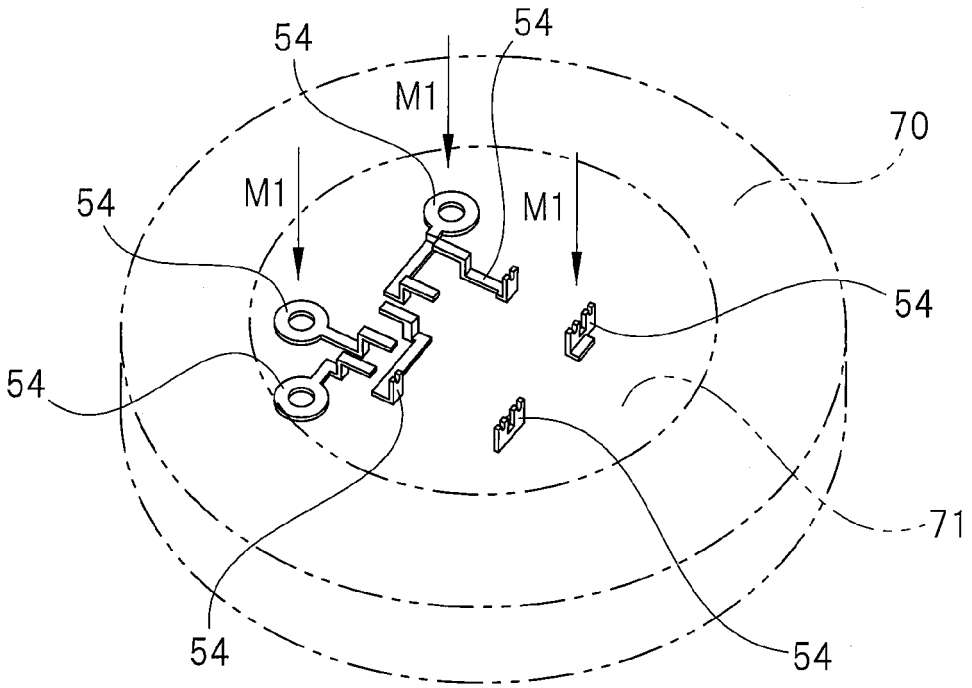

54
54
M1
70
54
M1
M1
54
54
71
54
54

FIG. 8B

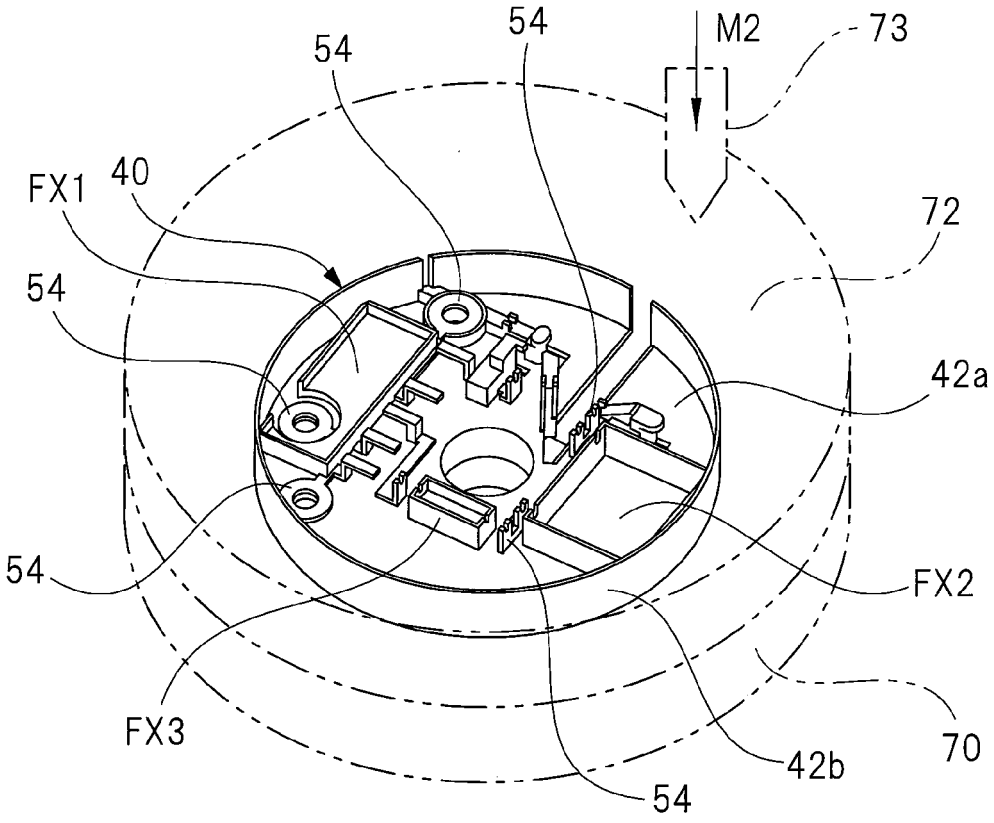

54
54
M2
73
54
FX1
40
72
54
42a
54
FX2
FX3
42b
70
54

FIG. 9

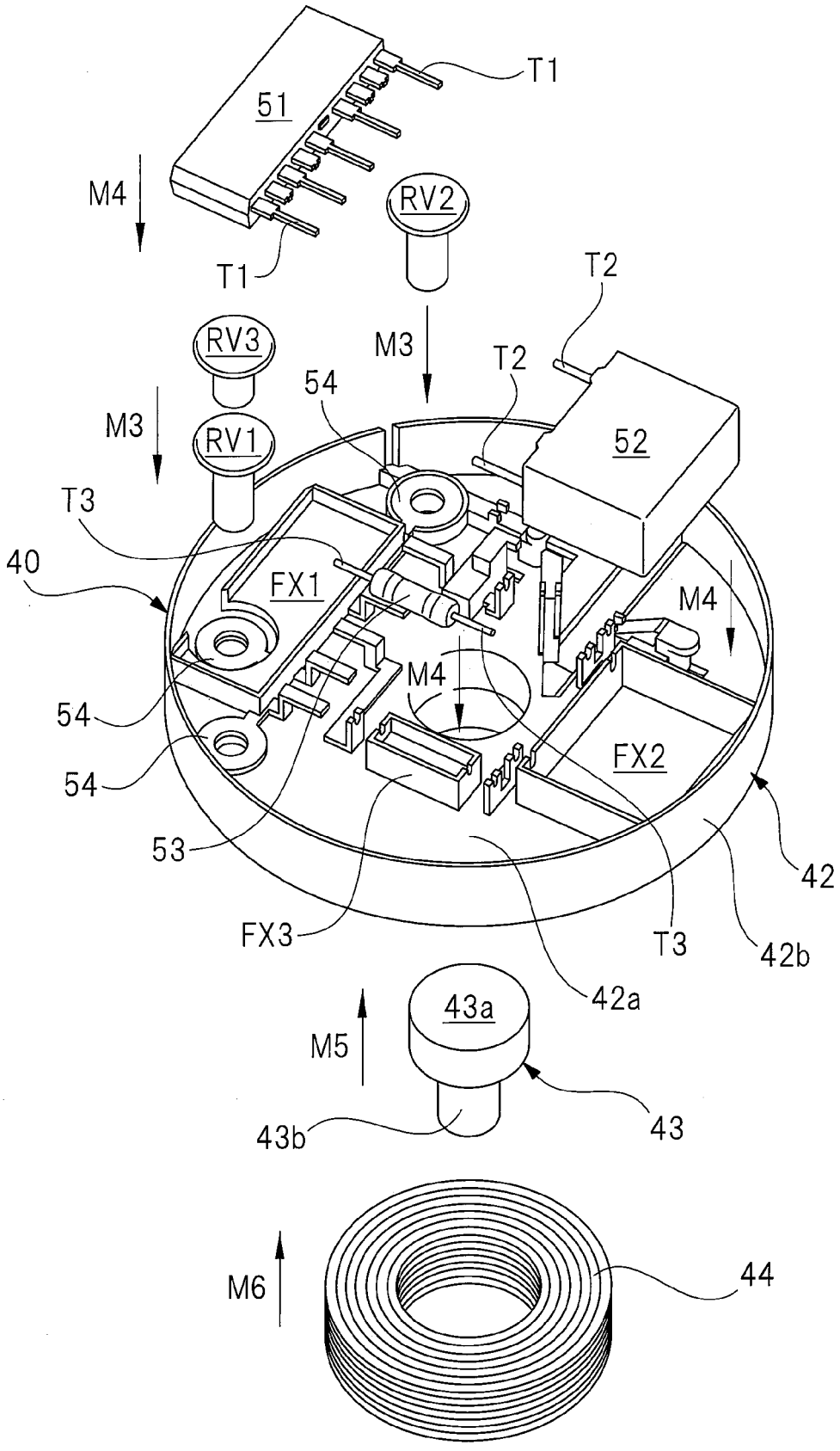

T1
51
M4
RV2
T1
T2
RV3
M3
T2
54
M3
RV1
52
T3
40
FX1
M4
M4
54
54
FX2
53
42
FX3
T3
42b
42a
43a
M5
43b
43
M6
44

FIG. 10

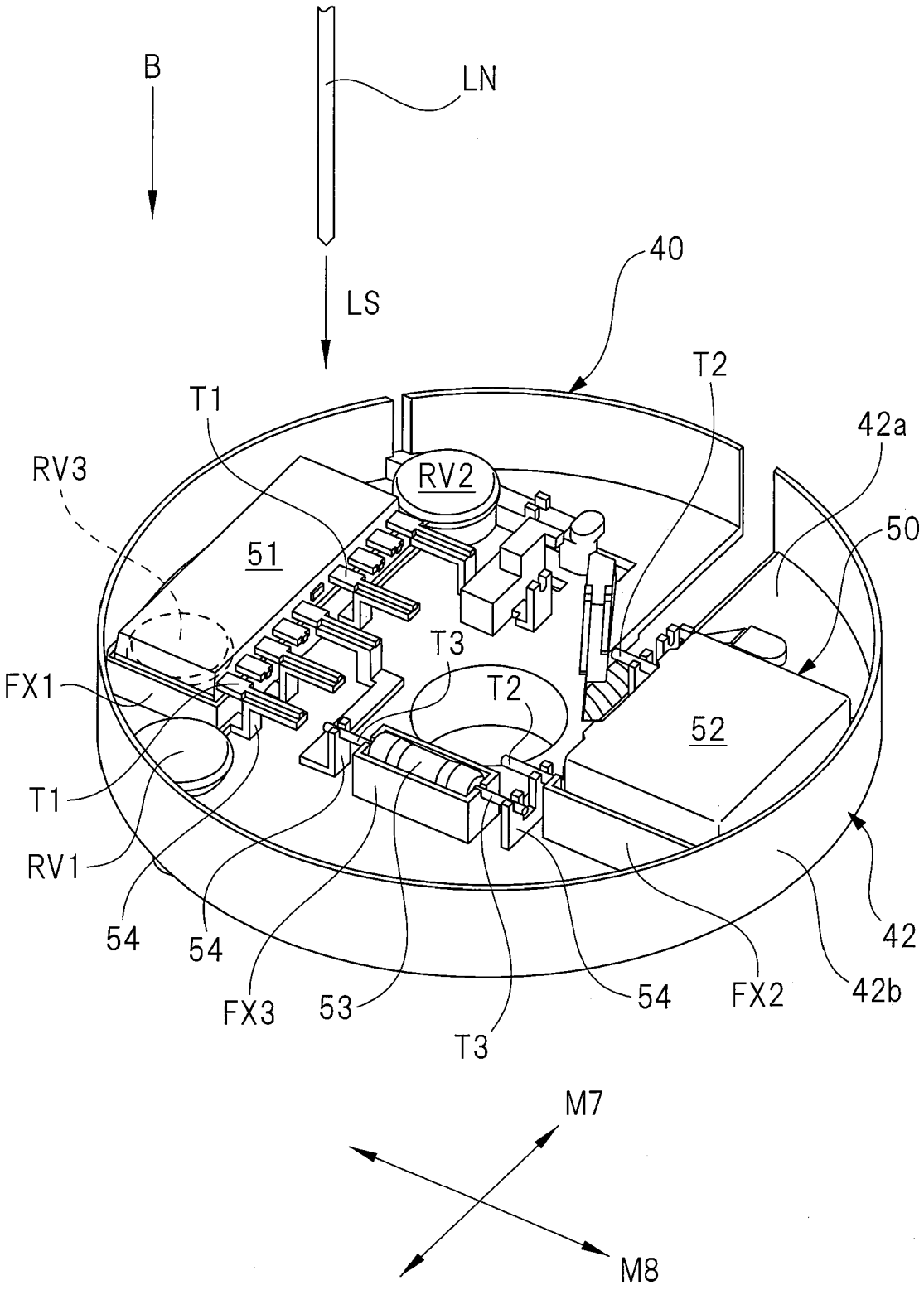

B
LN
LS
40
T2
T1
42a
RV3
RV2
50
51
T3
T2
FX1
52
T1
RV1
54
54
42
FX3
53
54
FX2
42b
T3
M7
M8

FIG. 11

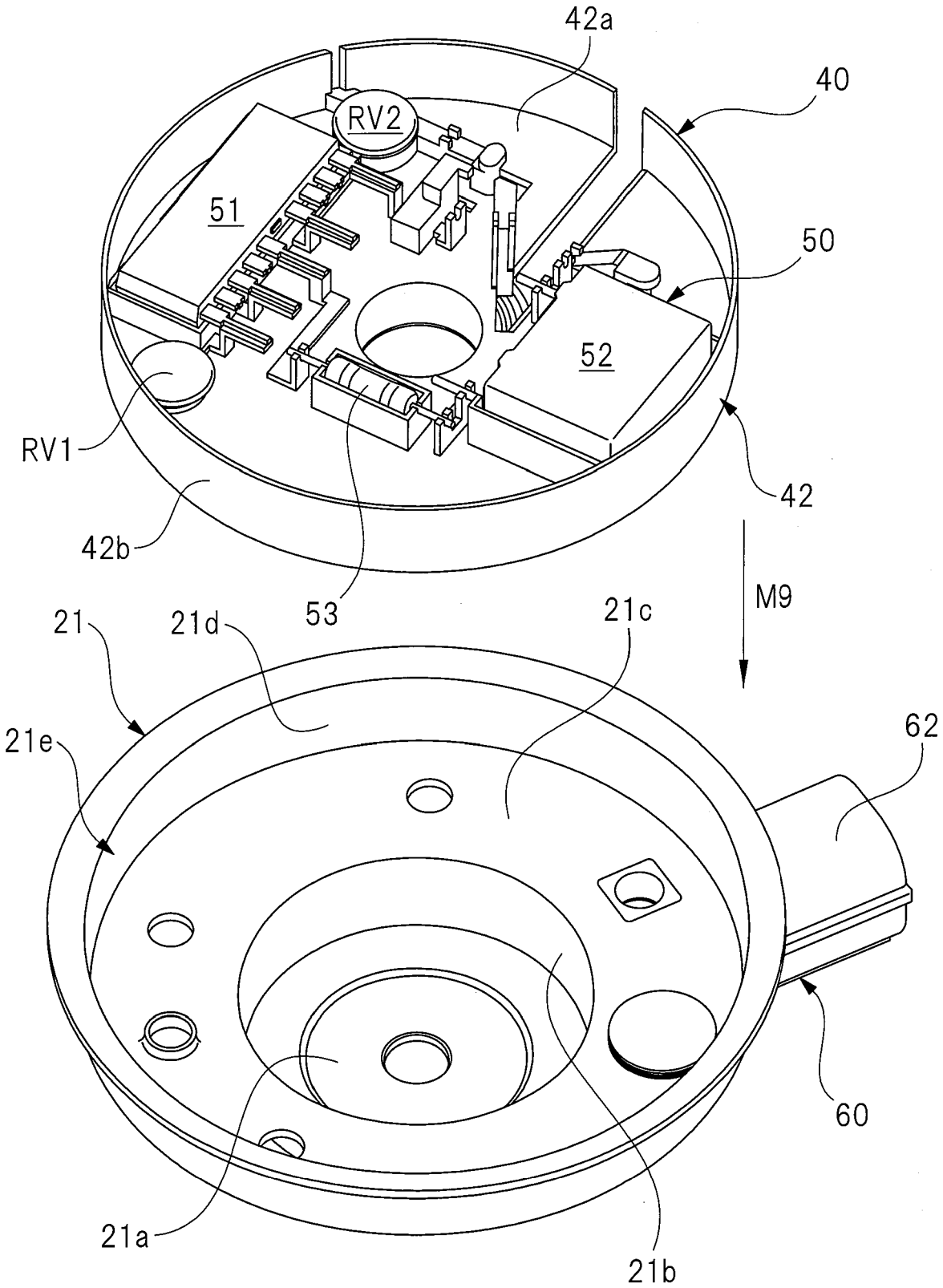


FIG. 12

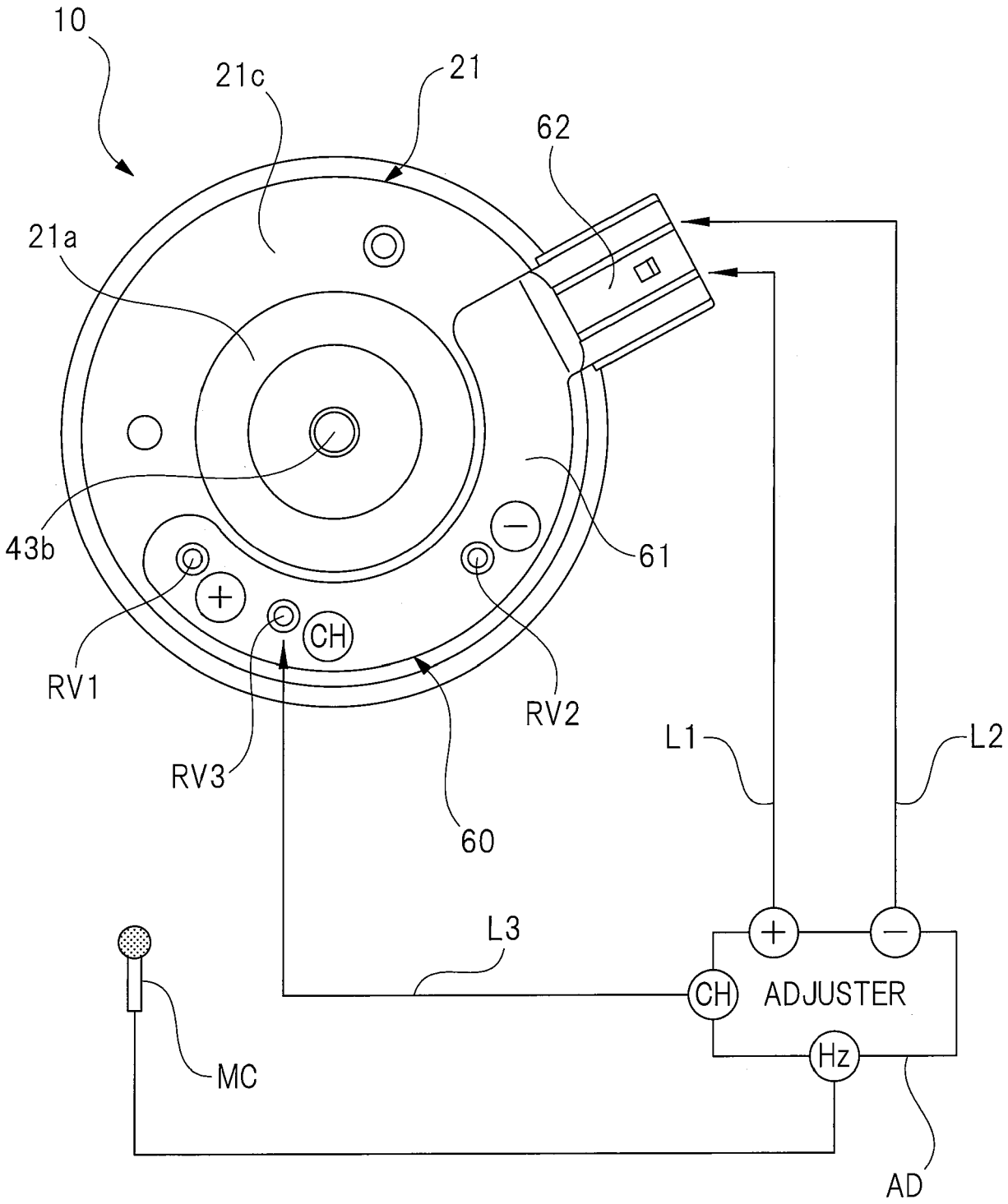
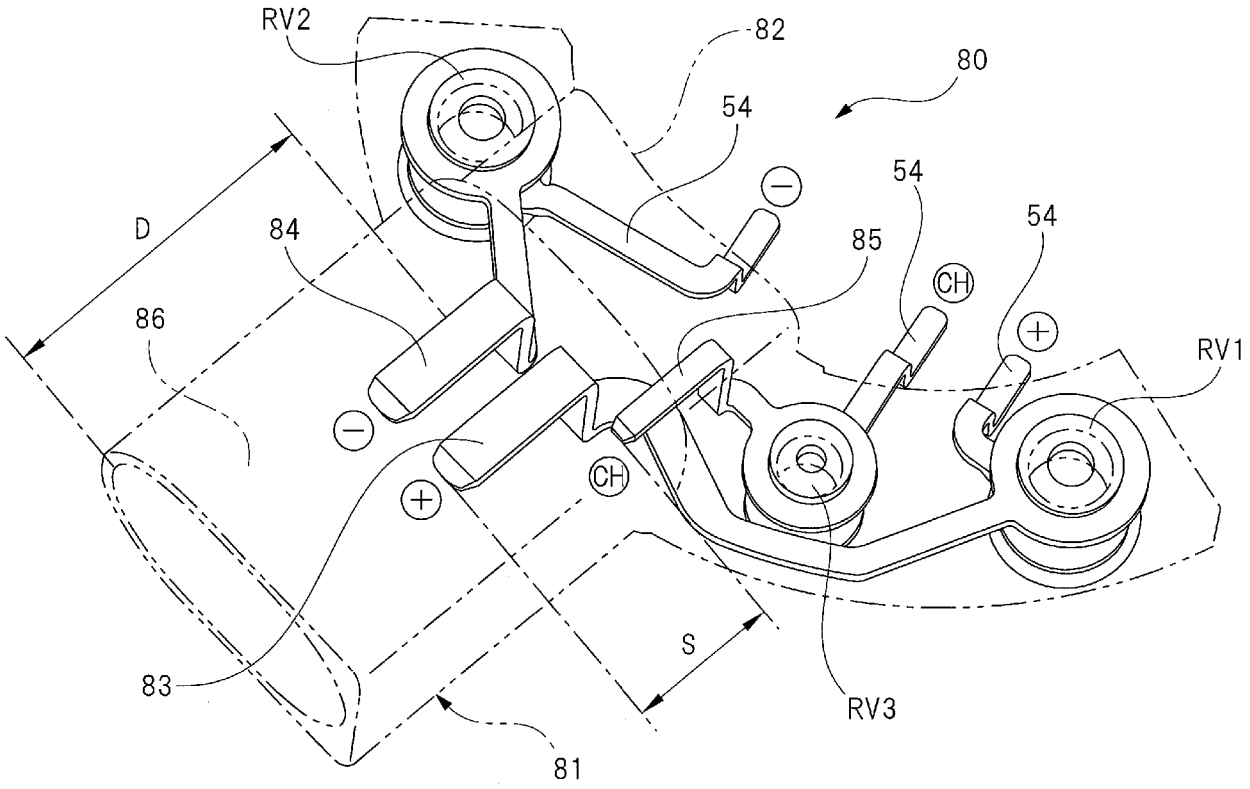

10
21c
21
62
21a
43b
61
RV1
RV3
CH
RV2
60
L1
L2
L3
MC
CH
ADJUSTER
Hz
AD

FIG. 13



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# EUROPEAN SEARCH REPORT

Application Number
EP 18 19 8613

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
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TECHNICAL FIELDS SEARCHED (IPC)

G10K
H04R
B06B

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| The Hague | 25 February 2019 | Fernandes, Paulo |

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25-02-2019

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| JP 2016218110 A | 22-12-2016 | NONE | |

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