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(54) **ULTRASOUND DIAGNOSTIC APPARATUS AND EXTERNAL BATTERY UNIT THEREOF**

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(57) **ABSTRACT**

An ultrasound diagnostic apparatus, including: an ultrasound diagnostic apparatus main body which transmits a drive signal to an ultrasound probe that transmits and receives ultrasound waves, and which generates an ultrasound image based on a received signal that is obtained from the ultrasound probe; and a battery unit which is externally attached to the ultrasound diagnostic apparatus main body and supplies electric power to the ultrasound diagnostic apparatus main body, wherein the battery unit includes: a battery housing which is made of resin and contains a battery therein; an electrical connector for connection to the ultrasound diagnostic apparatus main body, the electrical connector being fixed to the battery housing; and a conductive member which is arranged between the battery and an inner wall of the battery housing, and the conductive member is grounded to the ultrasound diagnostic apparatus main body.

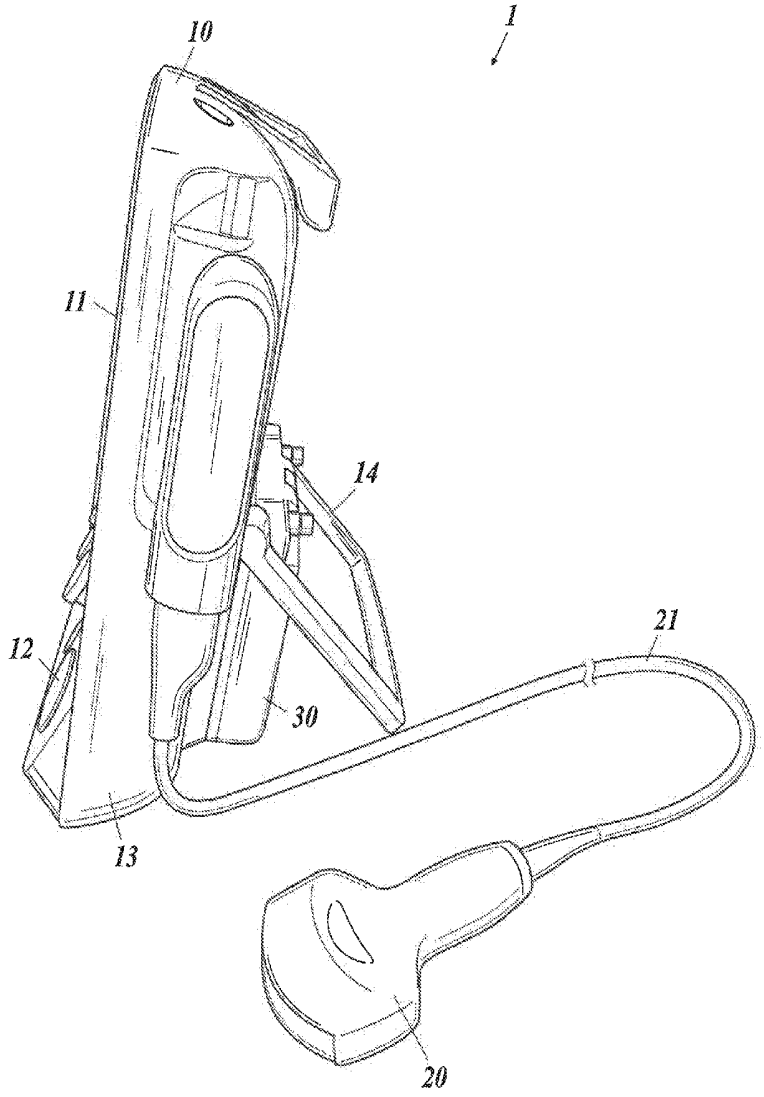

FIG.1

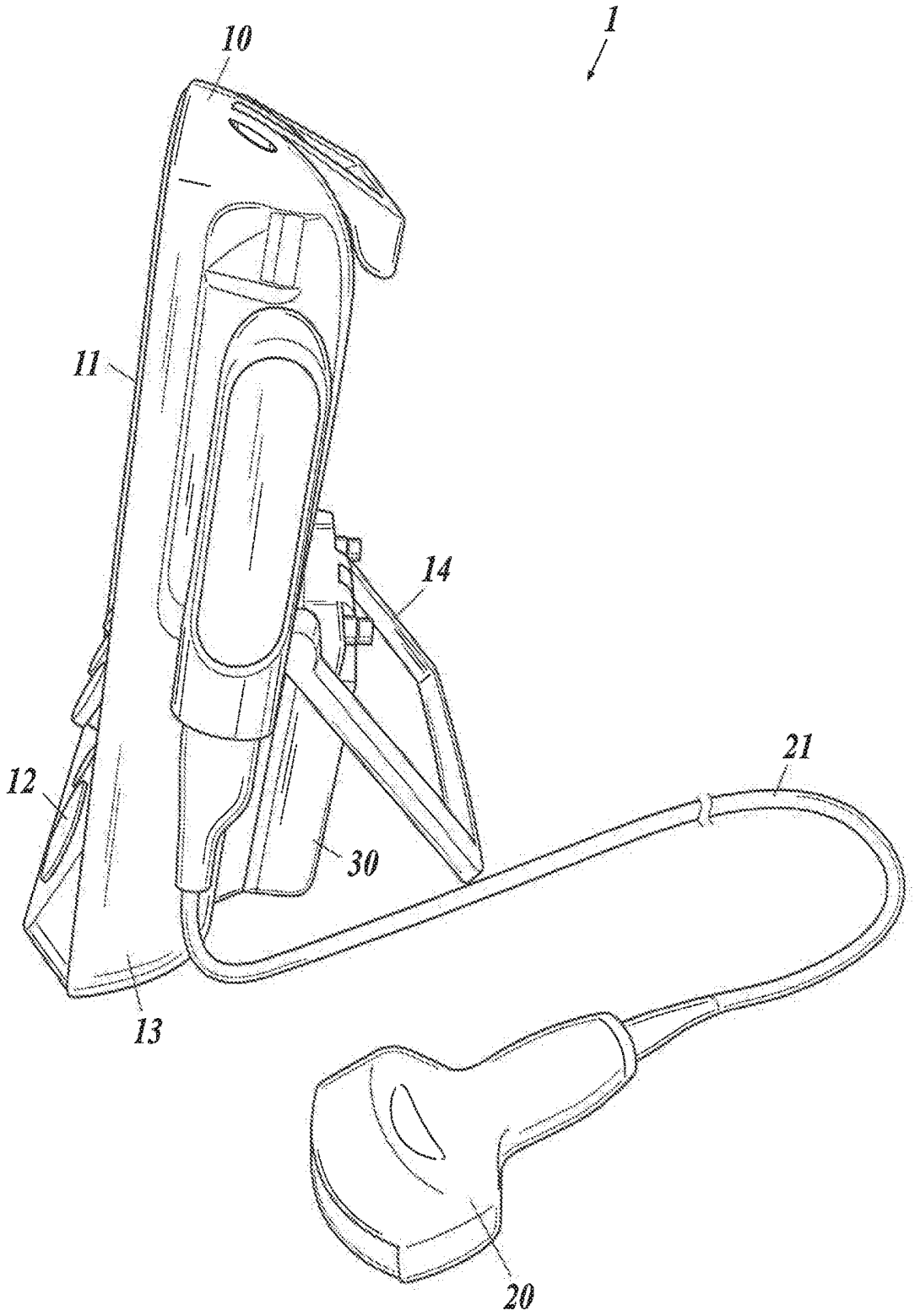

FIG.2

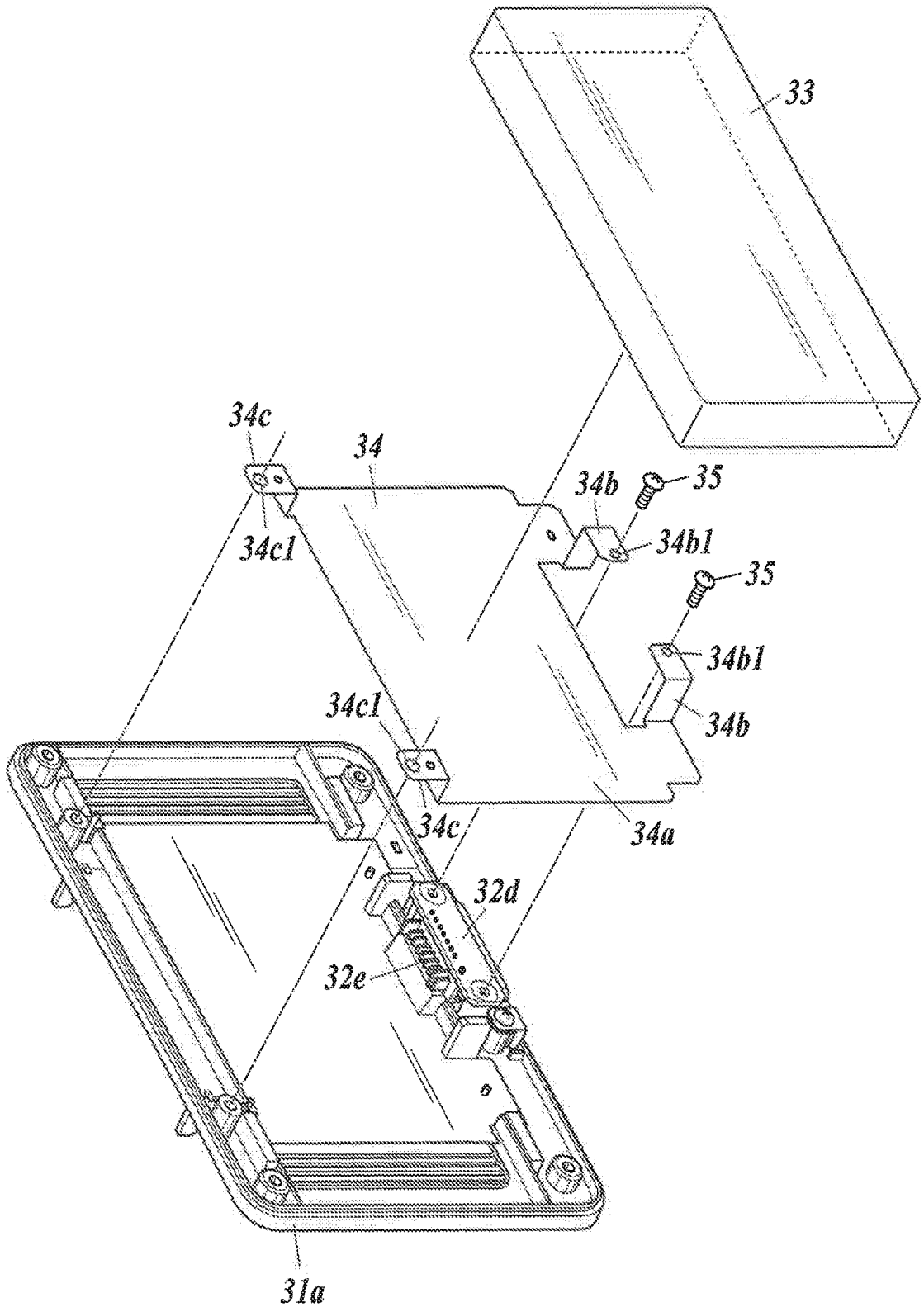

FIG.3

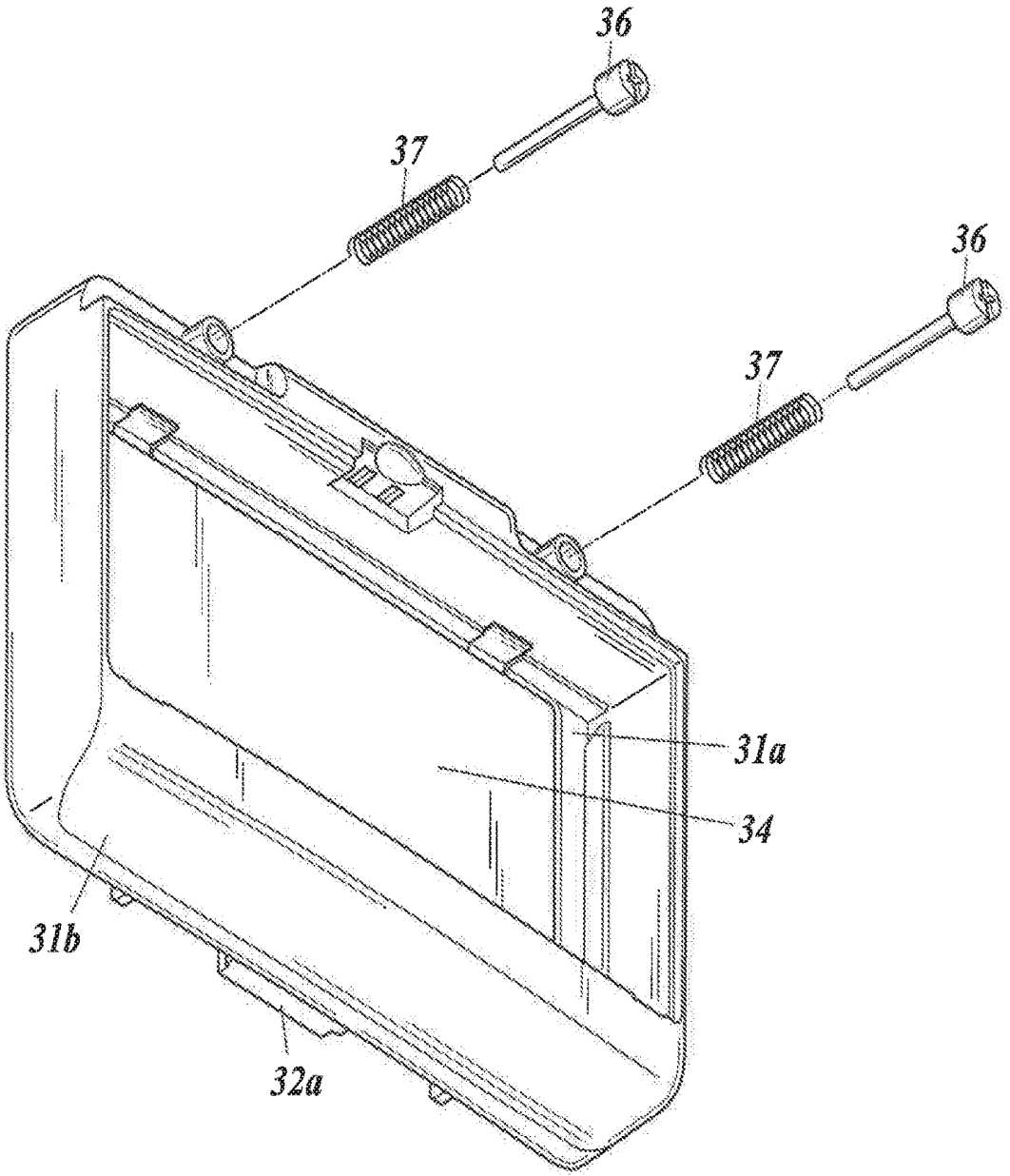

FIG. 4

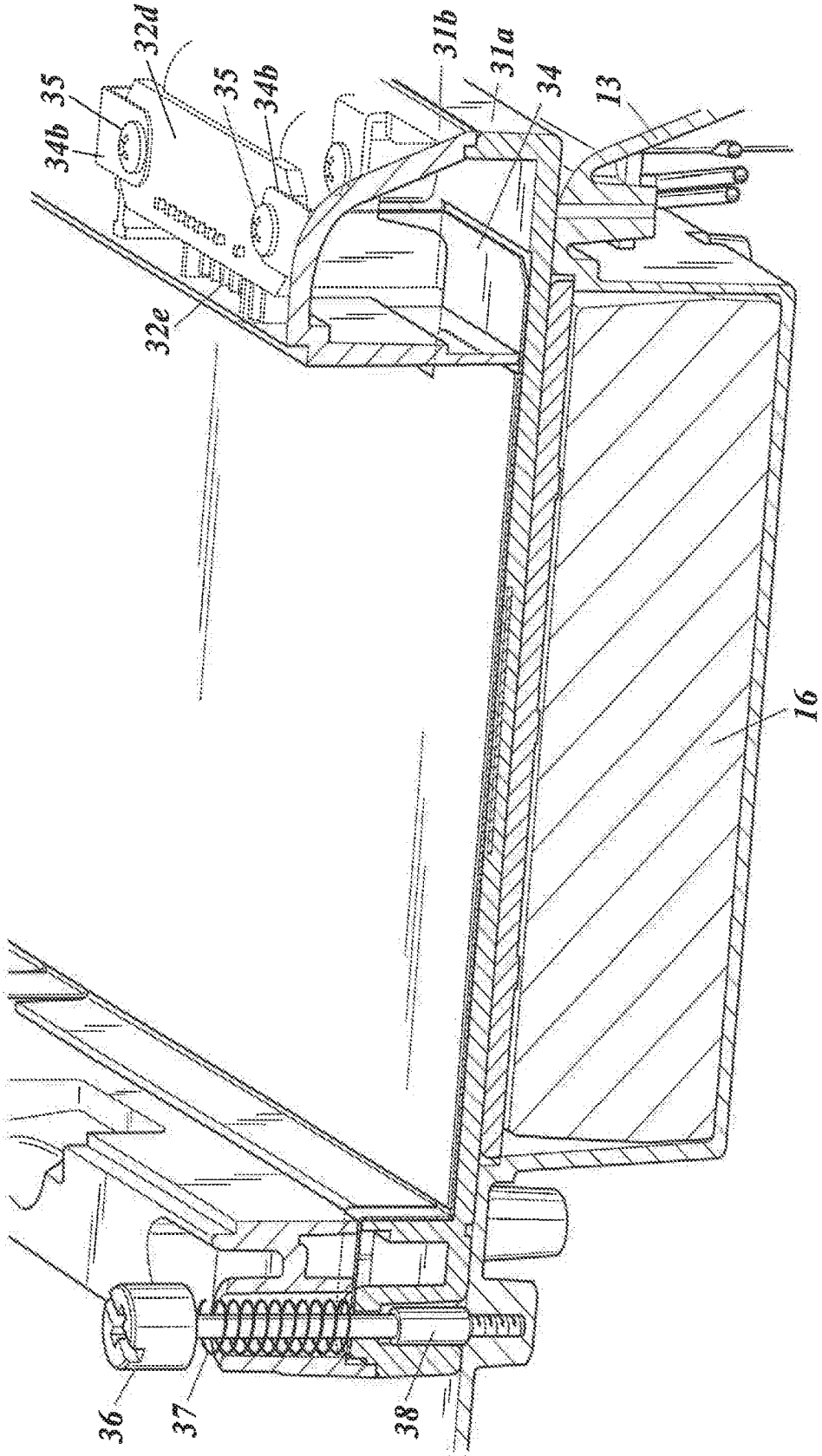

FIG. 5

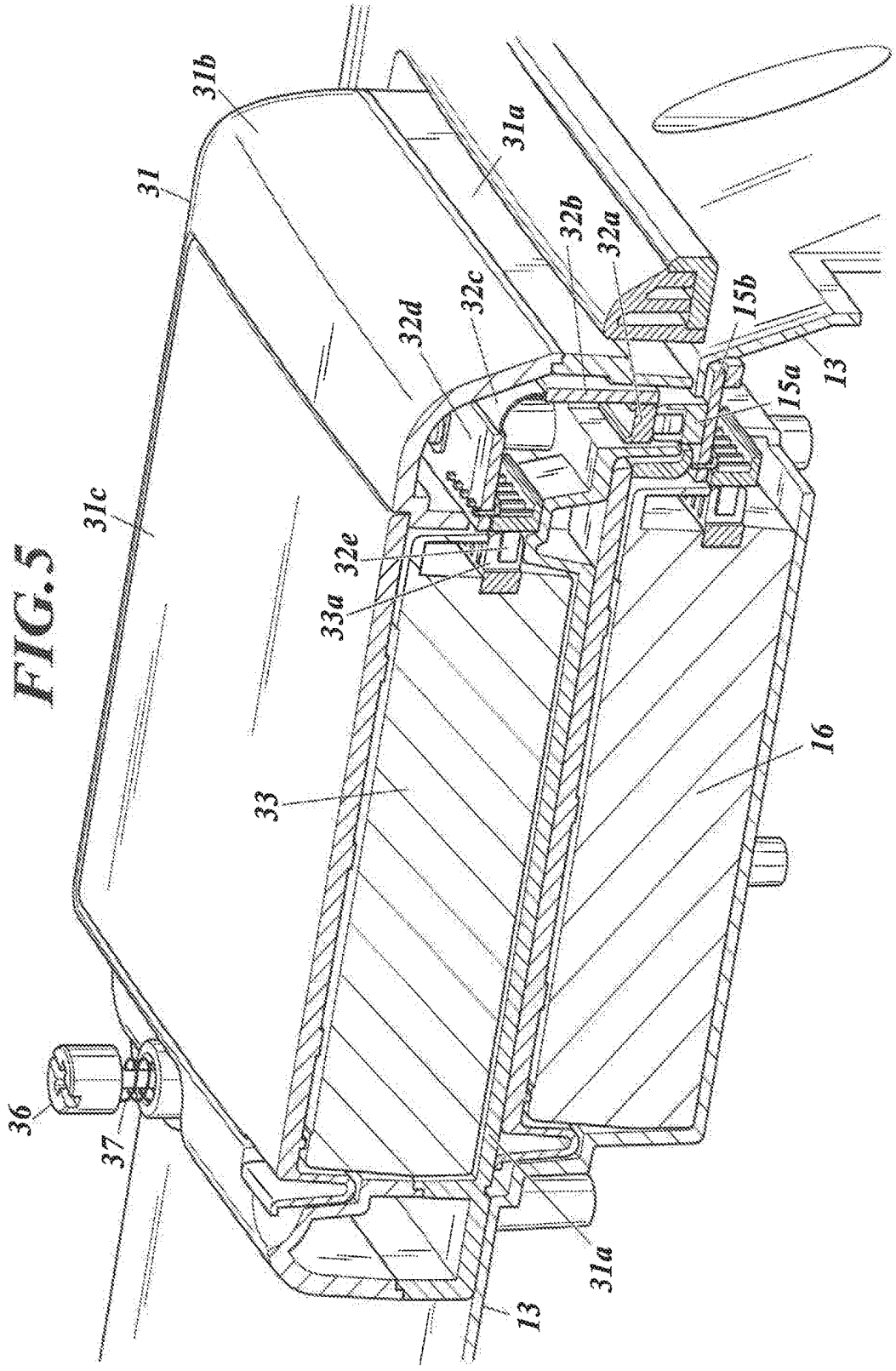
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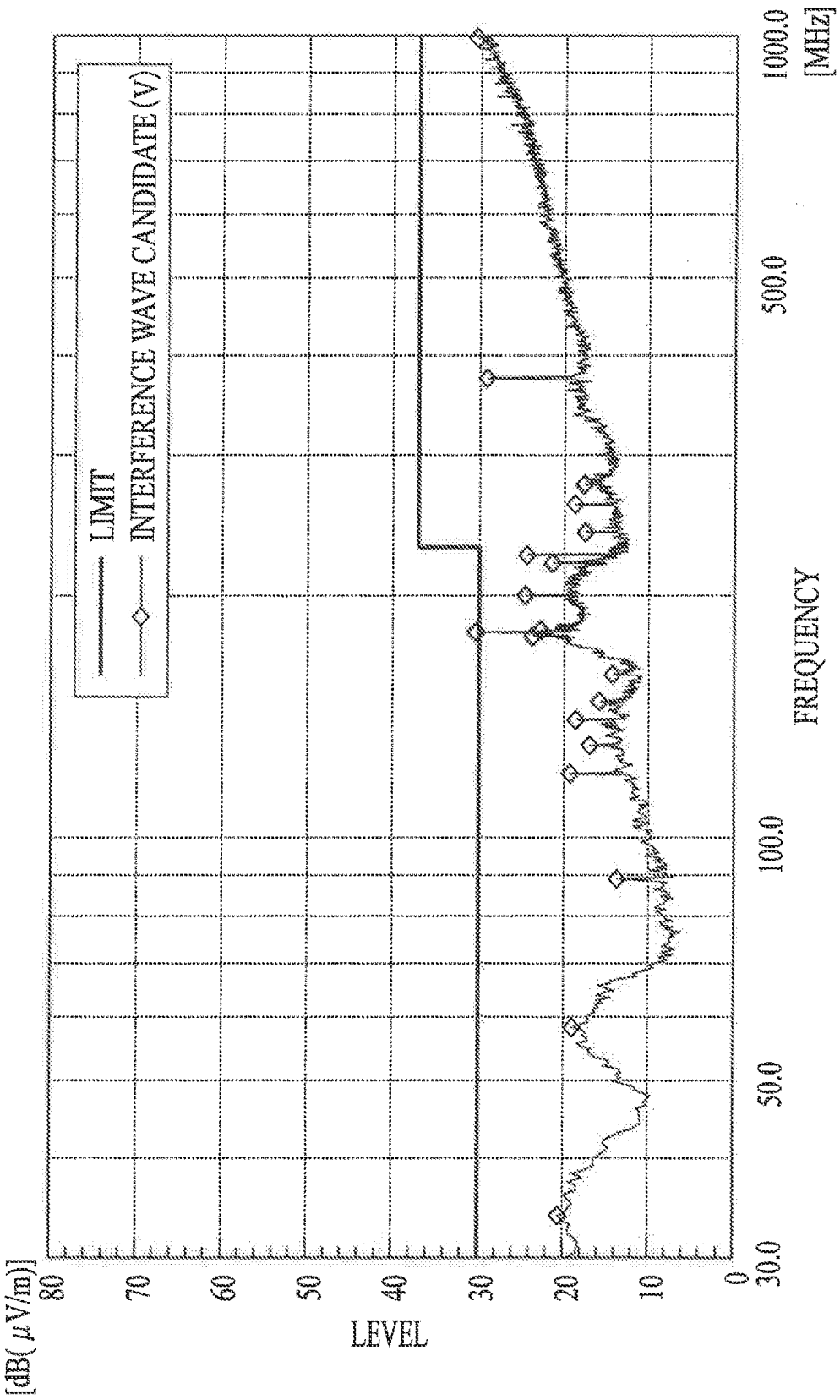
FIG. 6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50
40
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[MHz]
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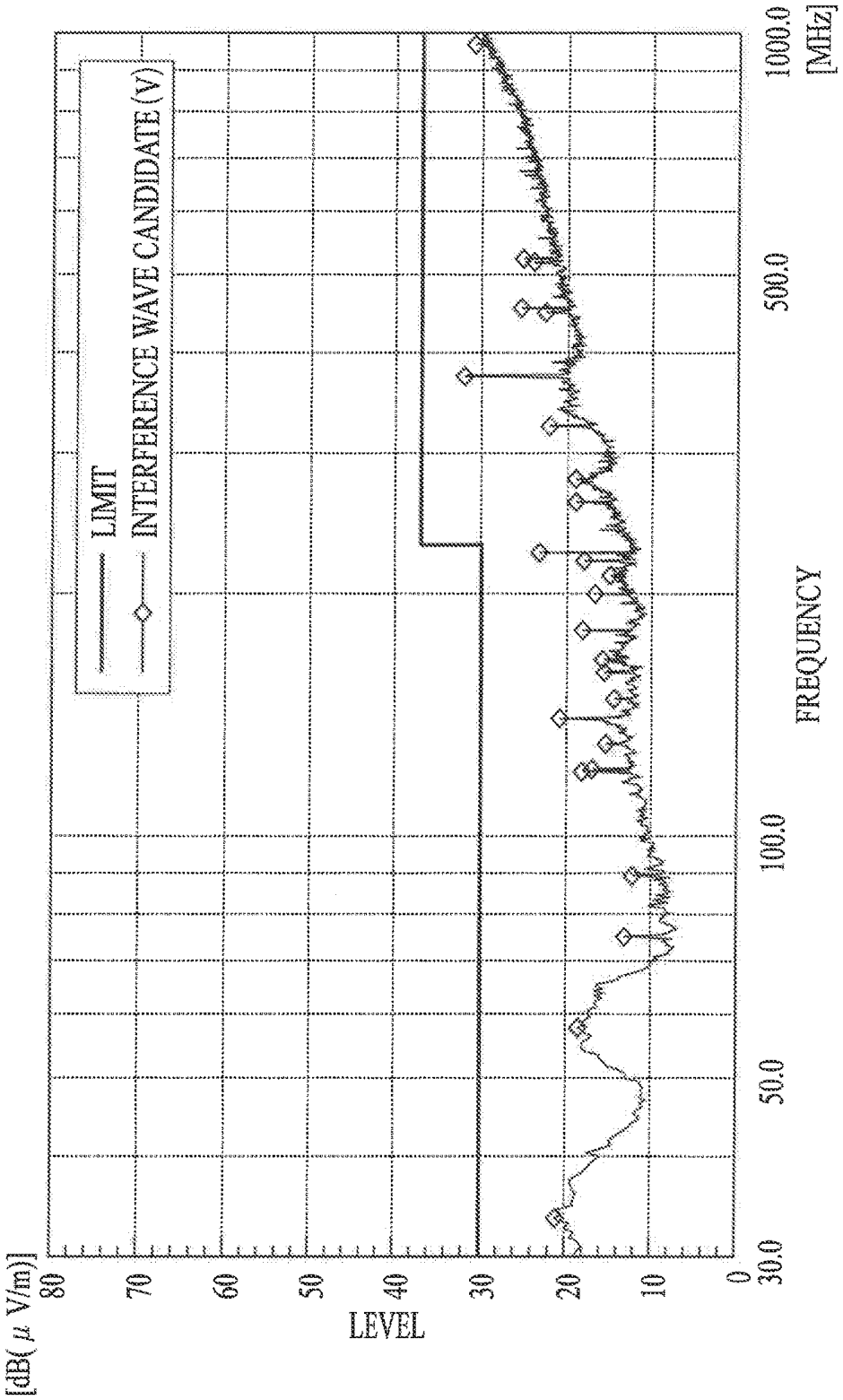
FIG. 7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50.0
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[MHz]
FREQUENCY

ULTRASOUND DIAGNOSTIC APPARATUS AND EXTERNAL BATTERY UNIT THEREOF

BACKGROUND

Technological Field

[0001] The present invention relates to an ultrasound diagnostic apparatus and an external battery unit thereof.

Description of the Related Art

[0002] There has been conventionally known an ultrasound diagnostic apparatus which performs, with an ultrasound probe, transmission and reception of ultrasound waves with respect to a subject under examination such as a living body, generates ultrasound image data on the basis of signals obtained from the received ultrasound waves, and displays an ultrasound image based on the data on an image display apparatus. Ultrasound image diagnosis using such an apparatus can be repeatedly performed since the state of heartbeat, movement of fetus and the like can be grasped real time with a simple operation of merely putting the ultrasound probe against the body surface of the subject, and the diagnosis is non-invasive and has a high safety.

[0003] In recent years, a portable ultrasound diagnostic apparatus which is compact and can be carried has been put into practical use, which enables diagnosis outside medical facilities such as hospitals.

[0004] In accordance with the development of portal ultrasound diagnostic apparatus, the battery drive system is adopted.

[0005] As a method for arranging the battery so as to be integrated with the ultrasound diagnostic apparatus, there is adopted an external attaching method of attaching the battery to the outer surface of the ultrasound diagnostic apparatus main body so as to be arranged outside the main body, besides an internal mounting method of arranging the battery inside the ultrasound diagnostic apparatus main body. For example, there is a method of enabling a user to use the external battery in addition to the internal battery. Since the external battery is not arranged in the internal space of the main body, the external battery has an advantage that a plurality of types of batteries having different capacities can be prepared without increasing the size of the main body.

[0006] The external battery is not internally mounted in the main body. Accordingly, it is preferable that the external battery unit has a housing (hard case) containing the battery for protecting the battery or the like. The housing makes it possible to fix, to the housing, an electrical connector for connection to the main body, and lock a fastening tool (bolt or the like) to the housing in order to surely fix the battery unit to the main body. Thus, it is easy to perform attachment/detachment and firm fixation of the external battery unit to the main body.

[0007] Metal or resin can be selected as a material of the housing of the battery unit. However, there is a tendency to require resin which is light and inexpensive in consideration of portability, low price and the like.

[0008] For example, there is a manner of mounting a plurality of batteries inside the apparatus, not limited to portable/cart type, as described in specification of US patent application publication No. 2013/0330588, and a manner of mounting a sub-battery inside an expansion apparatus such as a docking station and charging the main body battery from the sub-battery to enable extension of operation time of the apparatus as described in specifications of Japanese Patent No. 3828744 and U.S. Pat. No. 7,849,250.

[0009] However, when a plurality of batteries is mounted inside, the internal space of the main body possibly becomes tight. In a case where the housing containing the sub-battery is a metal housing, a total weight of the system increases, increasing situations in which the system cannot be carried easily.

[0010] Furthermore, in a case of producing the housing with light metal, the material is expensive and the processing cost is high, leading to a high original cost, in some cases. Thus, there are situations in which the user is required to adopt the resin housing.

[0011] However, when the housing of external battery unit is made of resin, the outer wall surrounding the battery is resin and the battery is not shielded by a metal material. Thus, it is not possible to effectively prevent electromagnetic radiation.

[0012] The resin housing of the battery unit cannot be electrically connected when contacting the ultrasound diagnostic apparatus main body since the housing is resin. Thus, the electrical connection between the battery unit and the ultrasound diagnostic apparatus main body is limited to an electrical connector.

[0013] In that case, the battery unit can be grounded only by the electrical connector, and the resin housing does not function as ground metal. Thus, the grounding of the battery unit is not sufficient, and there has been a problem in EMC (Electromagnetic Compatibility) performance. When the EMC performance is not sufficient, there can be troubles that the apparatus cannot meet the standard of EMC performance since the standard of EMC performance is strict in use of the ultrasound diagnostic apparatus, that the apparatus interferes with the operation of surrounding electronic devices, that noise is generated in the ultrasound images made by the apparatus itself, and the like.

SUMMARY

[0014] The present invention has been made in consideration of the above problems of conventional techniques, and an object of the present invention is to enhance grounding of the battery unit, reduce electromagnetic radiation from the battery unit, and improve the EMC performance.

[0015] To achieve at least one of the abovementioned objects, according to an aspect of the present invention, an ultrasound diagnostic apparatus reflecting one aspect of the present invention includes: an ultrasound diagnostic apparatus main body which transmits a drive signal to an ultrasound probe that transmits and receives ultrasound waves, and which generates an ultrasound image based on a received signal that is obtained from the ultrasound probe; and a battery unit which is externally attached to the ultrasound diagnostic apparatus main body and supplies electric power to the ultrasound diagnostic apparatus main body, wherein the battery unit includes: a battery housing which is made of resin and contains a battery therein; an electrical connector for connection to the ultrasound diagnostic apparatus main body, the electrical connector being fixed to the battery housing; and a conductive member which is arranged between the battery and an inner wall of the battery housing, and the conductive member is grounded to the ultrasound diagnostic apparatus main body.

[0016] According to an aspect of the present invention, an external battery unit of an ultrasound diagnostic apparatus reflecting one aspect of the present invention is externally attached to an ultrasound diagnostic apparatus main body and supplies electric power to the ultrasound diagnostic apparatus main body which transmits a drive signal to an ultrasound probe that transmits and receives ultrasound waves, and which generates an ultrasound image based on a received signal that is obtained from the ultrasound probe, and the battery unit includes: a battery housing which is made of resin and contains a battery therein; an electrical connector for connection to the ultrasound diagnostic apparatus main body, the electrical connector being fixed to the battery housing; and a conductive member which is arranged between the battery and an inner wall of the battery housing, wherein the conductive member is grounded to the ultrasound diagnostic apparatus main body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The advantages and features provided by one or more embodiments of the invention will become more fully understood from the detailed description given hereinafter and the appended drawings which are given by way of illustration only, and thus are not intended as a definition of the limits of the present invention, and wherein:

[0018] FIG. **1** is a perspective view showing an ultrasound diagnostic apparatus according to an embodiment of the present invention;

[0019] FIG. **2** is an exploded view of an external battery unit according to the embodiment of the present invention;

[0020] FIG. **3** is an exploded view of the external battery unit according to the embodiment of the present invention;

[0021] FIG. **4** is a sectional view in a state in which the battery unit is attached to the main body, according to the embodiment of the present invention;

[0022] FIG. **5** is a sectional view in a state in which the battery unit is attached to the main body, according to the embodiment of the present invention;

[0023] FIG. **6** is a graph showing frequency distribution of the electromagnetic radiation amount of an ultrasound diagnostic apparatus according to a comparative example; and

[0024] FIG. **7** is a graph showing frequency distribution of the electromagnetic radiation amount of an ultrasound diagnostic apparatus according to an example of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0025] Hereinafter, one or more embodiments of the present invention will be described in detail with reference to the drawings. However, the scope of the invention is not limited to the disclosed embodiments.

[0026] An embodiment according to the present invention will be described in detail with reference to the accompanying drawings.

[0027] FIG. **1** illustrates a configuration example of an ultrasound diagnostic apparatus.

[0028] The ultrasound diagnostic apparatus **1** is used at a medical facility such as a hospital, and diagnoses a subject under examination such as a living body of a patient. As shown in FIG. **1**, the ultrasound diagnostic apparatus **1** includes an ultrasound diagnostic apparatus main body **10**, an ultrasound probe **20** and an external battery unit **30**.

[0029] The ultrasound probe **20** transmits ultrasound waves (transmission ultrasound waves) to the subject under examination not shown in the drawings, and receives reflected waves (reflected ultrasound waves (including scattered ultrasound waves)) of the ultrasound waves reflected at this subject under examination. The ultrasound diagnostic apparatus main body **10** is connected to the ultrasound probe **20** via a cable **21**. The ultrasound diagnostic apparatus main body **10** causes the ultrasound probe **20** to transmit the transmission ultrasound waves to the subject under examination by transmitting a drive signal of an electrical signal to the ultrasound probe **20**, and performs imaging of the internal state of the subject under examination as an ultrasound image on the basis of the received signals which are electrical signals generated in the ultrasound probe **20** according to the reflected ultrasound waves from inside the subject under examination received by the ultrasound probe **20**.

[0030] In an example shown in FIG. **1**, the ultrasound diagnostic apparatus main body **10** includes a display monitor **11** for displaying the ultrasound image and the like, an operation button **12** and the like on the front surface. The main body housing **13** is made of metal (for example, made by magnesium die casting), and has a folding stand **14** on the back surface so as to be placed on a table or the like to be used.

[0031] The folding stand **14** is formed in a U-shape. The mounting portion of the battery unit **30** is provided on the main body back surface in the range surrounded when the folding stand **14** is folded. FIG. **1** shows a state in which the battery unit **30** is actually mounted.

[0032] The battery unit **30** is externally attached to the ultrasound diagnostic apparatus main body **10** as shown in FIG. **1**, that is, integrally attached to the ultrasound diagnostic apparatus main body **10** so as to be arranged in the external space of the ultrasound diagnostic apparatus main body **10**.

[0033] The battery unit **30** supplies electric power to the ultrasound diagnostic apparatus main body **10**. In the embodiment, the ultrasound diagnostic apparatus main body **10** includes an internal battery **16** (see FIGS. **4** and **5**). However, the ultrasound diagnostic apparatus main body **10** may not include the internal battery so that the ultrasound diagnostic apparatus main body **10** is used by battery drive only when the external battery unit **30** is attached.

[0034] FIGS. **2** and **3** show exploded views of the battery unit **30**. FIGS. **4** and **5** show sectional views in a state in which the battery unit **30** is attached to the ultrasound diagnostic apparatus main body **10**.

[0035] The battery unit **30** has a resin battery housing **31** formed of parts **31***a*, **31***b* and **31***c*. The battery housing **31** is configured in a box shape by the plate-like part **31***a* on the attachment side, the frame-like part **31***b* which is connected to the peripheral portion of the part **31***a* and surrounds the battery **33**, and the cover part **31***c* which covers the opening on the back side of the part **31***b*. The battery housing **31** contains the battery **33** therein.

[0036] An electrical connector **32***a* for connection to the ultrasound diagnostic apparatus main body **10** is fixed to the part **31***a* of the battery housing **31** via the wiring substrate **32***b* as shown in FIG. **5**. A wiring substrate **32***d* to be connected to the wiring substrate **32***b* via a flexible wiring substrate **32***c* is similarly fixed to the part **31***a* of the battery housing **31**. A connection terminal **32***e* of the battery **33** is

mounted on the wiring substrate **32***d*, and connected to a connection terminal **33***a* provided to the battery **33**, so as to be fit each other. As shown in FIG. **5**, in a state in which the battery unit **30** is attached to the ultrasound diagnostic apparatus main body **10**, the wiring substrate **32***b* is arranged in a direction orthogonal to the back surface of the ultrasound diagnostic apparatus main body **10**, the wiring substrate **32***d* is arranged in a direction parallel to the back surface, and thus the arrangement is made by a relative angle of 90 degrees. This is because the connection direction of the electrical connector **32***a* to the ultrasound diagnostic apparatus main body **10** and the connection direction of the connection terminal **32***e* to the battery **33** are different from each other by 90 degrees.

[0037] As shown in FIG. **2**, the conductive member **34** is arranged between the battery **33** and the internal wall (part **31***a*) of the battery housing **31**. The conductive member **34** is formed to be a plate-like member or a sheet-like member so as to increase the capacity of the conductive member **34** without making the space inside the battery housing **31** tight. In the conductive member **34**, a main part **34***a* having the largest area is arranged along the surface of the battery **33** and the internal wall (part **31***a*) of the battery housing **31** so as to be arranged between the battery **33** and the internal wall of the battery housing **31**.

[0038] Connection parts **34***b*, **34***b* are provided so as to extend from the main part **34***a* of the conductive member **34**. Holes **34***b***1** are formed at the ends of the connection parts **34***b*, **34***b*, and set screws **35** can be inserted through the holes **34***b***1**. The set screws **35** are inserted through the holes **34***b***1** and holes provided on the wiring substrate **32***d* and screwed to female screws formed in the part **31***a*, and the conductive member **34** and the wiring substrate **32***d* are joined to each other. The connection parts **34***b* is pressed against the ground pattern formed on the wiring substrate **32***d* via the set screws **35**, and electrically connected.

[0039] The ground pattern formed on the wiring substrate **32***d* functions as a ground by being connected to a conductive main body housing **13** via the wiring pattern in the flexible wiring substrate **32***c*, the wiring pattern in the wiring substrate **32***b*, the terminal in the electrical connector **32***a*, the terminal of an electrical connector **15***a* in the ultrasound diagnostic apparatus main body **10** shown in FIG. **5**, and a wiring substrate **15***b* of the ultrasound diagnostic apparatus main body **10**.

[0040] As described above, the conductive member **34** is grounded to the ultrasound diagnostic apparatus main body **10**. The conductive member **34** is grounded to the ultrasound diagnostic apparatus main body **10** via the electrical connector **32***a* of the battery unit **30**.

[0041] The conductive member **34** is also grounded to the ultrasound diagnostic apparatus main body **10** via the following path.

[0042] Connection parts **34***c*, **34***c* are extended from the main part **34***a* of the conductive member **34**. Holes **34***c***1** are formed at the ends of the connection parts **34***c*, **34***c*. Fixing bolts **36** shown in FIGS. **3** to **5** can be inserted through the holes **34***c***1**, and the inner diameter of the hole **34***c***1** is smaller than the outer diameter of a coil spring **37**. The fixing bolts **36** are inserted through the holes **34***c***1** and the holes provided in the parts **31***a* and **31***b*, and screwed so as to be joined to female screws formed in the conductive main body housing **13** via joint screws **38**. The fixing bolts **36** are inserted through the coil springs **37** and the holes **34***c***1** provided in the conductive member **34**, and the coil springs **37** are pressed against the heads of the fixing bolts **36** and the conductive member **34** around the holes **34***c***1**. Thereby, the conductive member **34** is electrically conducted to the fixing bolts **36**. The connection part **34***c* is sandwiched between the part **31***a* and the part **31***b*, and not exposed outside. Though the part **31***a* which is an insulating material intervenes between the heads of the fixing bolts **36** and the connection parts **34***c*, electrical connection is made by the coil springs **37**.

[0043] As described above, the conductive member **34** is grounded to the ultrasound diagnostic apparatus main body **10** via the bolts **36**, **38** for fixing the battery housing **31** to the ultrasound diagnostic apparatus main body **10**. The fixing bolts **36** may be directly screwed so as to be joined to the main body housing **13** without using the joint screws **38**.

Effect, Substantiative Measurement

[0044] According to the ultrasound diagnostic apparatus **1** in the embodiment, in a case where the housing **31** of the battery unit **30** which is externally attached to the ultrasound diagnostic apparatus main body **10** is a resin housing, it is possible to enhance grounding of the battery unit **30**, reduce electromagnetic radiation from the battery unit **30** and improve the EMC performance.

[0045] FIG. **6** is a graph showing frequency distribution of the result obtained by measuring the electromagnetic radiation amount of an ultrasound diagnostic apparatus according to a comparative example. FIG. **7** is a graph showing frequency distribution of the result obtained by measuring the electromagnetic radiation amount of an ultrasound diagnostic apparatus according to an example of the present invention.

[0046] The example of the present invention has the configuration according to the above-described embodiment. The comparative example has the configuration corresponding to the configuration excluding the conductive member **34** from the example of the present invention. In both of the examples, the measured position is on the main body back surface side and located around the electrical connection portion between the ultrasound diagnostic apparatus main body and (the battery **33** of) the external battery unit. Both of the examples have a common operation situation in which the ultrasound diagnostic apparatus main body is connected to the AC power source and (the battery **33** of) the external battery unit and the internal battery (**16**) are charged for use.

[0047] FIGS. **6** and **7** show a limit line of the electromagnetic interference wave applied in medical facilities.

[0048] As shown in FIG. **6**, in the comparative example, an interference wave candidate exceeding the limit line appeared among the interference wave candidates which are prominent peaks.

[0049] As shown in FIG. **7**, in the example of the present invention, it was possible to suppress all the interference wave candidates to be lower than the limit line. The factor of this is considered that the conductive member (**34**) arranged in the external battery unit is grounded and the ground potential of the battery unit is stabilized. Especially, the factor is considered that the grounding is enhanced by not only the connection via the electrical connector **32***a* but also by applying the fixing bolts **36** as the ground path in the example of the present invention as described in the above embodiment.

Others

[0050] In the above embodiment, the conductive member **34** arranged between the battery **33** and the internal wall of the battery housing **31** is grounded to the ultrasound diagnostic apparatus main body **10** via the electrical connector **32***a*, and grounded to the ultrasound diagnostic apparatus main body **10** also via the fixing bolts **36**. However, the grounding may be performed by only one of the paths of the electrical connector **32***a* and the fixing bolts **36**.

[0051] The conductive member **34** may be grounded to the ultrasound diagnostic apparatus main body **10** by connection via other paths. For example, when the conductive member **34** is partially exposed toward the outer surface side of the part **31***a* as a contact terminal portion to the main body housing **13** and the battery unit **30** is fixed to the main body housing **13** with the fixing bolts **36**, there can be a configuration such that the contact terminal portion is connected to the main body housing **13** by being pressed against the main body housing **13**. In such a case, it is possible to enhance water-tightness by dividing the part corresponding to the part **31***a* into two parts so that the wall portion to set the conductive member **34** in the part **31***a* has a double-walled structure and performing bonding and sealing so as to sandwich the conductive member **34** between the double walls.

[0052] As for detailed configurations and detailed operations of the components forming the ultrasound diagnostic apparatus **1** in the above embodiment, modifications can be performed as needed within the scope of the present invention.

[0053] Although embodiments of the present invention have been described and illustrated in detail, the disclosed embodiments are made for purposes of illustration and example only and not limitation. The scope of the present invention should be interpreted by terms of the appended claims.

[0054] The entire disclosure of Japanese Patent Application No. 2018-006820, filed on Jan. 19, 2018, is incorporated herein by reference in its entirety.

What is claimed is:

1. An ultrasound diagnostic apparatus, comprising:

an ultrasound diagnostic apparatus main body which transmits a drive signal to an ultrasound probe that transmits and receives ultrasound waves, and which generates an ultrasound image based on a received signal that is obtained from the ultrasound probe; and

a battery unit which is externally attached to the ultrasound diagnostic apparatus main body and supplies electric power to the ultrasound diagnostic apparatus main body, wherein

the battery unit includes:

a battery housing which is made of resin and contains a battery therein;

an electrical connector for connection to the ultrasound diagnostic apparatus main body, the electrical connector being fixed to the battery housing; and

a conductive member which is arranged between the battery and an inner wall of the battery housing, and

the conductive member is grounded to the ultrasound diagnostic apparatus main body.

2. The ultrasound diagnostic apparatus according to claim **1**, wherein the conductive member is grounded to the ultrasound diagnostic apparatus main body via the electrical connector.

3. The ultrasound diagnostic apparatus according to claim **1**, wherein the conductive member is grounded to the ultrasound diagnostic apparatus main body via a bolt for fixing the battery housing to the ultrasound diagnostic apparatus main body.

4. The ultrasound diagnostic apparatus according to claim **3**, wherein the conductive member and the bolt are electrically conducted to each other by inserting the bolt through a hole provided in the conductive member and a coil spring, and causing the coil spring to be pressed against a head of the bolt and the conductive member around the hole.

5. The ultrasound diagnostic apparatus according to claim **3**, wherein a main body housing which is a housing of the ultrasound diagnostic apparatus main body is conductive, and the conductive member is grounded to the ultrasound diagnostic apparatus main body by joining the bolt to the main body housing.

6. The ultrasound diagnostic apparatus according to claim **1**, wherein the conductive member is a plate-like member or a sheet-like member.

7. An external battery unit of an ultrasound diagnostic apparatus, the battery unit being externally attached to an ultrasound diagnostic apparatus main body and supplying electric power to the ultrasound diagnostic apparatus main body which transmits a drive signal to an ultrasound probe that transmits and receives ultrasound waves, and which generates an ultrasound image based on a received signal that is obtained from the ultrasound probe, and the battery unit comprising:

a battery housing which is made of resin and contains a battery therein;

an electrical connector for connection to the ultrasound diagnostic apparatus main body, the electrical connector being fixed to the battery housing; and

a conductive member which is arranged between the battery and an inner wall of the battery housing, wherein

the conductive member is grounded to the ultrasound diagnostic apparatus main body.

8. The external battery unit of the ultrasound diagnostic apparatus according to claim **7**, wherein the conductive member is grounded to the ultrasound diagnostic apparatus main body via the electrical connector.

9. The external battery unit of the ultrasound diagnostic apparatus according to claim **7**, wherein the conductive member is grounded to the ultrasound diagnostic apparatus main body via a bolt for fixing the battery housing to the ultrasound diagnostic apparatus main body.

10. The external battery unit of the ultrasound diagnostic apparatus according to claim **9**, wherein the conductive member and the bolt are electrically conducted to each other by inserting the bolt through a hole provided in the conductive member and a coil spring, and causing the coil spring to be pressed against a head of the bolt and the conductive member around the hole.

11. The external battery unit of the ultrasound diagnostic apparatus according to claim **9**, wherein the conductive member is grounded to the ultrasound diagnostic apparatus main body by joining the bolt to a main body housing which is a housing of the ultrasound diagnostic apparatus main body and which is conductive.

12. The external battery unit of the ultrasound diagnostic apparatus according to claim **7**, wherein the conductive member is a plate-like member or a sheet-like member.

* * * * *

专利名称(译)	超声波诊断装置及其外部电池单元		
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[标]申请(专利权)人(译)	柯尼卡株式会社		
申请(专利权)人(译)	柯尼卡美能达，INC.		
当前申请(专利权)人(译)	柯尼卡美能达，INC.		
[标]发明人	MURAMATSU YUKI SHIRAISHI TAKAHIKO NOGUCHI SHINYA		
发明人	MURAMATSU, YUKI SHIRAISHI, TAKAHIKO NOGUCHI, SHINYA		
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外部链接	Espacenet USPTO		

摘要(译)

一种超声波诊断装置，包括：超声波诊断装置主体，其将驱动信号发送到发送和接收超声波的超声波探头，并且基于从超声波探头获得的接收信号生成超声波图像;电池单元，其外部安装在超声波诊断装置主体上，向超声波诊断装置主体供给电力，电池单元包括：电池壳体，由树脂制成，内部装有电池;电连接器，用于连接到超声诊断设备主体，电连接器固定到电池壳体;导电构件设置在电池和电池壳体的内壁之间，导电构件接地到超声波诊断装置主体。