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(54) **PHANTOM AND PHANTOM ASSEMBLY**

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(73) Assignee: **National Institute of Radiological Sciences**

(57) **ABSTRACT**

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A phantom assembly of the present invention comprises a plurality of the phantoms **21**, **22**, and **23**, and a plurality of the phantoms **11**, **12**; and an x-ray radiation from an x-ray CT device inserted in the through-holes.

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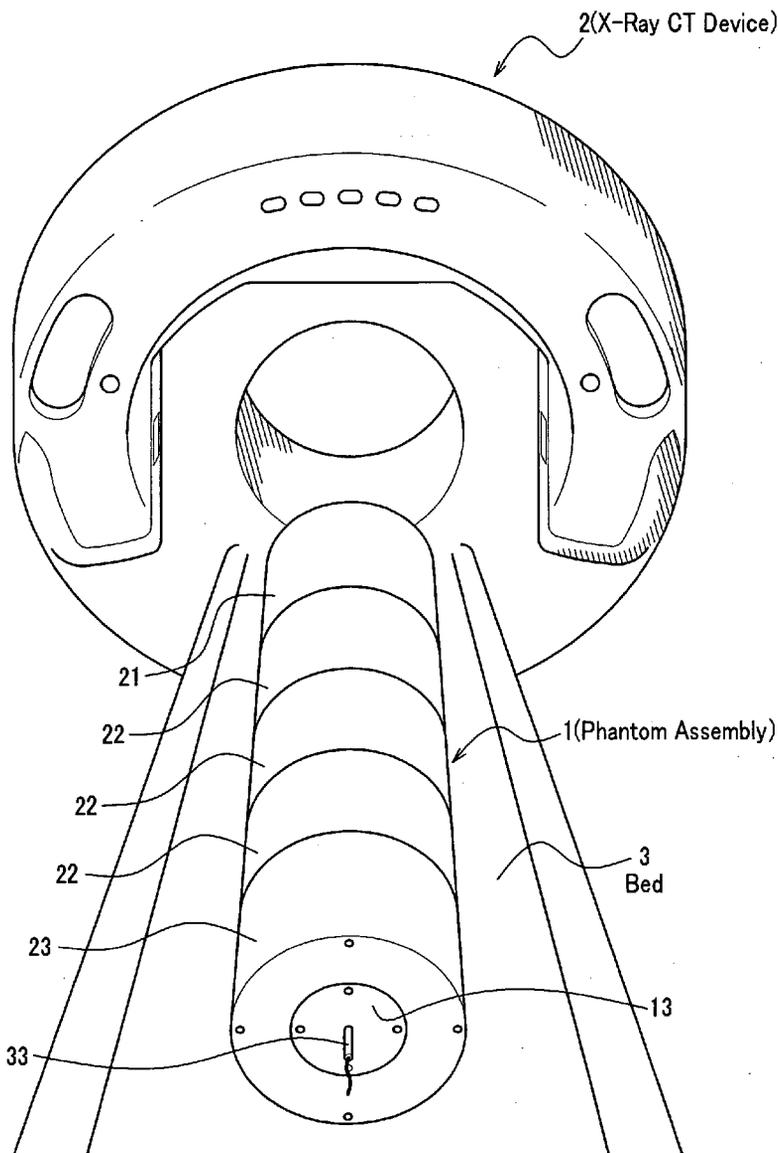
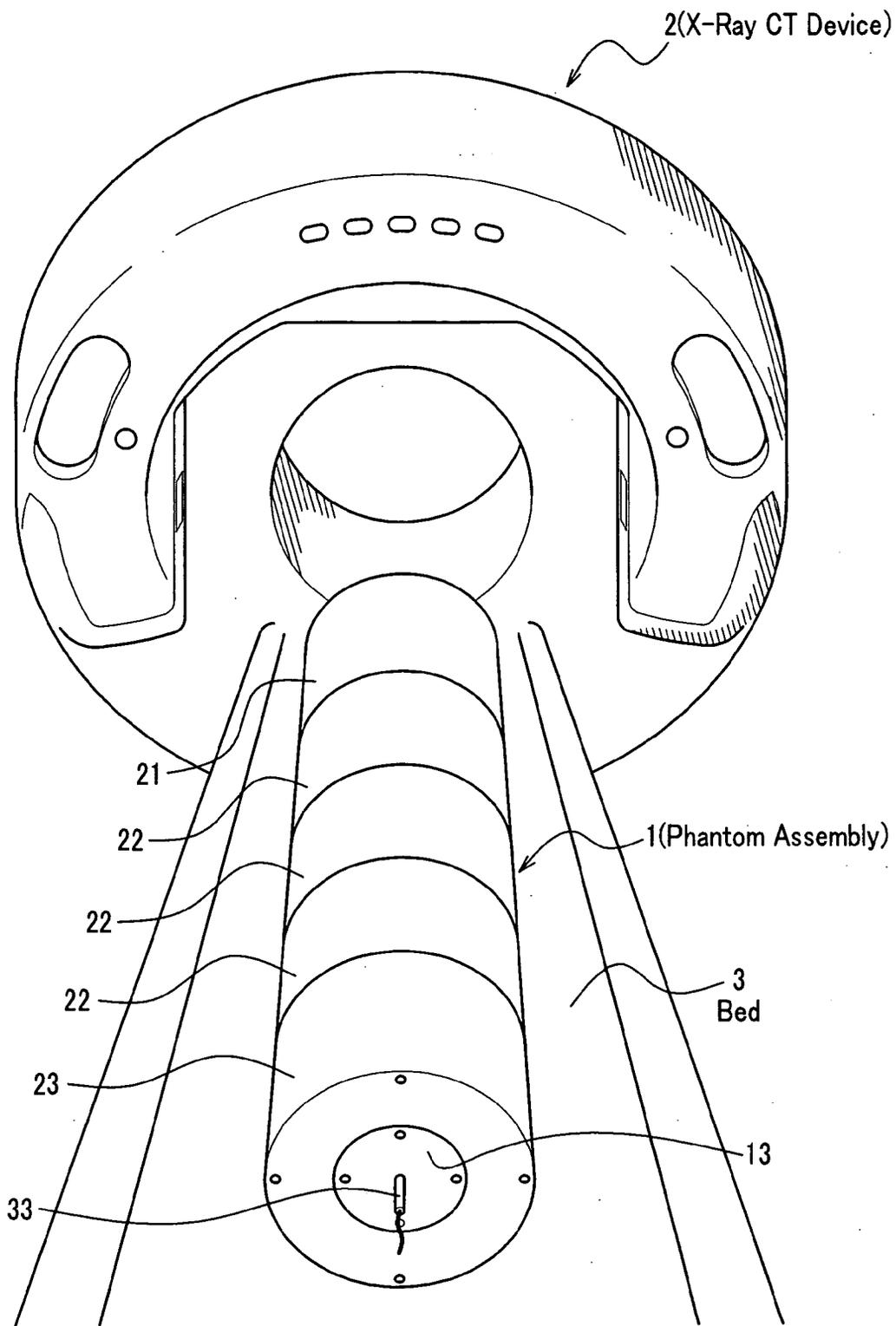


FIG. 1



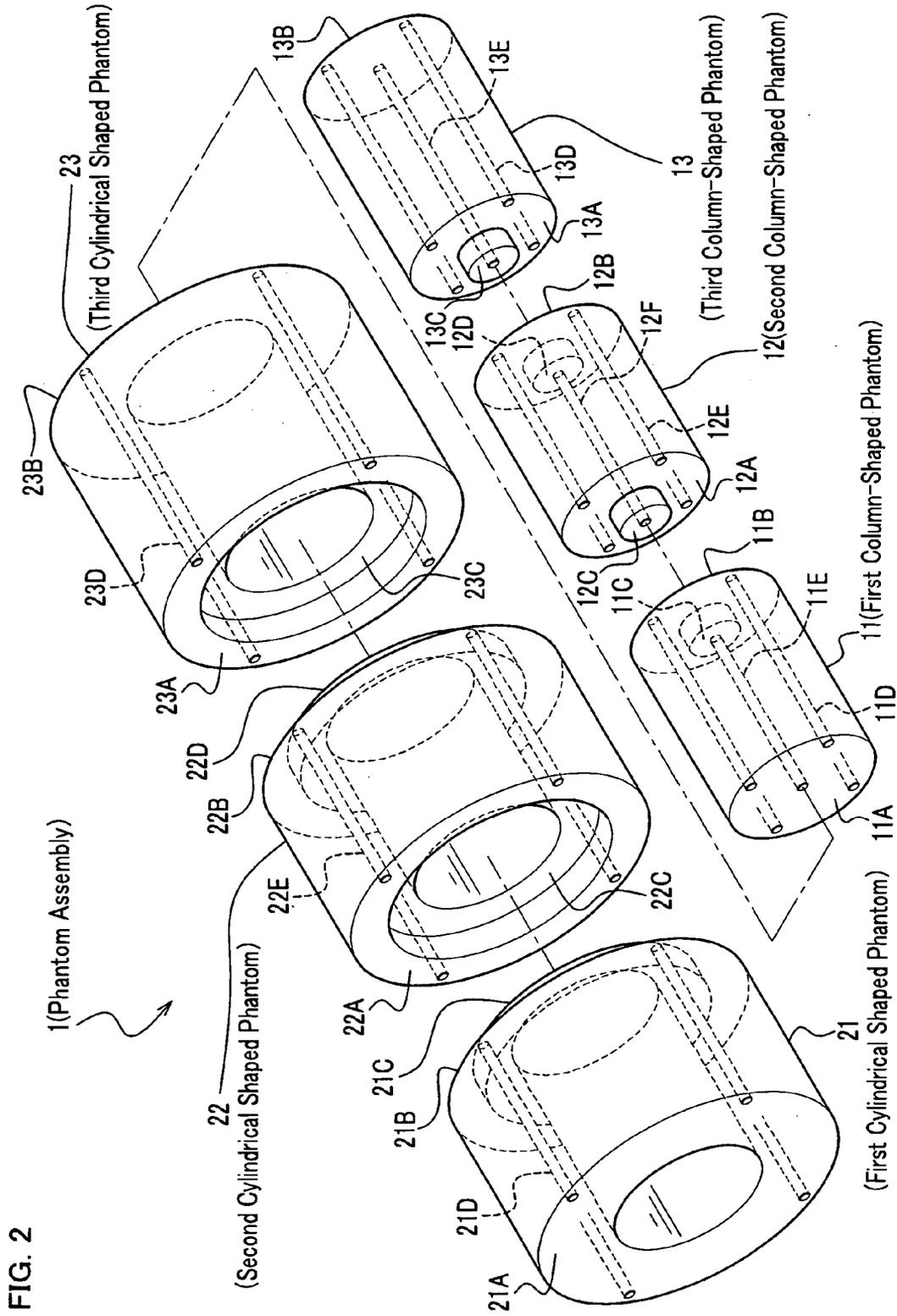


FIG. 3

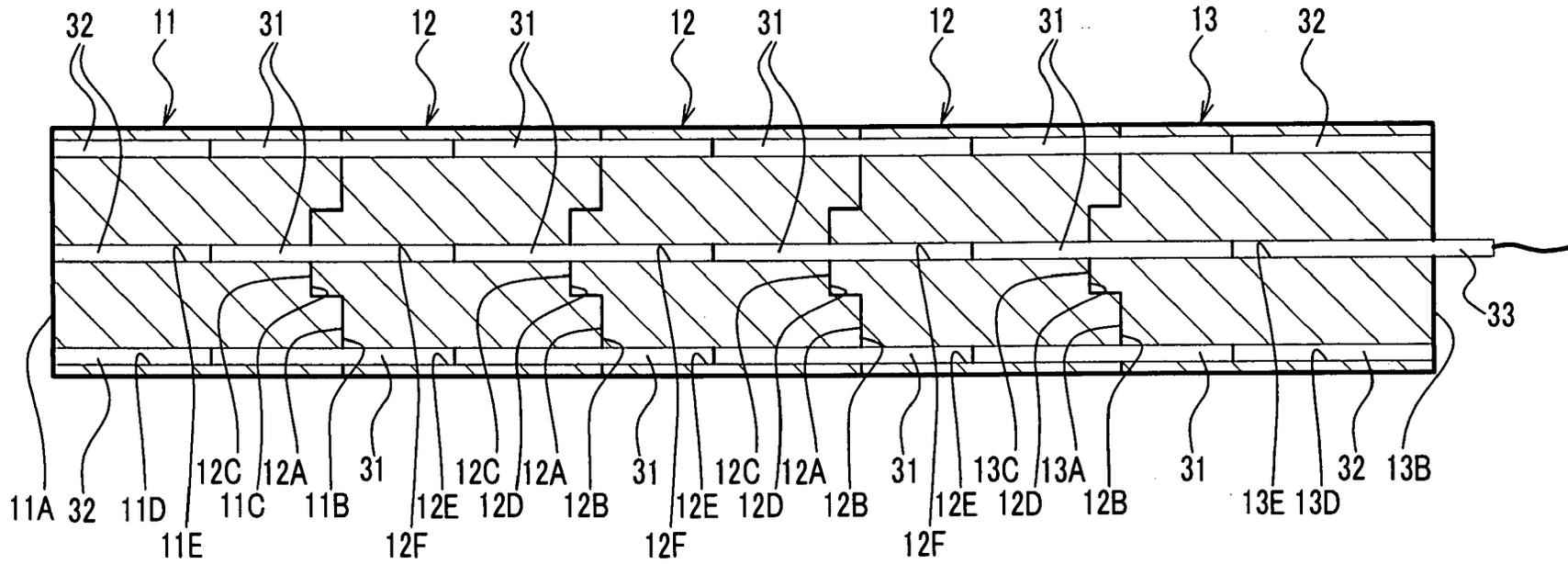


FIG. 4

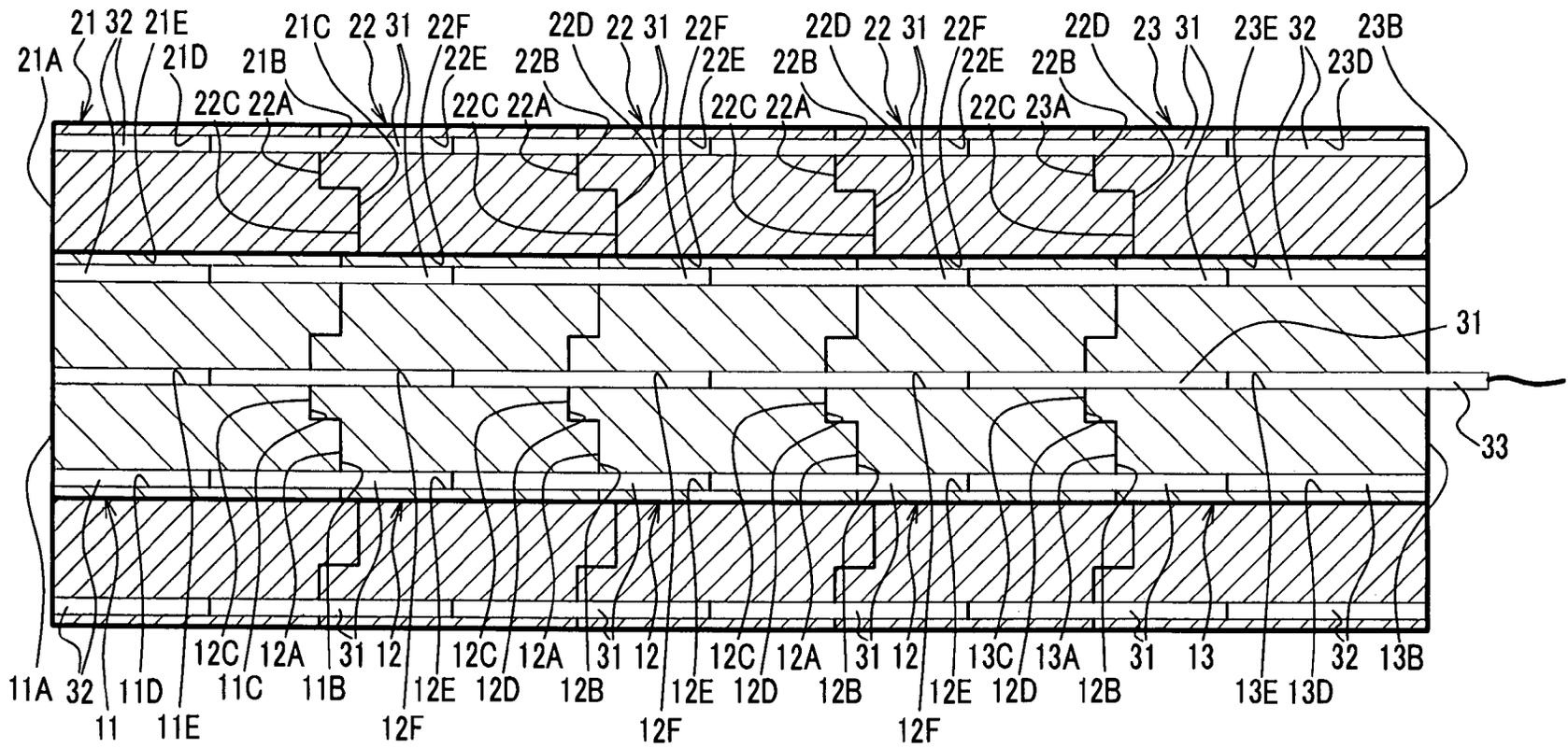


FIG. 5A

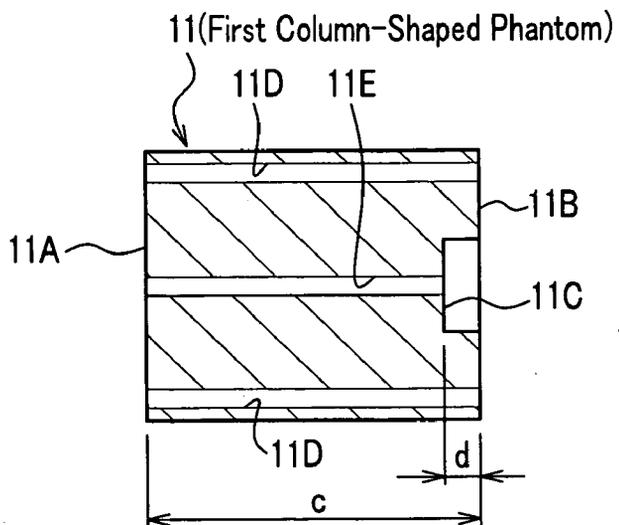


FIG. 5B

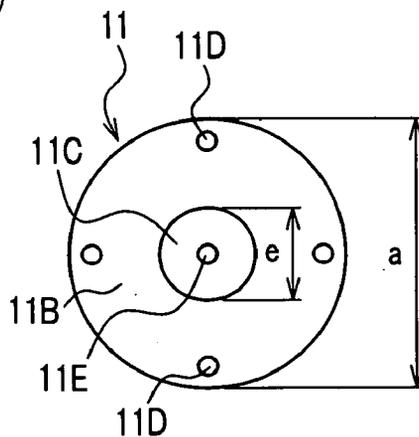


FIG. 6A

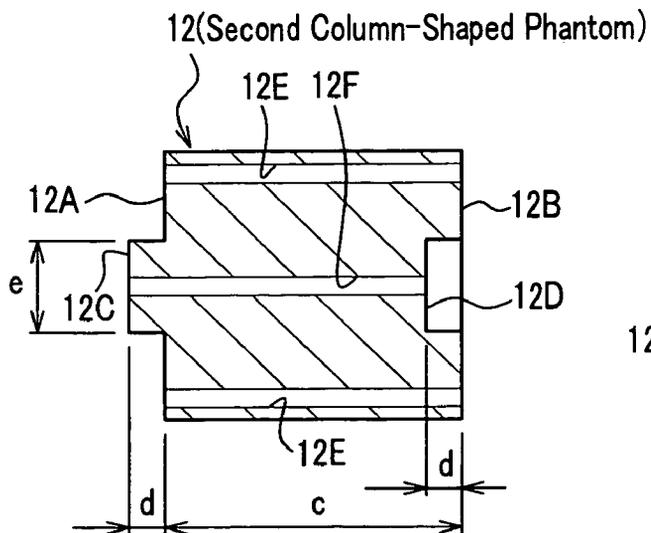


FIG. 6B

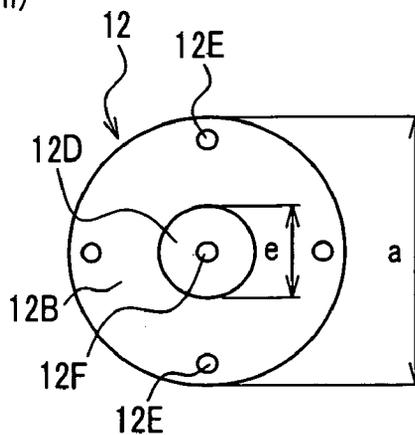


FIG. 7A

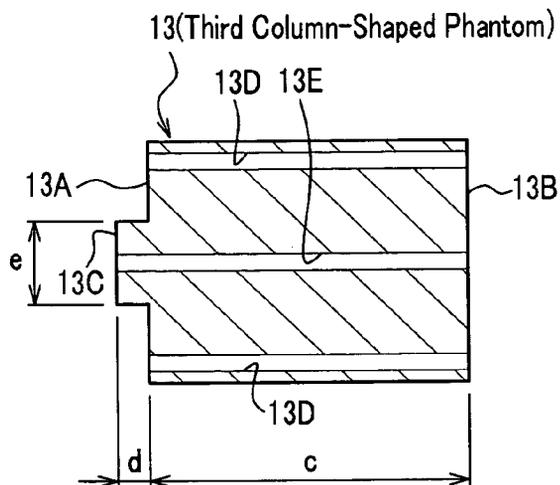


FIG. 7B

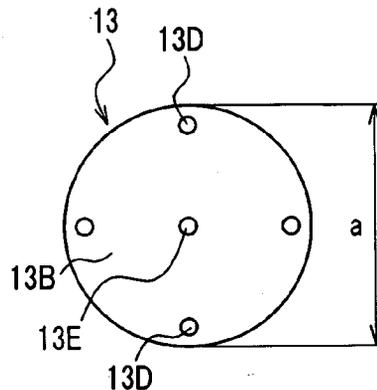


FIG. 8A

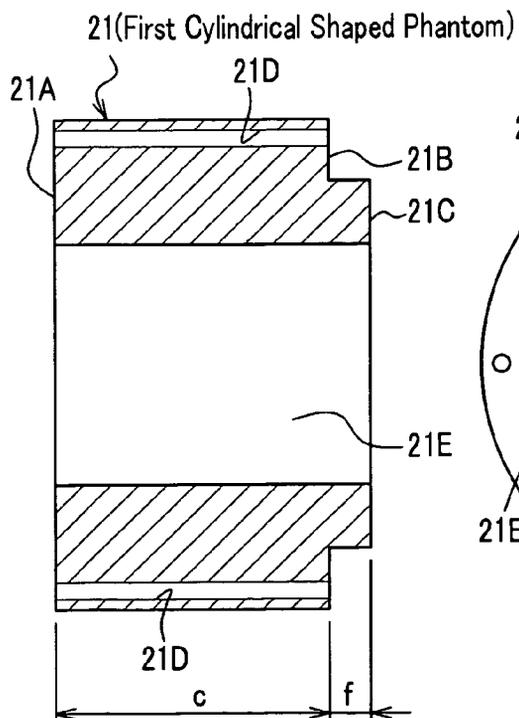


FIG. 8B

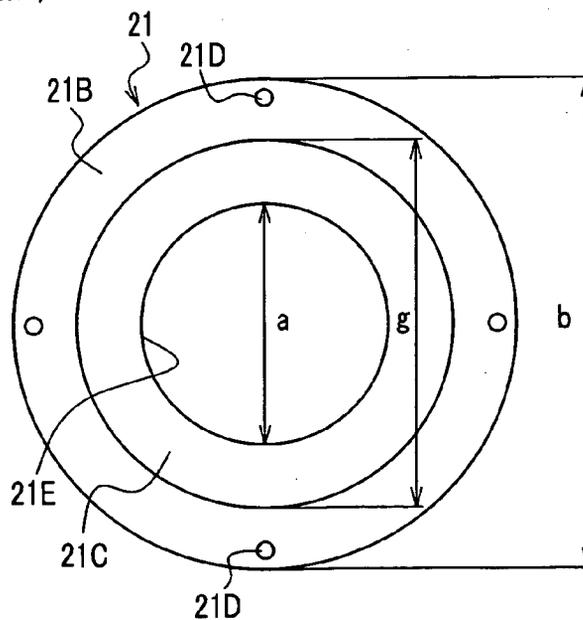


FIG. 9A

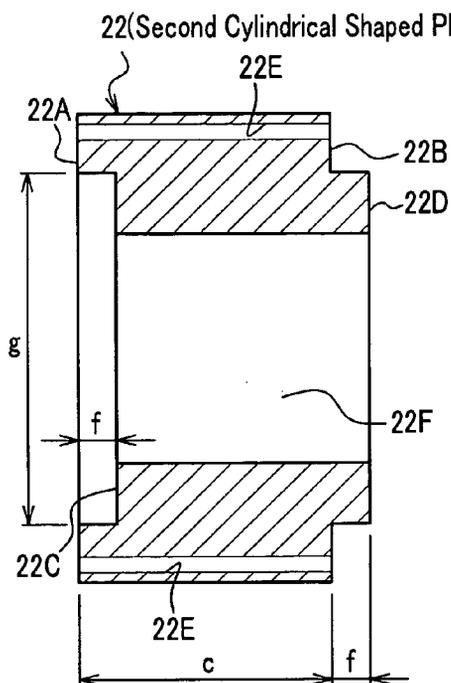


FIG. 9B

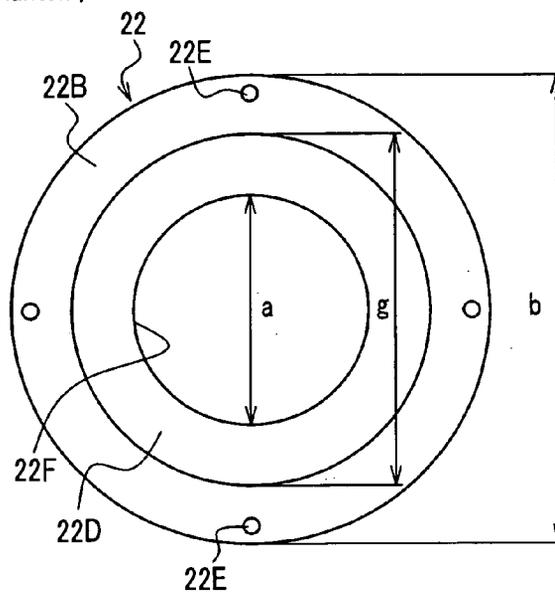


FIG. 10A

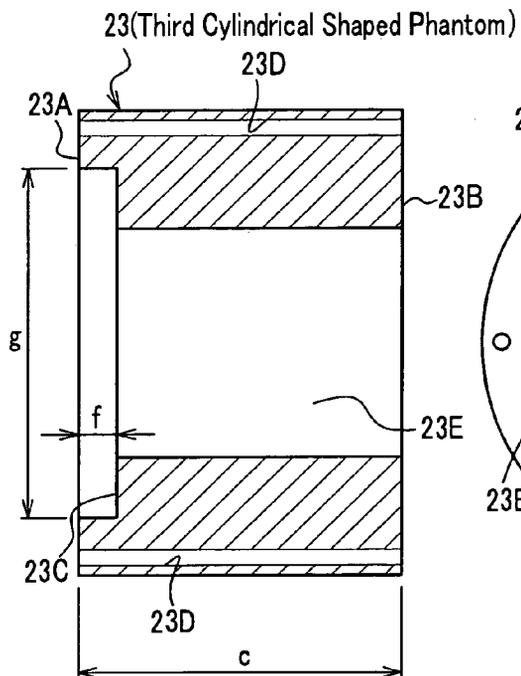


FIG. 10B

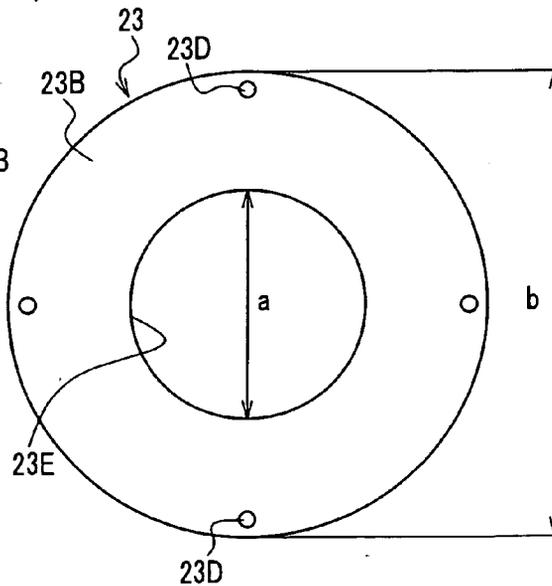


FIG. 11A

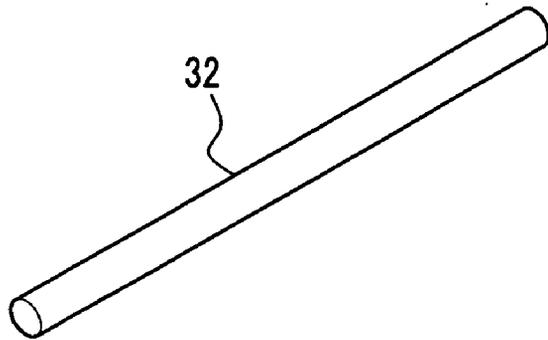


FIG. 11B

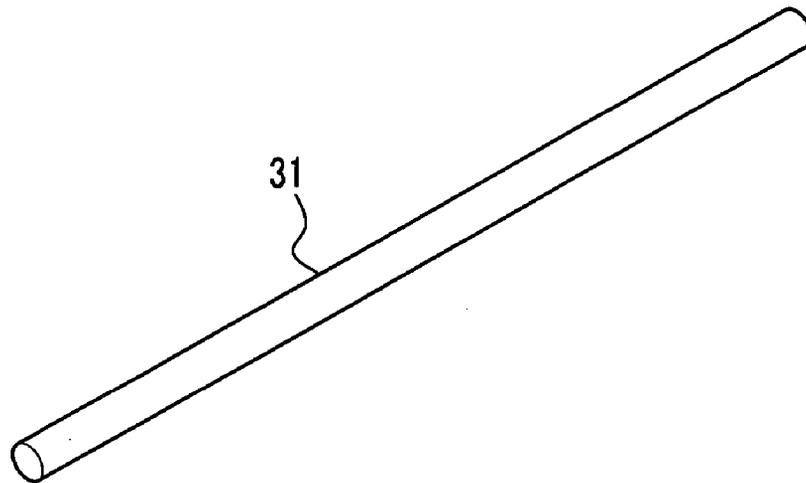


FIG. 12

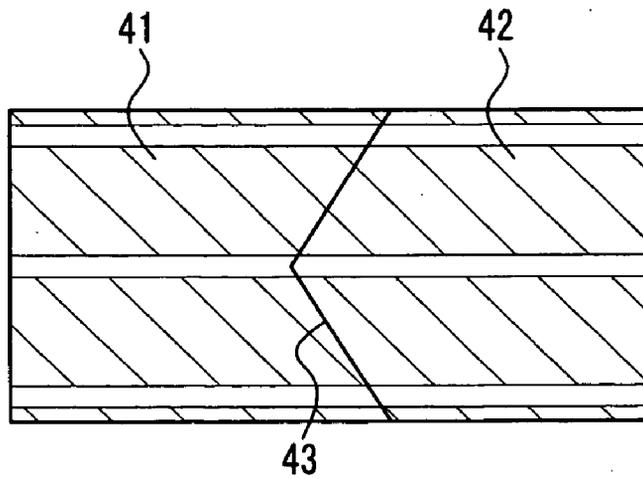
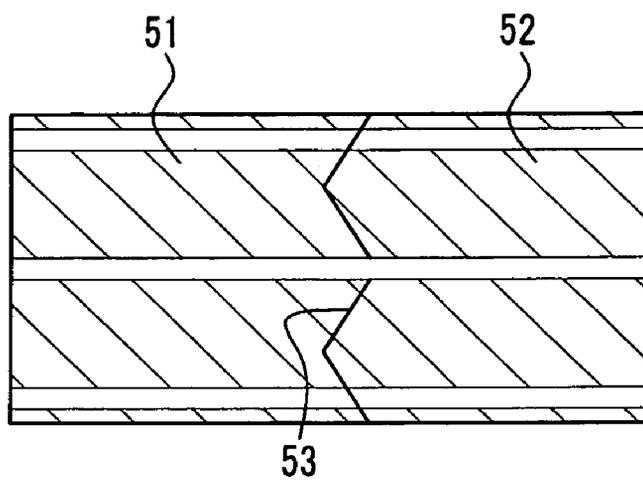


FIG. 13



PHANTOM AND PHANTOM ASSEMBLY

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a phantom and a phantom assembly (phantom unit) used as a dummy for a human body in assessing CT dosage of x-ray radiation, and is based on Japanese Patent Application No. 2003-427312, filed on Dec. 12, 2003, the disclosure of which is incorporated herein by reference.

[0003] 2. Description of Related Arts

[0004] In a conventional assessment of CT dose, phantoms according to IEC (International Electrotechnical Commission) have been used (For example, see International Electrotechnical Commission, "Evaluation and routine testing in medical imaging departments constancy tests-x-ray equipment for computed tomography," pub. IEC, 1223-2-6 (1994); T. B. Shope, R. M. Gane, and G. C. Johnson, "A method for describing the doses delivered by transmission x-ray computed tomography," *Med. Phys.* 8, 448-495 (1981); and W. Leitz, B. Axelsson, and G. Szendro, "Computed tomography dose assessment—A practical Approach." *Radiat. Prot. Dosim.*, 57, 377-380 (1995)). In this case, for example, two phantoms, one for body portion, and another for head, are ready and each made of an acrylic resin and formed into a cylinder having a diameter of 320 mm and 160 mm, respectively, and a length of 150 mm. Cavities (cavity is similar to "hole", so alternative use in throughout the document. I think "hole" is better due to using in IEC document. However "Cavity" is only used in this part.) of 10 mm diameter were located parallel to the central axis of the cylinders, and the centers of the holes were located at the cylinder center and also 10 mm below the cylinder surface at 90 degree intervals (detailed in IEC document), and evaluation of x-ray irradiated onto a human body has been made by inserting a device for measuring dose.

[0005] In the conventional assessment of CT dose as described above, if conical beam having a large beam width of x-ray, what is called, cone beam is assessed by utilizing the phantoms, the phantoms should be form in a shape where the length of the shaft direction is large to meet the shape of the cone beam. In this case, weight and the size of the phantom are increased, inconvenient for carrying the phantom and for storing it. As a result, only an x-ray having a narrow beam width can be assessed by the conventional phantom.

[0006] When an x-ray is irradiated with such a phantom, the x-ray induces scattered radiation within the phantom, which is scattered distributed at random. Accordingly, when the assessment of the x-ray radiation (patient dose) including the scattered radiation will be made, the weight and the size of the phantom will be much more increased, leading to inconvenience in terms of portability and storage of the phantom. (For dose assessment for the cone-beam, although the weight of the phantom will be increased, the phantom length should be longer than the conventional one, because the scattered radiation is distributed wider than that in the narrow beam width.)

[0007] In order to overcome the inadequacy just mentioned, it can be considered that edges portion of phantoms

are lined up in a face-to-face manner whereby the length of the phantoms in the shaft direction is set to be large as a whole. However, lining up of the phantoms has problems that fixation of the phantoms is incomplete and that x-ray radiation is passed through from gaps between the edge portions of the phantoms and, thus, no accurate assessment can be made. In order to make a long phantom from a practical point of view, we joined unit phantoms together to provide phantoms of the necessary length.

[0008] An object of the present invention is to provide a phantom and a phantom assembly which can easily be carried, in which the length of the phantom can be freely set to meet the shape of an x-ray beam, in which phantoms can be tightly connected, and which can assess CT dose of x-ray radiation in an accurate manner without passing the radial from phantoms. By inserting acrylic sticks through these holes, the cylinders were more tightly fixed to each other. Moreover, the connection portion of the phantoms was step-shaped so as not to allow direct passage of x-rays through any gaps.

SUMMARY OF THE INVENTION

[0009] According to a first aspect of the present invention, there is provided a phantom with which an x-ray radiation from an x-ray CT device is irradiated, comprising:

[0010] a fitting portion formed on at least one edge portion of the edge portions of both sides in the shaft direction, and a plurality of through-holes which are pierced through the shaft direction of the phantom.

[0011] In a preferred embodiment, the phantom according to the present invention possesses a totally column-shaped through-hole and the central portion thereof is pierced through the shaft direction of the phantom.

[0012] In a preferred embodiment, the phantom according to the present invention possesses a totally cylindrical-shaped through-hole having a hollow portion in which the hollow portion is pierced through the shaft direction of the phantom.

[0013] According to a second aspect of the present invention, there is provided a phantom assembly comprising:

[0014] a plurality of the phantoms according to the present invention connected with each other at the fitting portions thereof; and

[0015] an x-ray radiation from an x-ray CT device, which has been inserted in the through-holes.

[0016] In a preferred embodiment, a stick or sticks is/are inserted into a part or whole of gaps generated by the through-holes for embedding the gaps.

[0017] More preferably, a stick is arranged over two or more phantoms.

[0018] According to a third aspect of the present invention, there is provided a phantom assembly, comprising

[0019] a plurality of the phantoms according to the present invention, possessing through-holes having a cylindrical shape each having a hollow portion as a whole in which the hollow portion is pierced through the shaft direction of the phantom, connected with each other at the fitting portions thereof,

[0020] a plurality of the phantoms according to the present invention, possessing through-holes having a column shape as a whole and the central portion thereof is pierced through the shaft direction of the phantom inserted into said hollow portions; and

[0021] an x-ray radiation from an x-ray CT device inserted in the through-holes.

[0022] In a preferred embodiment, a stick or sticks is/are inserted into a part or whole of gaps generated by the through-holes except for the portion having the x-ray radiation from an x-ray CT device inserted therein, for embedding the gaps.

[0023] More preferably, a stick is arranged over two or more phantoms.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] FIG. 1 is a perspective view showing an x-ray CT device and a phantom assembly according to one embodiment of the present invention.

[0025] FIG. 2 is an expansion perspective view of the phantom assembly in FIG. 1.

[0026] FIG. 3 is a longitudinal cross-sectional view showing a column-shaped phantom according to the present invention in the state where they are assembled.

[0027] FIG. 4 is a longitudinal cross-sectional view showing a cylindrical phantom according to the present invention in the state where they are assembled.

[0028] FIG. 5 is a drawing showing one first column-shaped phantom in FIG. 3, wherein FIG. 5A is a longitudinal cross-sectional view of the first column-shaped phantom, and FIG. 5B is a right side view of the first column-shaped phantom.

[0029] FIG. 6 is a drawing showing one second column-shaped phantom in FIG. 3, wherein FIG. 6A is a longitudinal cross-sectional view of the second column-shaped phantom, and FIG. 6B is a right side view of the second column-shaped phantom.

[0030] FIG. 7 is a drawing showing one third column-shaped phantom in FIG. 3, wherein FIG. 7A is a longitudinal cross-sectional view of the third column-shaped phantom, and FIG. 7B is a right side view of the third column-shaped phantom.

[0031] FIG. 8 is a drawing showing one first cylindrical phantom in FIG. 4, wherein FIG. 8A is a longitudinal cross-sectional view of the first cylindrical phantom, and FIG. 8B is a right side view of the first cylindrical phantom.

[0032] FIG. 9 is a drawing showing one second cylindrical phantom in FIG. 4, wherein FIG. 9A is a longitudinal cross-sectional view of the second cylindrical phantom, and FIG. 9B is a right side view of the second cylindrical phantom.

[0033] FIG. 10 is a drawing showing one third cylindrical phantom in FIG. 4, wherein FIG. 10A is a longitudinal cross-sectional view of the third cylindrical phantom, and FIG. 10B is a right side view of the third cylindrical phantom.

[0034] FIG. 11 is a drawing showing one stick in FIG. 4, wherein FIG. 11A is a perspective view showing one stick, and FIG. 11B is a perspective view showing another stick.

[0035] FIG. 12 is a longitudinal view showing column-shaped phantoms according to a first variant of the present invention in the state where they are assembled.

[0036] FIG. 13 is a longitudinal view showing column-shaped phantoms according to a second variant of the present invention in the state where they are assembled.

BEST MODES FOR CARRYING OUT THE INVENTION

[0037] The phantoms and the phantom assemblies according to embodiments of the present invention will now be described by referring to FIG. 1 to FIG. 11.

[0038] In the following description, the term "column-shaped phantom" used herein intended to encompass circular solid-, oval solid-, and in some cases, polygonal solid-phantoms. Also, the term "cylindrical shaped" used herein is intended to encompass circular hollow-, oval hollow-, and in some cases, polygonal hollow-phantoms.

[0039] FIG. 1 is a perspective view showing an x-ray CT device and a phantom assembly according to one embodiment of the present invention, and FIG. 2 is an expansion perspective view of the phantom assembly in FIG. 1.

[0040] As shown in FIG. 1, a phantom assembly 1 made of an acrylic resin assuming as a human body is placed on a bed 3 on which a patient is lying, and at this state, an x-ray radiation from an x-ray CT device 2 is irradiated with the phantom 2 to measure an x-ray radiation irradiated onto a human body.

[0041] The phantom assembly 1 according to this embodiment will now be described. As shown in FIG. 2 and FIG. 3, the phantom assembly 1 possesses a first column-shaped phantom 11, a second column-shaped phantom 12, 12, 12 (only one phantom shown in FIG. 2), and a third column-shaped phantom 13. Also, as shown in FIG. 2 and FIG. 4, the phantom assembly 1 possesses a first cylindrical phantom 21, a second cylindrical phantom 22, 22, 22 (only one phantom shown in FIG. 2), and a third cylindrical phantom 23. As shown in FIG. 3, FIG. 4, and FIG. 11, the phantom assembly 1 also possesses a plurality of sticks 31 and 32 (only one stick shown in FIG. 11), which are column-shaped rod members, and a device 33 for measuring dose.

[0042] The cylindrical phantoms 22 and 23 are used as a dummy for measuring dose on a human body. For example, the cylindrical phantom 23 shown in FIG. 2 produced may have an outer diameter of 160 mm to be used for measuring dosage on a head portion; while the cylindrical phantom 22 shown in FIG. 2 produced may have an outer diameter of 320 mm and the cylindrical phantom 23 may be inserted into the hollow portion thereof to be used for measuring dosage on a body portion. This reduces total production cost. Through-holes 22E and 22D are provided for the purpose of the device 33 for measuring dose into the phantom assembly 1. The device 33 for measuring dose measures a strength of the x-ray radiation which is irradiated from the x-ray CT device 2 and arrived at the device 33 while the strength is attenuated during the passage through phantoms 11, 12, 13, 21, 22, and 23 depending upon the passing distance. Each of

sticks 31 and 32 is embedded into spaces of the through-holes 1 ID, 11E, 12R, 12F, 13D, 13E, 21D, 22E, and 23D, to make dose assessment much more accurate.

[0043] As shown in FIG. 2 and FIG. 5, the first column-shaped phantom 11 has edge portions 11A and 11B perpendicular to the shaft direction at both sides of the shaft direction. One edge portion 11A of the first column-shaped phantom 11 perpendicular to the shaft direction is formed as a circular flat surface. In contrast, another edge portion 11B of the first column-shaped phantom 11 perpendicular to the shaft direction has a concave portion 11C for fitting, which is a fitting portion and which has a concave cross-section (formed as a circular hole having a bottom) provided thereon. Four through-holes 11D extending towards the shaft direction and opening towards both edge portions 11A and 11B are formed on the column-shaped phantom 11 at equal intervals in the circumference direction. Another through-holes 11E are also formed on the column-shaped phantom 11 at a central portion along the shaft direction. Both ends of the through-hole 11E are opening towards the edge portion 11A and the concave portion 11C for fitting. As shown in FIG. 5, the column-shaped phantom 11 is formed so as to have an outer diameter [size a] and to have a length in the shaft direction [size c]. The depth of the concave portion 11C for fitting is size d and the hole size of the concave portion 11C for fitting is size e.

[0044] As shown in FIG. 2 and FIG. 6, the second column-shape phantom 12 has edge portions 12A and 12B perpendicular to the shaft direction at both sides of the shaft direction. One edge portion 12A of the second column-shaped phantom 12 perpendicular to the shaft direction has a convex portion 12C for fitting, which is a fitting portion and which has a convex cross-section (formed as a circular column-shaped projection portion) provided thereon. In contrast, another edge portion 12B of the second column-shaped phantom 12 perpendicular to the shaft direction has a concave portion 12D for fitting, which is a fitting portion and which has a concave cross-section (formed as a circular hole having a bottom) provided thereon. Similar to the first column-shaped phantom 11, four through-holes 12E are formed on the column-shaped phantom 12 at equal intervals in the circumference direction, and another through-holes 12F are also formed on the column-shaped phantom 12 at a central portion. As shown in FIG. 6, the column-shaped phantom 12 is formed so as to have an outer diameter [size a] and to have a length in the shaft direction [size c]. The height of the projection possessed by the convex portion 12C for fitting is size d and the depth of the concave portion 12D for fitting is also size d. Further, the outer diameter of the convex portion 12C for fitting and the hole size of the concave portion 12D for fitting are size e.

[0045] As shown in FIG. 2 and FIG. 7, the third column-shaped phantom 13 has edge portions 13A and 13B perpendicular to the shaft direction at both sides of the shaft direction. One edge portion 13A of the third column-shaped phantom 13 perpendicular to the shaft direction has a convex portion 13C for fitting, which is a fitting portion and which has a convex portion 12C for fitting, (formed as a circular column-shaped projection portion) provided thereon. Similar to the first column-shaped phantom 11, four through-holes 13D are formed on the column-shaped phantom 13 at equal intervals, and another through-holes 13E are also formed on the column-shaped phantom 13 at a central

portion. As shown in FIG. 7, the column-shaped phantom 13 is formed so as to have an outer diameter [size a] and to have a length in the shaft direction [size c]. The height of the convex portion possessed by the convex portion 13C for fitting is size d and the outer diameter of the convex portion 13C for fitting is size e.

[0046] As shown in FIG. 2 and FIG. 8, the first cylindrical phantom 21 has edge portions 21A and 22B perpendicular to the shaft direction at both sides of the shaft direction. One edge portion 21A of the first cylindrical phantom 21 perpendicular to the shaft direction is formed as a ring-shaped flat surface. In contrast, another edge portion 21B of the first cylindrical phantom 21 perpendicular to the shaft direction has a cylindrical projection 21C, which is a fitting portion, formed thereon. Four through-holes 21D are formed on the cylindrical phantom 21 at equal intervals in the circumference direction. As shown in FIG. 8, the inner diameter of the hollow portion 21E is set to be size a. Consequently, into the hollow portion 21E of the cylindrical phantom 21 can be inserted the column-shaped phantom 13, which has an outer diameter of size a with no space. The cylindrical phantom 21 is formed so as to have an outer diameter [size a] and to have a length in the shaft direction [size c]. The height of the projection of the convex portion 21C for fitting is size f and the outer diameter size of the convex portion 21C for fitting is set to be size g.

[0047] As shown in FIG. 2 and FIG. 9, the second cylindrical phantom 22 has edge portions 22A and 22B perpendicular to the shaft direction (the term "shaft direction" is described as longitudinal direction in radiology, and the term "perpendicular to the longitudinal direction" is described in transverse direction) at both sides of the shaft direction. One edge portion 22A of the second cylindrical phantom 22 perpendicular to the shaft direction has a stepped portion 22C, which is a fitting portion, formed thereon. In contrast, another edge portion 22B of the second cylindrical phantom 22 perpendicular to the shaft direction has a cylindrical projection 22D, which is another fitting portion, formed thereon. Four through-holes 22E are formed on the cylindrical phantom 22 at equal intervals in the circumference direction. As shown in FIG. 9, the inner diameter of the hollow portion 22F is set to be size a. Consequently, into the hollow portion 22F of the cylindrical phantom 22 can be inserted the column-shaped phantom 12, which has an outer diameter of size a with no space. The depth of the stepped portion 22C of the cylindrical phantom 22 is set to be size f, and the height of the projection of the convex portion 22D for fitting is also set to be size f. The hole size of the stepped portion 22C and the outer diameter size of the convex portion 22D for fitting are set to be size g, respectively.

[0048] As shown in FIG. 2 and FIG. 10, the third cylindrical phantom 23 has edge portions 23A and 23B perpendicular to the shaft direction at both sides of the shaft direction. One edge portion 23A of the third cylindrical phantom 23 perpendicular to the shaft direction has a stepped portion 23C, which is a fitting portion, formed thereon. In contrast. Another edge portion 23B of the third cylindrical phantom 23 perpendicular to the shaft direction is formed as a ring-shaped flat surface. Four through-holes 23D are formed on the cylindrical phantom 23 at equal intervals in the circumference direction. As shown in FIG. 10, the inner diameter of the hollow portion 23E of the

phantom **23** is set to be size a. Consequently, into the hollow portion **23E** of the cylindrical phantom **23** can be inserted the column-shaped phantom **13**, which has an outer diameter of size a with no space. The outer diameter of the cylindrical phantom **23** is set to be size b, and the length in the shaft direction is set to be size c. The depth of the stepped portion **22C** of the cylindrical phantom **22** is set to be size f, and the inner diameter is set to be size g.

[0049] Referring to **FIG. 1** and **FIG. 3**, a method for measuring a dose of x-ray irradiated, for example, onto a human head utilizing the phantom assembly **1** of the present invention will be described. As shown in **FIG. 3**, first, one column-shaped phantom **11**, three cylindrical phantoms **12**, **12**, and **12**, and one column-shaped phantom **13** are ready on a bed **3** (see **FIG. 1**). Then, the convex portion **12C** for fitting of the cylindrical phantom **12** is inserted into and fitted to the concave portion **11C** for fitting of the column-shaped phantom **11**, and the edge portions **11B** and **12A** are collided with each other. Here, since the concave portion **11C** for fitting of the column shaped phantom **11** is set so as to have a depth of size d, and since the projection size of the convex portion **12C** for fitting of the cylindrical phantom **12** is set to be d, these phantoms **11** and **12** are connected without any space. Similarly, with regard to two phantoms **12** and **12**, the convex portion **12C** for fitting is inserted into and fitted to the concave portion **12D** for fitting, whereby they can be connected without any space. Also, with regard to the phantoms **12** and **13**, the convex portion **12C** for fitting is inserted into and fitted to the concave portion **13D** for fitting, whereby they can be connected without any space. In this case, the through-holes **11D**, **11E**, **12E**, **12F**, **13D**, **13E**, **21D**, **22E**, and **23D** provided on the phantoms **11**, **12**, **13**, **21**, **22**, and **23** connect the connected phantoms **11**, **12**, **13**, **21**, **22** and **23** in a straight, respectively.

[0050] Next, the device **33** for measuring dose is inserted, for example, in the through-hole **13E** provided on the column-shaped phantom **13**. The sticks **31** and **32** are inserted into the through-holes **11D**, **11E**, **12E**, **12F**, and **13D** except for the through-hole **13E** having the device **33** for measuring dose inserted therein, to embed the through-holes **11D**, **11E**, **12E**, **12F**, **13D** and part of the through-hole **13E** without any space. In this state, the x-ray radiation from the x-ray CT device **2** is irradiated with the column-shaped phantoms **11**, **12**, **12**, **12**, and **13**, the dose of the x-ray radiation irradiated onto the human head is measured (deduced).

[0051] Subsequently, referring to **FIG. 1** and **FIG. 4**, a method for measuring a dose of x-ray radiation irradiated onto a human body utilizing the phantom assembly **1** of the present invention will be described. First, one cylindrical phantom **21**, three cylindrical phantoms **22**, **22**, and **22**, and one cylindrical phantom **23** are ready on a bed **3** (see **FIG. 1**). Then, the cylindrical projection **21C** of the cylindrical phantom **21** is inserted into and fitted to the stepped portion **22C** of the cylindrical phantom **22**, and the edge portions **21B** and **22A** are collided with each other. Here, since the projection size of the cylindrical projection **21C** of the cylindrical phantom **21** is set to be size f and since the depth of the step of the stepped portion **22C** of the cylindrical phantom **22** is also set to be size f, these phantoms **21** and **22** are connected without any space. Similarly, with regard to two phantoms **22** and **22**, the cylindrical projection **22D** is inserted into and fitted to the stepped portion **22C**,

whereby they can be connected without any space. Also, with regard to the phantoms **22** and **23**, the cylindrical projection **22D** is inserted into and fitted to the stepped portion **23C**, whereby they can be connected without any space.

[0052] Subsequently, the column-shaped phantoms **11**, **12**, **12**, **12**, and **13** are inserted step by step from the side of the hollow portion **23E** of the cylindrical phantom **23**, whereby the column-shaped phantoms **11**, **12**, **12**, **12**, and **13** are inserted into the hollow portions of **21E**, **22F**, **22F**, **22F**, and **23E** without any space, respectively. Subsequently, as shown in **FIG. 4**, the device **33** for measuring dose is inserted, for example, into the through-hole **13E** provided so that it is pierced through the central portion of the column-shaped phantom **13** in the shaft direction. Since total nine through-holes **11D**, **11E**, **12E**, **12F**, **13D**, **13E**, **21D**, **22E**, and **23D** are provided on the phantom assembly **1**, the sticks **31** and **32** are inserted into eight through-holes **11D**, **11E**, **12E**, **12F**, **13D**, **21D**, **22E**, and **23D** except for the through-hole **13E** having the device **33** for measuring dose inserted therein, to embed these through-holes without any space. Preferably, the space of the through-hole **13E** having the device **33** for measuring dose inserted therein is embedded by the through-holes **11E**, and **12F**. It should be noted that in the case where the device **33** for measuring dose is inserted at the central portion of the through-hole **13E**, the portion of the through-hole which takes up the cable cause a cable interruption. For this reason, such a stick as that having a shape of the stick **31** or such cannot be inserted. However, since the influence of the space generated at this portion upon the measurement of dose is enough for the measurement, the stick is not necessarily inserted therein.

[0053] Here, the stick **31** is configured so that it is inserted, for example, over the through-holes **11D** and **12E** of the column-shape phantoms **11** and **12** and also inserted over the through-holes **11E** and **12F**. Similarly, the stick is inserted over the through-holes as for the column-shaped phantoms **12** and **12**, for the cylindrical phantoms **22** and **22** and for the cylindrical phantoms **22** and **23**.

[0054] In this state, the x-ray radiation from the x-ray CT device **2** is irradiated with the column-shaped phantoms **11**, **12**, **12**, **12**, and **13**, the dose of the x-ray radiation irradiated onto the human body is measured (deduced).

[0055] Consequently, according to this embodiment, by suitably connecting the short column-shaped phantoms **11**, **12**, **12**, and **13** and the short cylindrical phantoms **21**, **22**, **22**, **22**, and **23** or separating the connected phantom(s) to meet the shape of the beam, the whole length of the phantom assembly **1** can be changed in a step-by-step manner. For this reason, the phantom assembly **1** according to this embodiment can be applicable over all of the dose assessment of beams from those which have short beam width irradiated from the x-ray CT device from cone beams, which are long beam length.

[0056] By setting the whole length of the phantom assembly **1** at long, at the time of irradiation of x-ray radiation, the scattered radiation generated within the phantom assembly **1** can be capture by the phantom assembly **1** and, thus, the assessment considering the scattered radiation can be made. Consequently, the x-ray dose assessment can be performed in an accurate manner.

[0057] Since the column-shaped phantoms **11**, **12**, **12**, and **13** and the cylindrical phantoms **21**, **22**, **22**, **22**, and **23** can

be separated into pieces from the phantom assembly 1, the space for storing the column-shaped phantoms 11 to 13 and the cylindrical phantoms 22 to 23 can easily be ensured and the transferring can easily be made.

[0058] What is more, since the phantom assembly 1 according to the present invention has a configuration that the column-shaped phantoms 11, 12, 12, 12, and 13 and the cylindrical phantoms 21, 22, 22, 22, and 23 are inserted into and fitted with each other by inserting the concave portions 11C and 12D for fitting into the convex portions 12C and 13C to be fitted with each other, and/or when the projection size d, for example, of the convex portion 12C of the phantom 11C to be fitted is made to a minus allowance relative to the depth d, for example, of the concave portion 11C for fitting of the phantom 11 so that edge portions 11B and 12A can be closely contact with each other, an amount of x-ray radiation passing through a space, for example, between the edge portion 11B of the column-shaped phantom 11 and the edge portion 12A of the column-shaped phantom 12, and a space, for example, between the edge portion 12B of the column-shaped phantom 12 and the edge portion 13A of the column-shaped phantom 13 can be markedly decreased. This also makes it possible to perform x-ray dose assessment in a much more accurate manner.

[0059] Similarly, when the cylindrical phantoms 21, 22, 22, 22, and 23 are fitted to each other, it becomes difficult to pass the x-ray radiation form a space, for example, between the edge portion 21B of the cylindrical phantom 21 and the edge portion 22A of the cylindrical phantom 22, and a space, for example, between the edge portion 22B of the cylindrical phantom 22 and the edge portion 23A of the cylindrical phantom 23. This also makes it possible to perform x-ray dose assessment in a much more accurate manner.

[0060] Also, as described above, since it is configured that the column-shaped phantoms 11, 12, 12, 12, and 13 are tightly connected (fitted) to each other by inserting the concave portions 11C and 12D for fitting into the convex portions 12C and 13C for fitting, these phantoms 11, 12, 12, 12, and 13 can be fixed in a stable manner. By inserting acrylic sticks through these holes, the phantoms were more tightly fixed to each other.

[0061] Furthermore, since it is configured that the stick 31 is inserted over a plurality of through-holes of the column-shaped phantoms, i.e., through-holes 11D and 11E of the column-shaped phantom 11, and through-holes 12E and 12F of the column-shaped phantom 12, the column-shaped phantoms can be connected by the stick 31 in much more tight manner. Similarly, when the stick 31 is inserted over a plurality of through-holes of the cylindrical phantoms, the cylindrical phantoms 21 and 22, the cylindrical phantoms 22 and 22, and the cylindrical phantoms 22 and 23 can also be much more tightly fixed.

[0062] In the foregoing embodiments, while the collision surface between the column-shaped phantoms 11 and 12 is configured to be formed into a stepped shaped, it should be noted that the present invention is not restricted thereto. For example, as shown in FIG. 12, which shows a first variant, a collision surface 42 between column-shaped phantoms 41 and 42 may be formed into a tapered shape where the collision surface 42 is slanted. Also, as shown in FIG. 13, which shows a second variant, a collision surface 52 between column-shaped phantoms 51 and 52 may be formed into a cone shape.

[0063] Also, in the foregoing embodiments, the case where three column-shaped phantoms 12 are utilized has been exemplified, the present invention is not restricted thereto. For example, four or more phantoms or two phantoms may be used to meet the shape of the x-ray. Also, the column-shaped phantoms 12 may not used and the column-shaped phantoms 11 and 13 may be directly connected.

[0064] Furthermore, in the foregoing embodiments, the case where three cylindrical phantoms 22 are utilized has been exemplified, the present invention is not restricted thereto. For example, four or more phantoms or two phantoms may be used to meet the shape of the x-ray. Also, the cylindrical phantoms 22 may not used and the cylindrical phantoms 21 and 23 may be directly connected.

[0065] Also, in the foregoing embodiments, the case where the device 33 for measuring dose is inserted into the through-hole 13E has been exemplified, the present invention is not restricted thereto. For example, one or more device(s) 33 for measuring dose may be inserted into one or more of through-hole(s) 11E, 12E, 12F, 13D, 21D, 22E, and 23D.

[0066] While the phantom assembly where the column-shaped phantoms 11 to 13 are inserted into the cylindrical phantoms 21 to 23 has been exemplified to be used for assessment for a head portion, the present invention is not restricted thereto. For example, column-shaped phantoms having an outer diameter substantially the same as that of the cylindrical phantoms are produced and they may be connected for use in assessment of body.

[0067] Also, the hole size (inner diameter) of each of the through-holes 11D, 11E, 12E, 12F, 13D, 13E, 21D, 22E, and 23D may be determined so to meet the outer shape of the device 33 for measuring dose, and the hole size (inner sizes) a of each of the hollow portions 21E, 22F, and 23E may be determined so as to the outer sizes a of each of the column-shaped phantoms 11, 12 and 13. The number of through-holes 11D, 11E, 12R, 12F, 13D, 13E, 21D, 22E, and 23F may be determined depending upon the object of the measurement.

What is claimed is:

1. A phantom with which an x-ray radiation from an x-ray CT device is irradiated, comprising:

a fitting portion formed on at least one edge portion of the edge portions of both sides in the shaft direction, and

a plurality of through-holes which are pierced through the shaft direction of the phantom.

2. The phantom according to claim 1, which possesses a totally column-shaped through-hole and the central portion thereof is pierced through the shaft direction of the phantom.

3. The phantom according to claim 1, which possesses a totally cylindrical-shaped through-hole each having a hollow portion in which the hollow portion is pierced through the shaft direction of the phantom.

4. A phantom assembly comprising:

a plurality of the phantom according to the present invention connected with each other at the fitting portions thereof; and

an x-ray radiation from an x-ray CT device, which has been inserted in the through-holes.

5. The phantom assembly according to claim 4, wherein a stick or sticks is/are inserted into a part or whole of gaps generated by the through-holes for embedding the gaps.

6. The phantom assembly according to claim 5, a stick is arranged over two ore more phantoms.

7. A phantom assembly, comprising

a plurality of the phantoms each possessing through-holes having a cylindrical shape each having a hollow portion as a whole in which the hollow portion is pierced through the shaft direction of the phantom, connected with each other at the fitting portions thereof;

a plurality of the phantoms, possessing through-holes having a column shape as a whole and the central

portion thereof is pierced through the shaft direction of the phantom inserted into said hollow portions; and

an x-ray radiation from an x-ray CT device inserted in the through-holes.

8. The phantom assembly according to claim 7, wherein a stick or sticks is/are inserted into a part or whole of gaps generated by the through-holes for embedding the gaps.

9. The phantom assembly according to claim 8, a stick is arranged over two ore more phantoms.

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