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(54) PHANTOM AND PHANTOM ASSEMBLY

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(57) ABSTRACT

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.

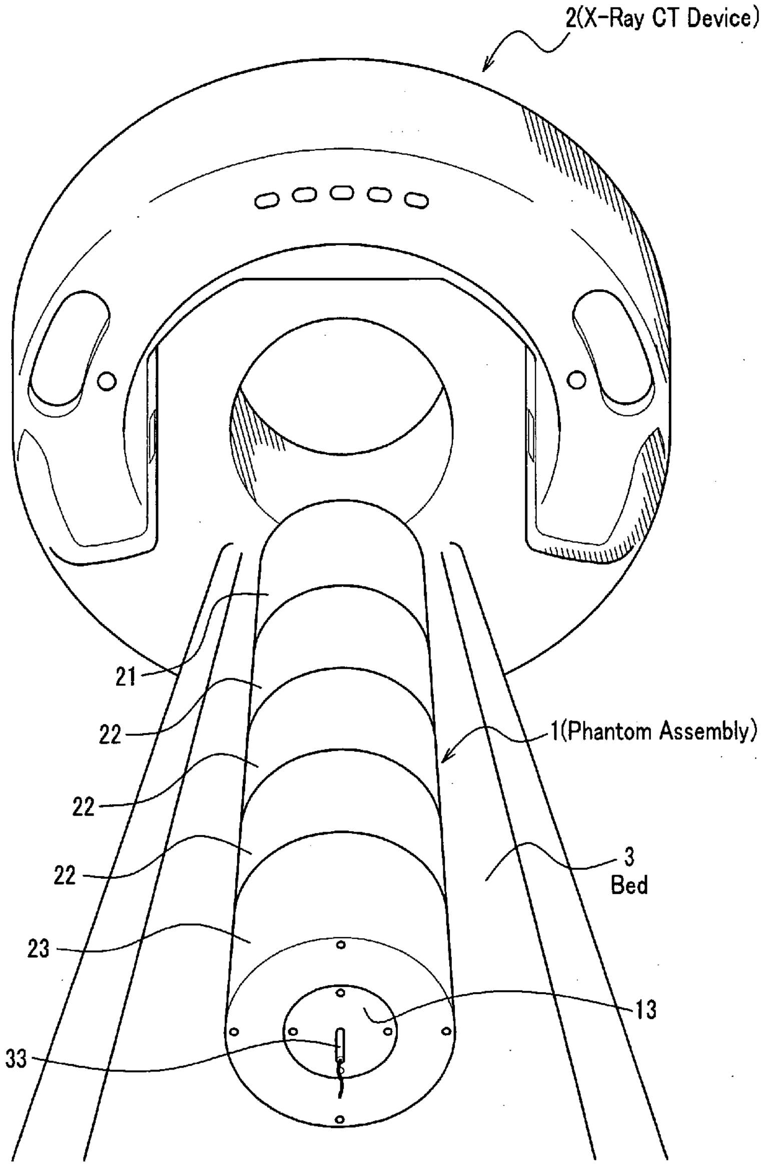


FIG. 1

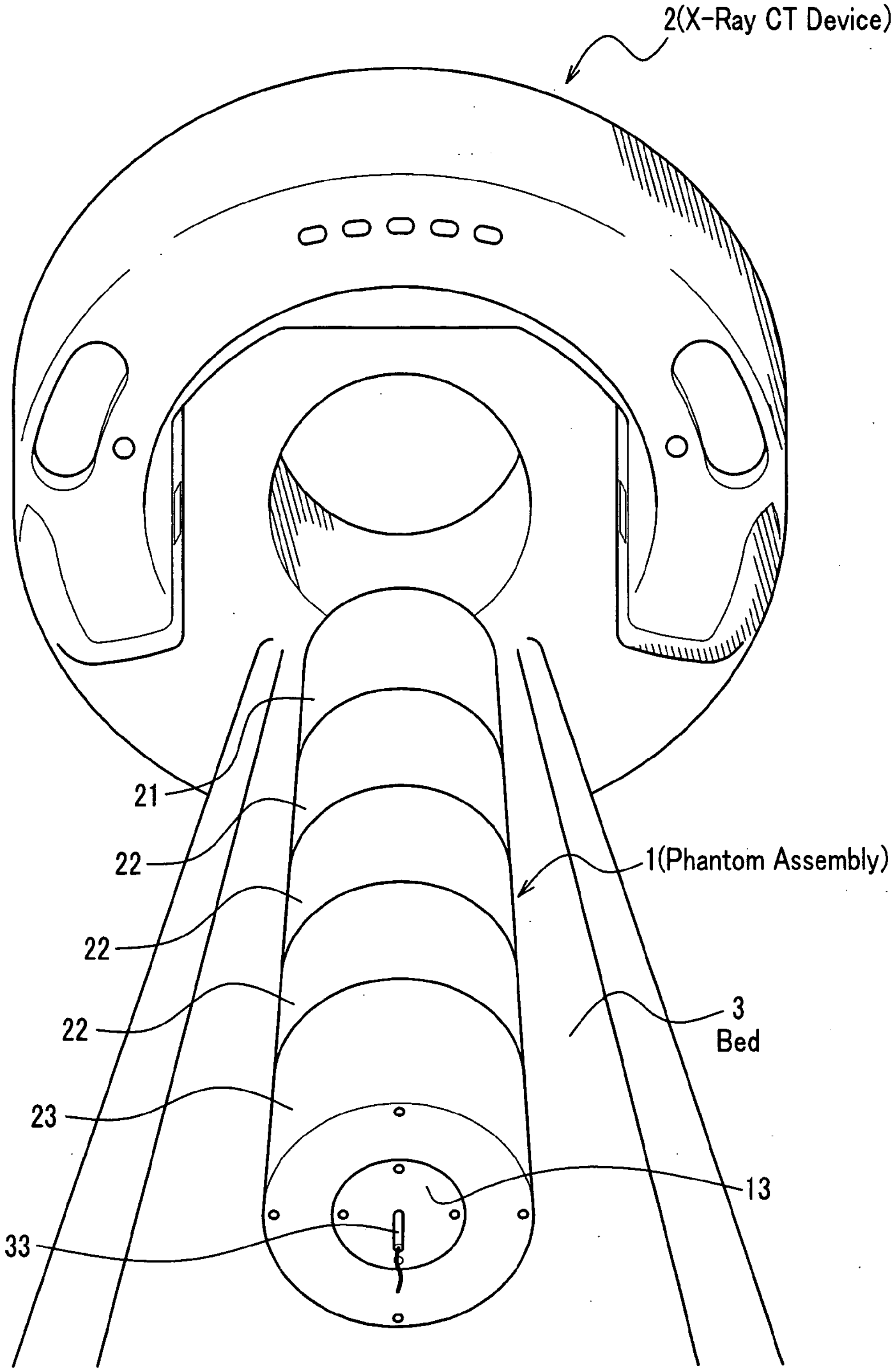


FIG. 2

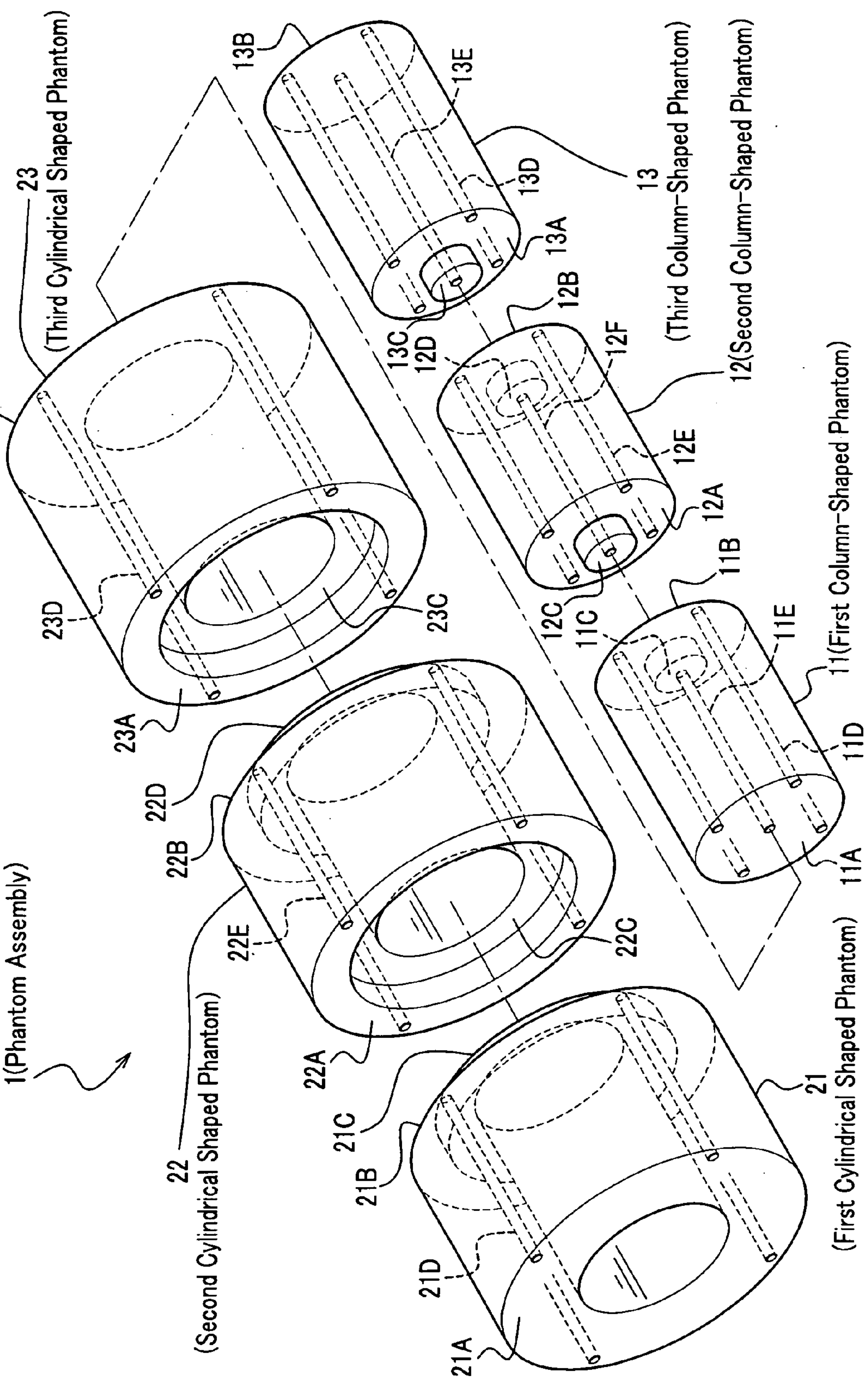

1(Phantom Assembly)
21 (First Cylindrical Shaped Phantom)
21A
21B
21C
21D
22 (Second Cylindrical Shaped Phantom)
22A
22B
22C
22D
22E
23 (Third Cylindrical Shaped Phantom)
23A
23B
23C
23D
11(First Column-Shaped Phantom)
11A
11B
11C
11D
11E
12(Second Column-Shaped Phantom)
12A
12B
12C
12D
12E
12F
13 (Third Column-Shaped Phantom)
13A
13B
13C
13D
13E

FIG. 3

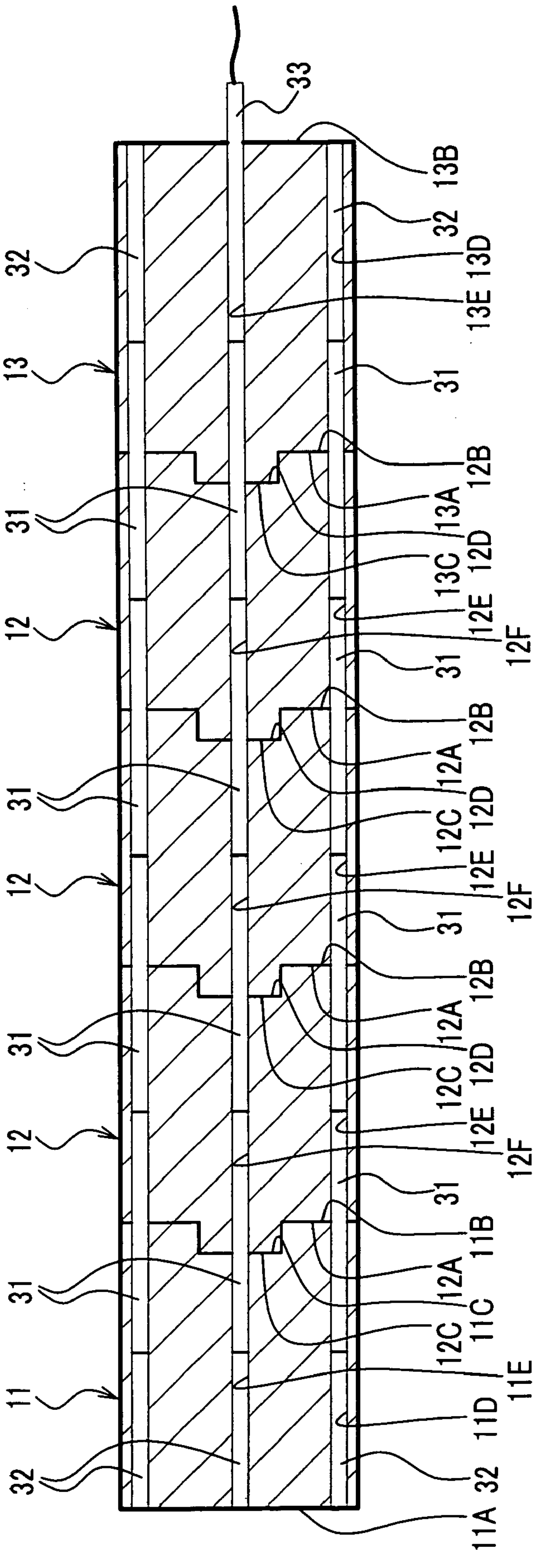

33
13B
32
13D
13E
31
12B
13A
13C
12D
12E
12F
12A
12C
11B
11C
11E
11D
11A
32
31
13
12
11

FIG. 4

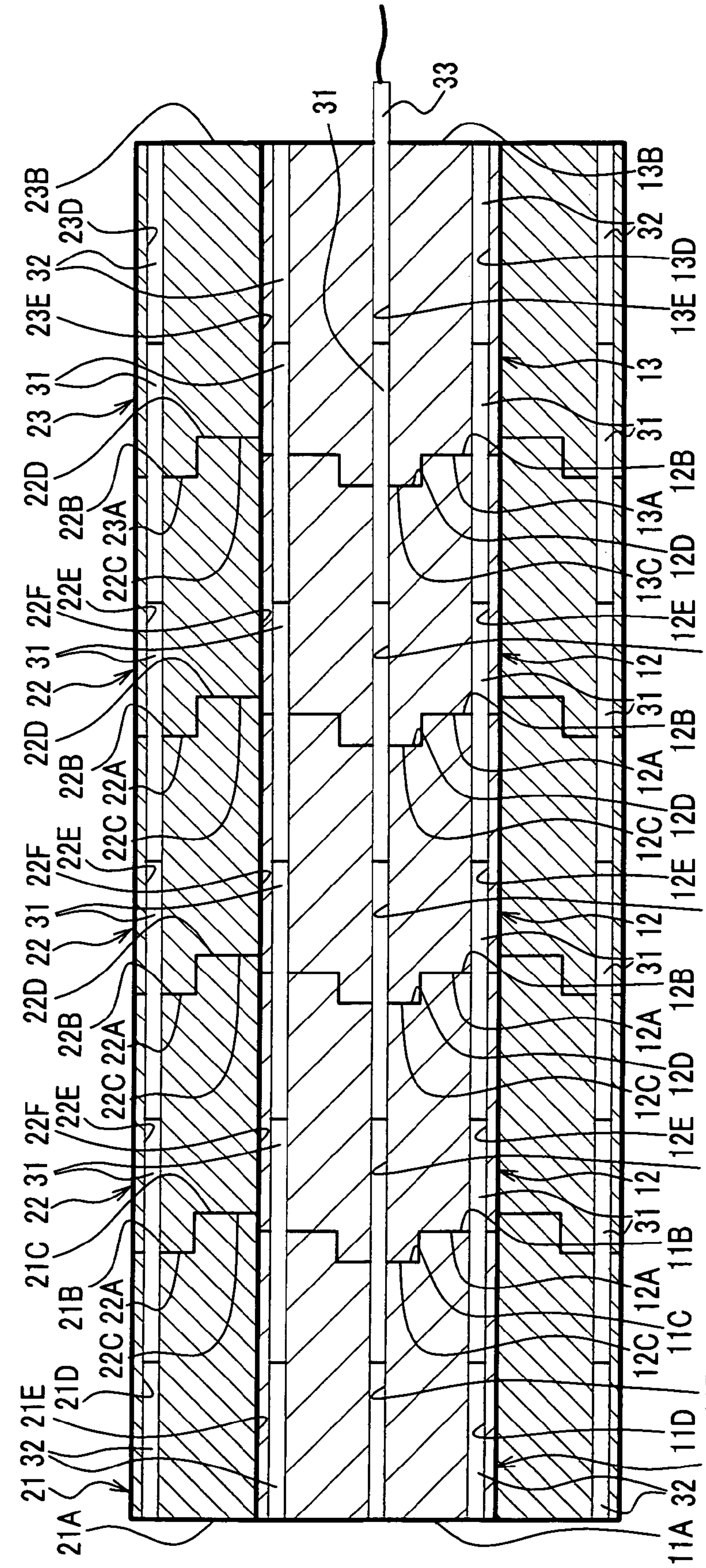

33
31
23B
23D
23E 32
23 31
22D
22B
22C 23A
22F
22E
22 31
22C 22A
21C
21B
22C 22A
21E
21D
21 32
21A
13B
32
13D
13E
13
31
12B
13A
13C 12D
12E
12F
12
12A
12C 12D
11B
12C 12A
11C
11E
11D
11
11A 32

FIG. 5A

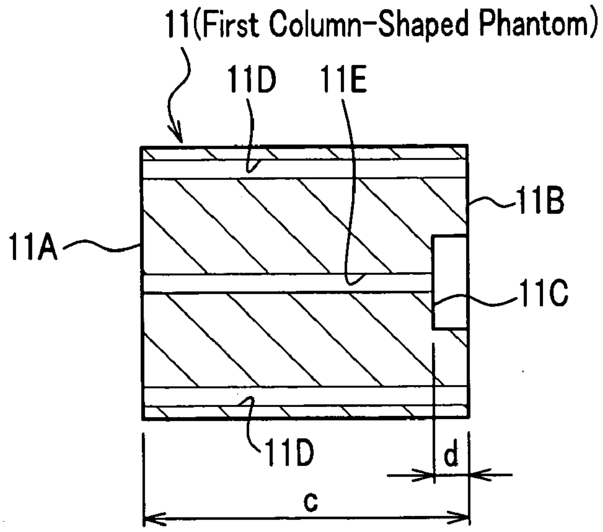


FIG. 5B

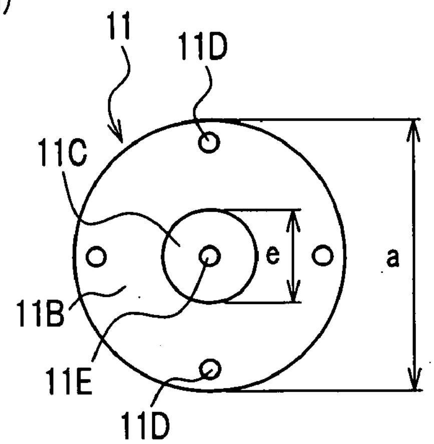


FIG. 6A

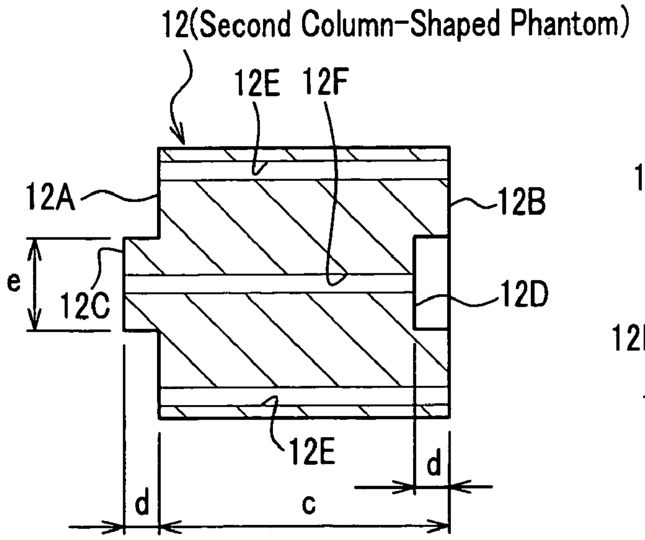


FIG. 6B

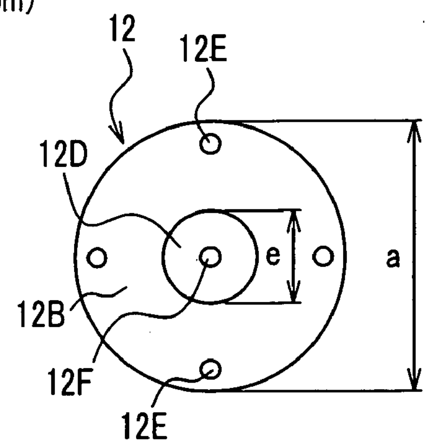


FIG. 7A

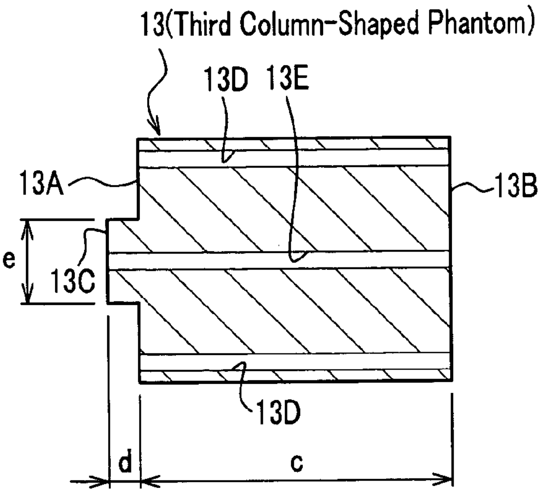


FIG. 7B

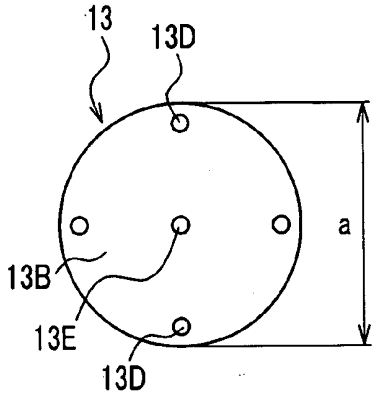


FIG. 8A

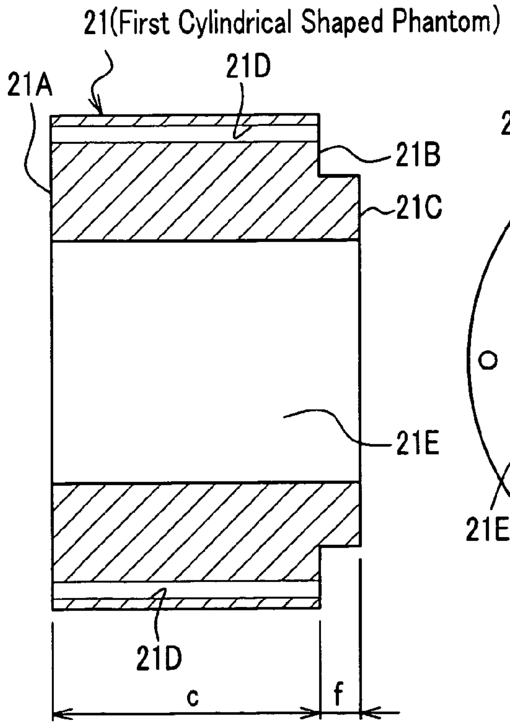


FIG. 8B

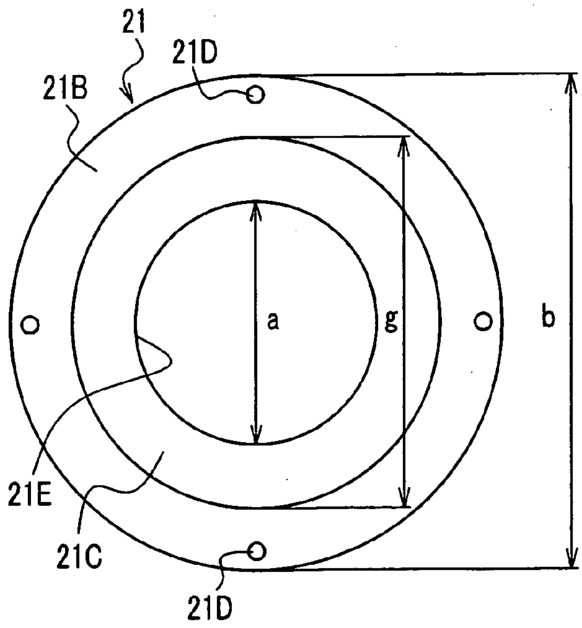


FIG. 9A

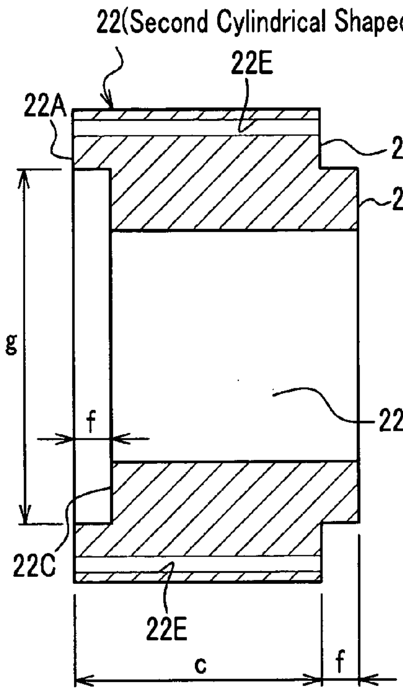


FIG. 9B

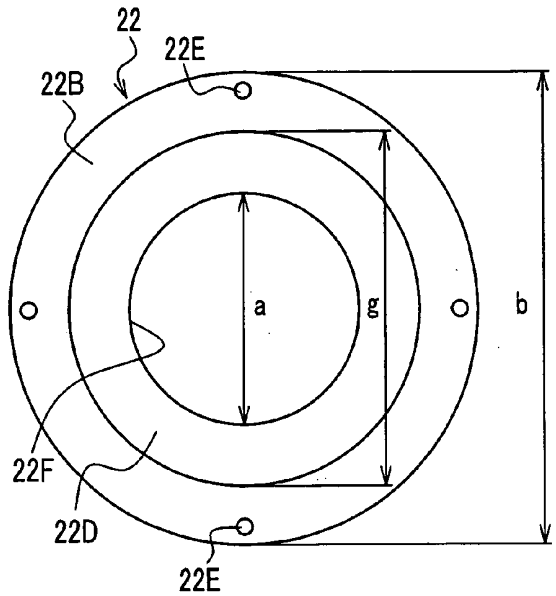


FIG. 10A

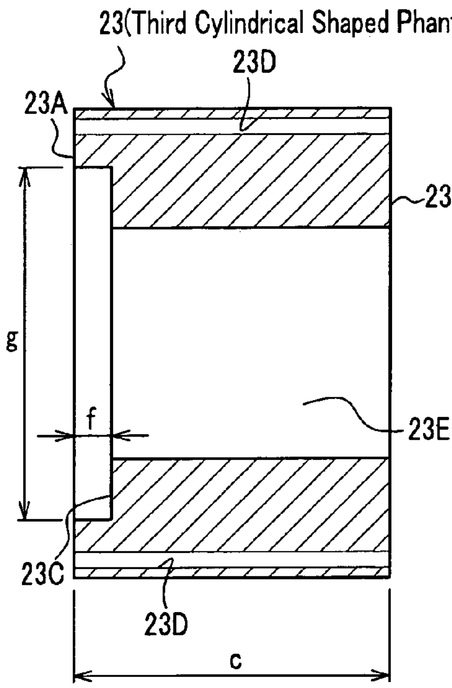


FIG. 10B

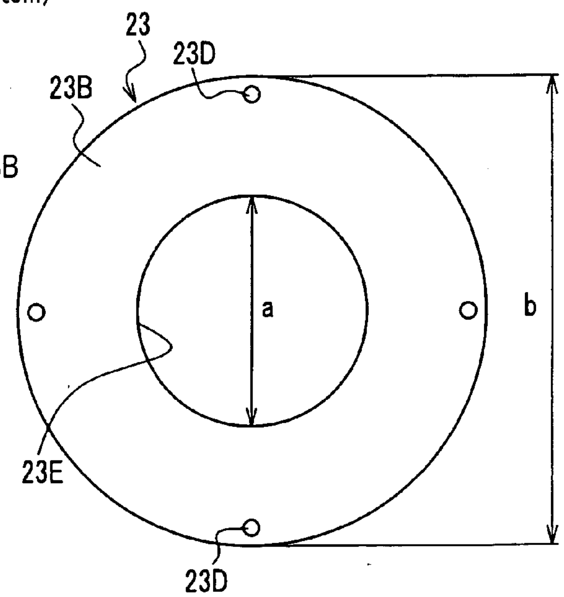


FIG. 11A

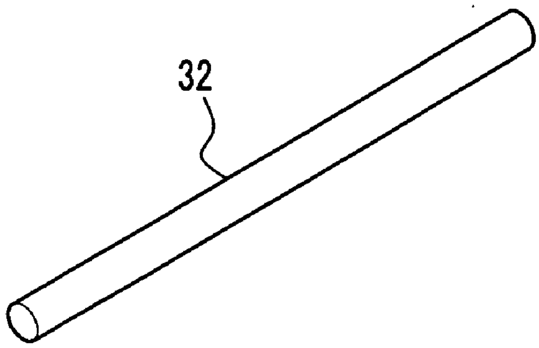


FIG. 11B

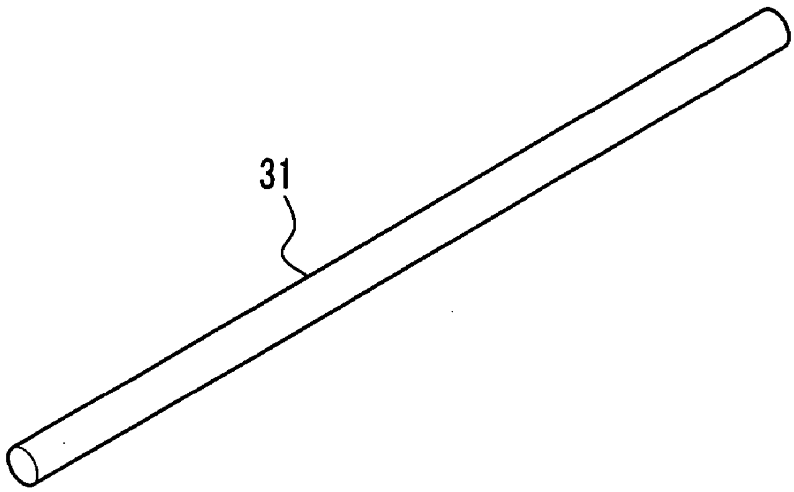


FIG. 12

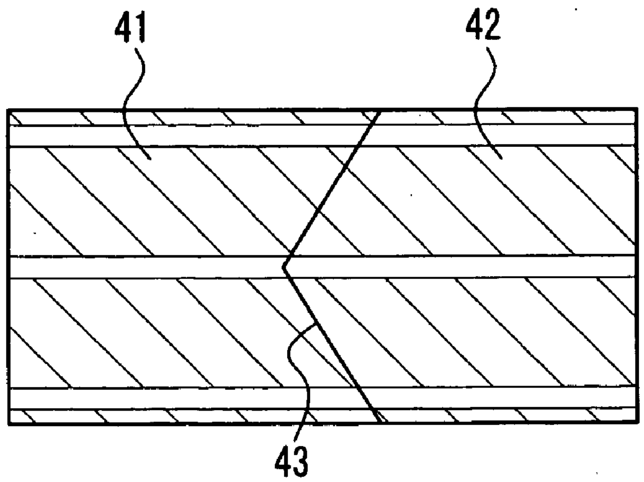
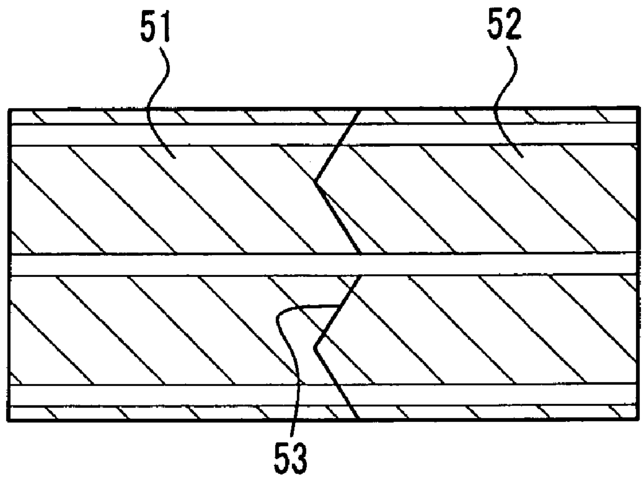


FIG. 13



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 does 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 ore more phantoms.

[0018] According to a third aspect of the present invention, there is a 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 ore 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 phantoms according to the present invention in the state where they are assembled.

[0027] **FIG. 4 a** longitudinal cross-sectional view showing a cylindrical phantom phantoms 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. 5B** 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 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 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 phantoms **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 phantoms **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 member, 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 **11**A and **11**B perpendicular to the shaft direction at both sides of the shaft direction. One edge portion **11**A of the first column-shaped phantom **11** perpendicular to the shaft direction is formed as a circular flat surface. In contrast, another edge portion **11**B of the first column-shaped phantom **11** perpendicular to the shaft direction has a concave portion **11**C 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 **11**D extending towards the shaft direction and opening towards both edge portions **11**A and **11**B are formed on the column-shaped phantom **11** at equal intervals in the circumference direction. Another through-holes **11**E are also formed on the column-shaped phantom **11** at a central portion along the shaft direction. Both ends of the through-hole **11**E are opening towards the edge portion **11**A and the concave portion **11**C 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 **11**C for fitting is size d and the hole size of the concave portion **11**C for fitting is size e.

[0044] As shown in **FIG. 2** and **FIG. 6**, the second column-shape phantom **12** has edge portions **12**A and **12**B perpendicular to the shaft direction at both sides of the shaft direction. One edge portion **12**A of the second column-shaped phantom **12** perpendicular to the shaft direction has a convex portion **12**C 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 **12**B of the second column-shaped phantom **12** perpendicular to the shaft direction has a concave portion **12**D 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 **12**E are formed on the column-shaped phantom **12** at equal intervals in the circumference direction, and another through-holes **12**F 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 **11**C for fitting is size d and the depth of the concave portion **11**D for fitting is also size d. Further, the outer diameter of the convex portion **12**C for fitting and the hole size of the concave portion **12**D for fitting are size e.

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

[0046] As shown in **FIG. 2** and **FIG. 8**, the first cylindrical phantom **21** has edge portions **21**A and **22**B perpendicular to the shaft direction at both sides of the shaft direction. One edge portion **21**A of the first cylindrical phantom **21** perpendicular to the shaft direction is formed as a ring-shaped flat surface. In contrast, another edge portion **21**B of the first cylindrical phantom **21** perpendicular to the shaft direction has a cylindrical projection **21**C, which is a fitting portion, formed thereon. Four through-holes **21**D 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 **21**E is set to be size a. Consequently, into the hollow portion **21**E 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 **21**C for fitting is size f and the outer diameter size of the convex portion **21**C 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 **22**A and **22**B 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 **22**A of the second cylindrical phantom **22** perpendicular to the shaft direction has a stepped portion **22**C, which is a fitting portion, formed thereon. In contrast, another edge portion **22**B of the second cylindrical phantom **22** perpendicular to the shaft direction has a cylindrical projection **22**D, which is another fitting portion, formed thereon. Four through-holes **22**E 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 **22**F is set to be size a. Consequently, into the hollow portion **22**F 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 **22**C of the cylindrical phantom **22** is set to be size f, and the height of the projection of the convex portion **21**C for fitting is also set to be size f. The hole size of the stepped portion **22**C and the outer diameter size of the convex portion **21**C 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 **23**A and **23**B perpendicular to the shaft direction at both sides of the shaft direction. One edge portion **23**A of the third cylindrical phantom **23** perpendicular to the shaft direction has a stepped portion **23**C, which is a fitting portion, formed thereon. In contrast. Another edge portion **23**B of the third cylindrical phantom **23** perpendicular to the shaft direction is formed as a ring-shaped flat surface. Four through-holes **23**D 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 **23**E of the phantom **23** is set to be size a. Consequently, into the hollow portion **23**E 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 **22**C 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 **12**C for fitting of the cylindrical phantom **12** is inserted into and fitted to the concave portion **11**C for fitting of the column-shaped phantom **11**, and the edge portions **11**B and **12**A are collided with each other. Here, since the concave portion **11**C 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 **12**C 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 **12**C for fitting is inserted into and fitted to the concave portion **12**D for fitting, whereby they can be connected without any space. Also, with regard to the phantoms **12** and **13**, the convex portion **12**C for fitting is inserted into and fitted to the concave portion **13**D for fitting, whereby they can be connected without any space. In this case, the through-holes **11**D, **11**E, **12**E, **12**F, **13**D, **13**E, **21**D, **22**E, and **23**D 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 **13**E provided on the column-shaped phantom **13**. The sticks **31** and **32** are inserted into the through-holes **11**D, **11**E, **12**E, **12**F, and **13**D except for the through-hole **13**E having the device **33** for measuring dose inserted therein, to embed the through-holes **11**D, IE, **12**E, **12**F, **13**D and part of the through-hole **13**E 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 **21**C of the cylindrical phantom **21** is inserted into and fitted to the stepped portion **22**C of the cylindrical phantom **22**, and the edge portions **21**B and **22**A are collided with each other. Here, since the projection size of the cylindrical projection **21**C of the cylindrical phantom **21** is set to be size f and since the depth of the step of the stepped portion **22**C 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 **22**D is inserted into and fitted to the stepped portion **22**C, whereby they can be connected without any space. Also, with regard to the phantoms **22** and **23**, the cylindrical projection **22**D is inserted into and fitted to the stepped portion **23**C, 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 **23**E of the cylindrical phantom **23**, whereby the column-shaped phantoms **11**, **12**, **12**, **12**, and **13** are inserted into the hollow portions of **21**E, **22**F, **22**F, **22**F, and **23**E without any space, respectively. Subsequently, as shown in **FIG. 4**, the device **33** for measuring dose is inserted, for example, into the through-hole **13**E 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 **11**D, **11**E, **12**E, **12**F, **13**D, **13**E, **21**D, **22**E, and **23**D are provided on the phantom assembly **1**, the sticks **31** and **32** are inserted into eight through-holes **1** ID, **1** IE, **12**E, **12**F, **13**D, **21**D, **22**E, and **23**D except for the through-hole **13**E having the device **33** for measuring dose inserted therein, to embed these through-holes without any space. Preferably, the space of the through-hole **13**E having the device **33** for measuring dose inserted therein is embedded by the through-holes **11**E, and **12**F. 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 **13**E, 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** id configured so that it is inserted, for example, over the through-holes **11**D and **12**E of the column-shape phantoms **11** and **12** and also inserted over the through-holes **11**E and **12**F. 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 bean 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 **11**C and **12**D for fitting into the convex portions **12**C and **13**C to be fitted with each other, and/or when the projection size d, for example, of the convex portion **12**C of the phantom **11**C to be fitted is made to a minus allowance relative to the depth d, for example, of the concave portion **11**C for fitting of the phantom **11** so that edge portions **11**B and **12**A can be closely contact with each other, an amount of x-ray radiation passing through a space, for example, between the edge portion **11**B of the column-shaped phantom **11** and the edge portion **12**A of the column-shaped phantom **12**, and a space, for example, between the edge portion **12**B of the column-shaped phantom **12** and the edge portion **13**A 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 **21**B of the cylindrical phantom **21** and the edge portion **22**A of the cylindrical phantom **22**, and a space, for example, between the edge portion **22**B of the cylindrical phantom **22** and the edge portion **23**A 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 **11**C and **12**D for fitting into the convex portions **12**C and **13**C 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 **11**D and **11**E of the column-shaped phantom **11**, and through-holes **12**E and **12**F 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 **13**E 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 ore more of through-hole(s) **11**E, **12**E, **12**F, **13**D, **21**D, **22**E, and **23**D.

[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 **11**D, **11**E, **12**E, **12**F, **13**D, **13**E, **21**D, **22**E, and **23**D 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 **21**E, **22**F, and **23**E 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 **11**D, **11**E, **12**R, **12**F, **13**D, **13**E, **21**D, **22**E, and **23**F 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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