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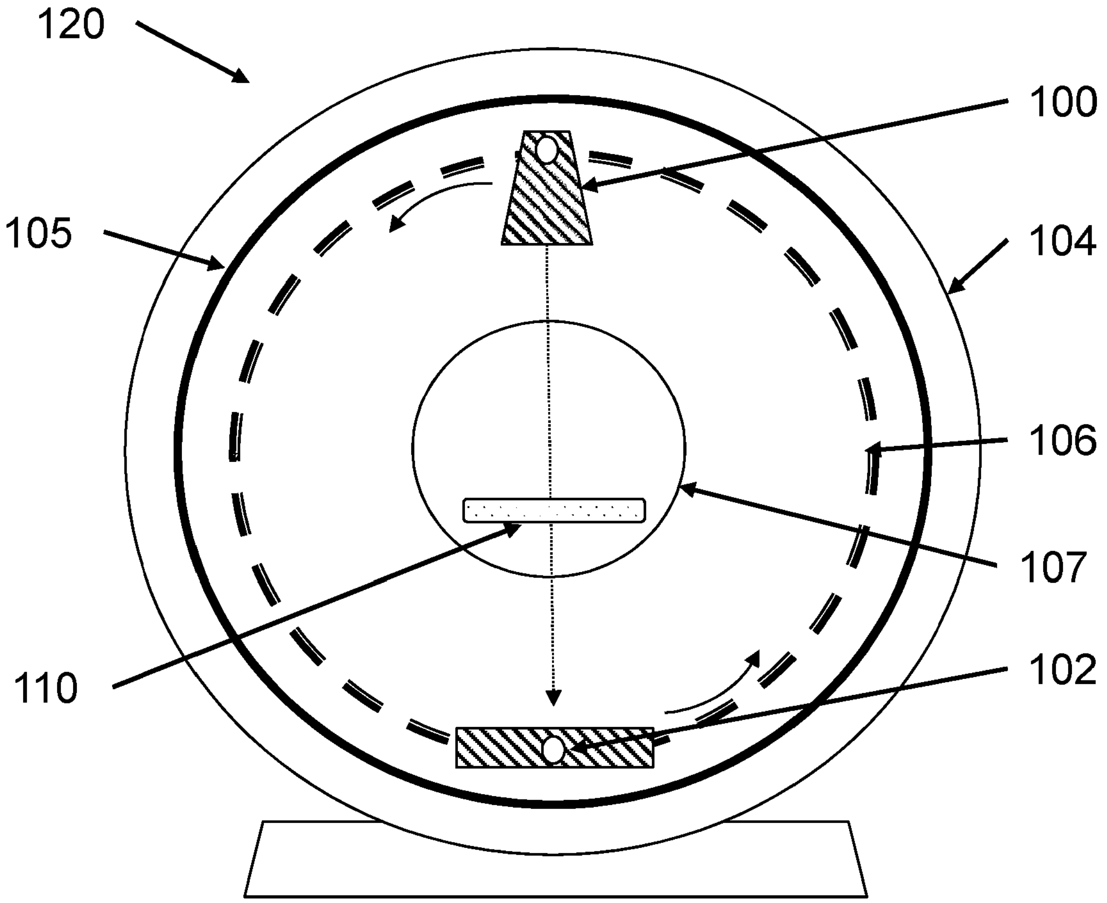


Fig. 1a

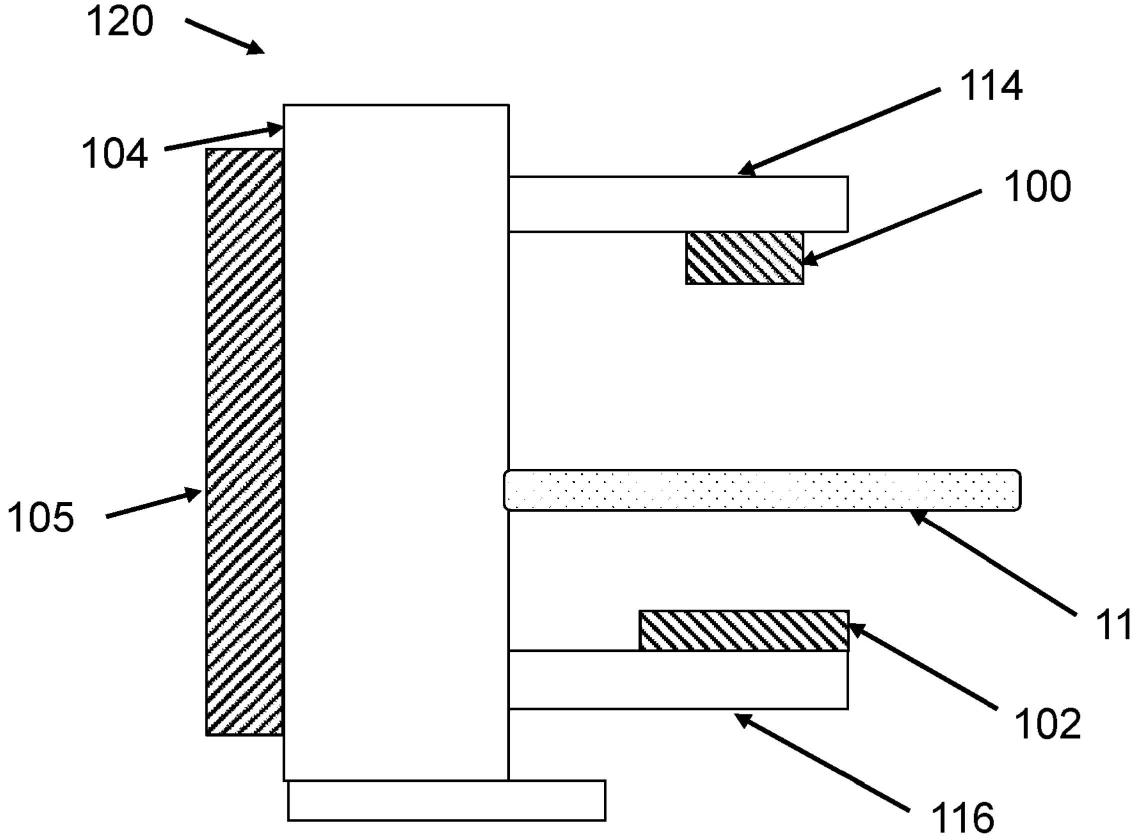


Fig. 1b

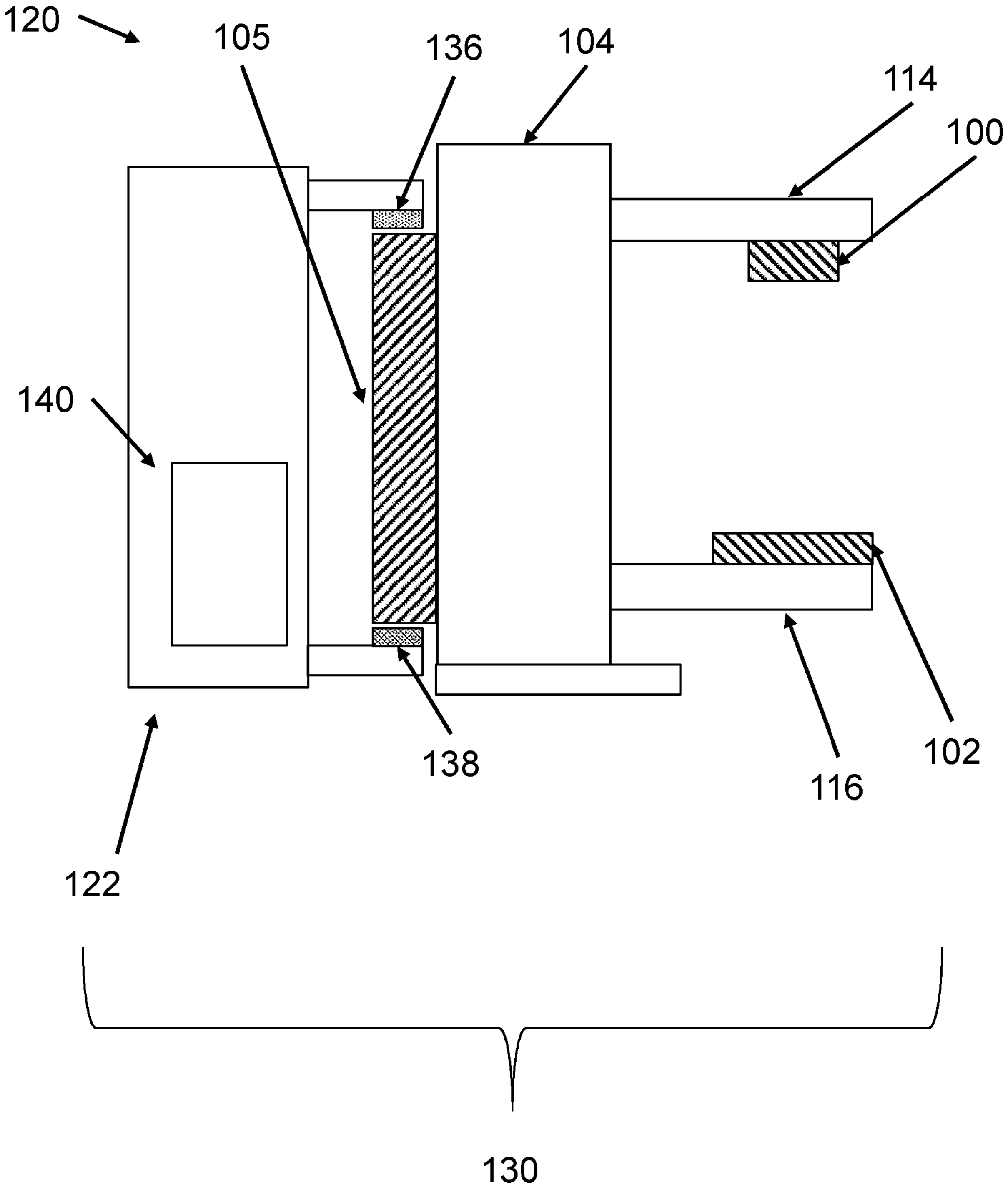
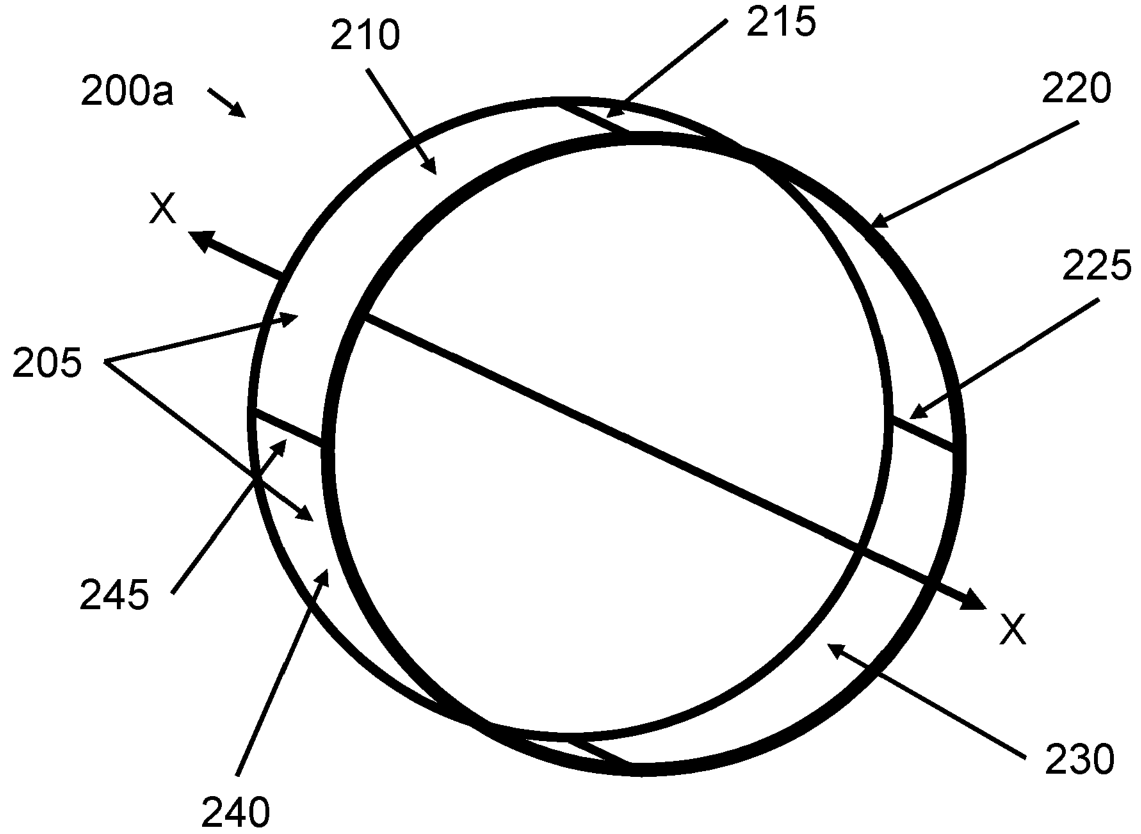


Fig. 1c


210
215
200a
220
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205
245
X
230
240

Fig. 2a

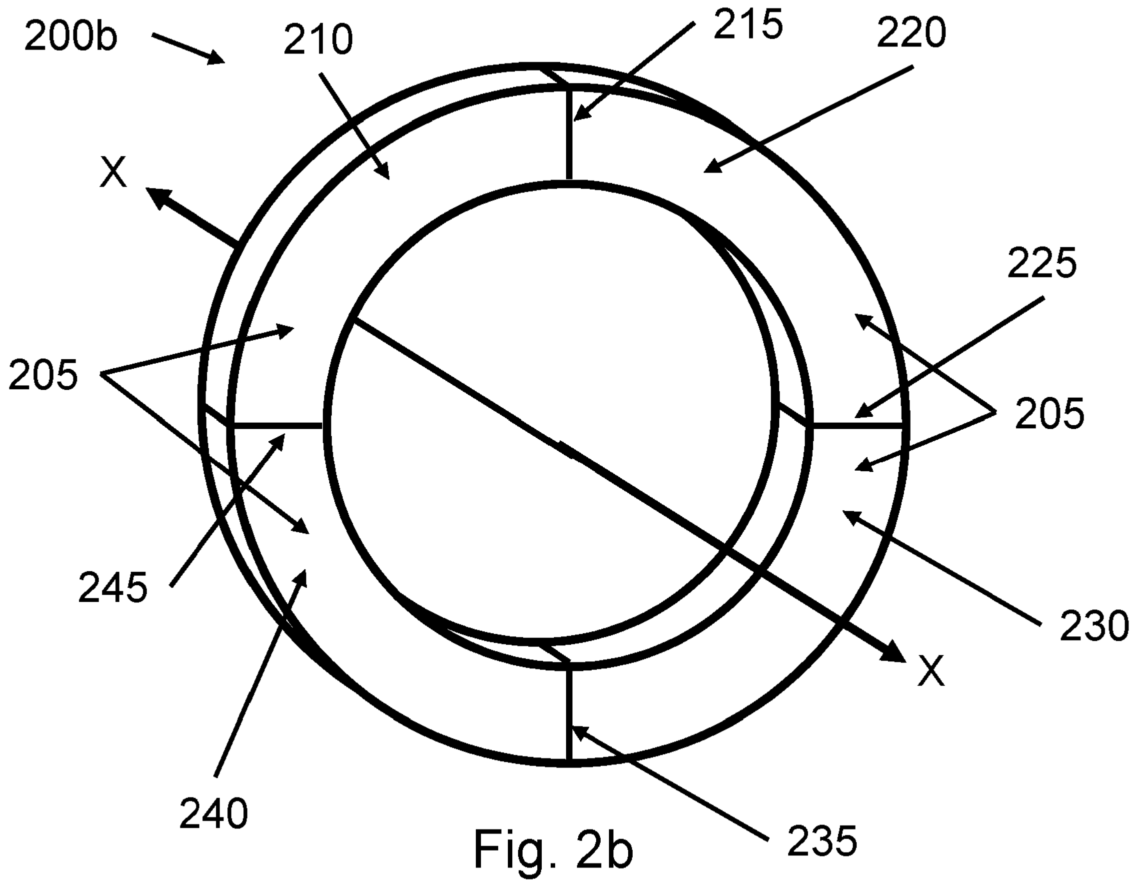
215
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Fig. 2b

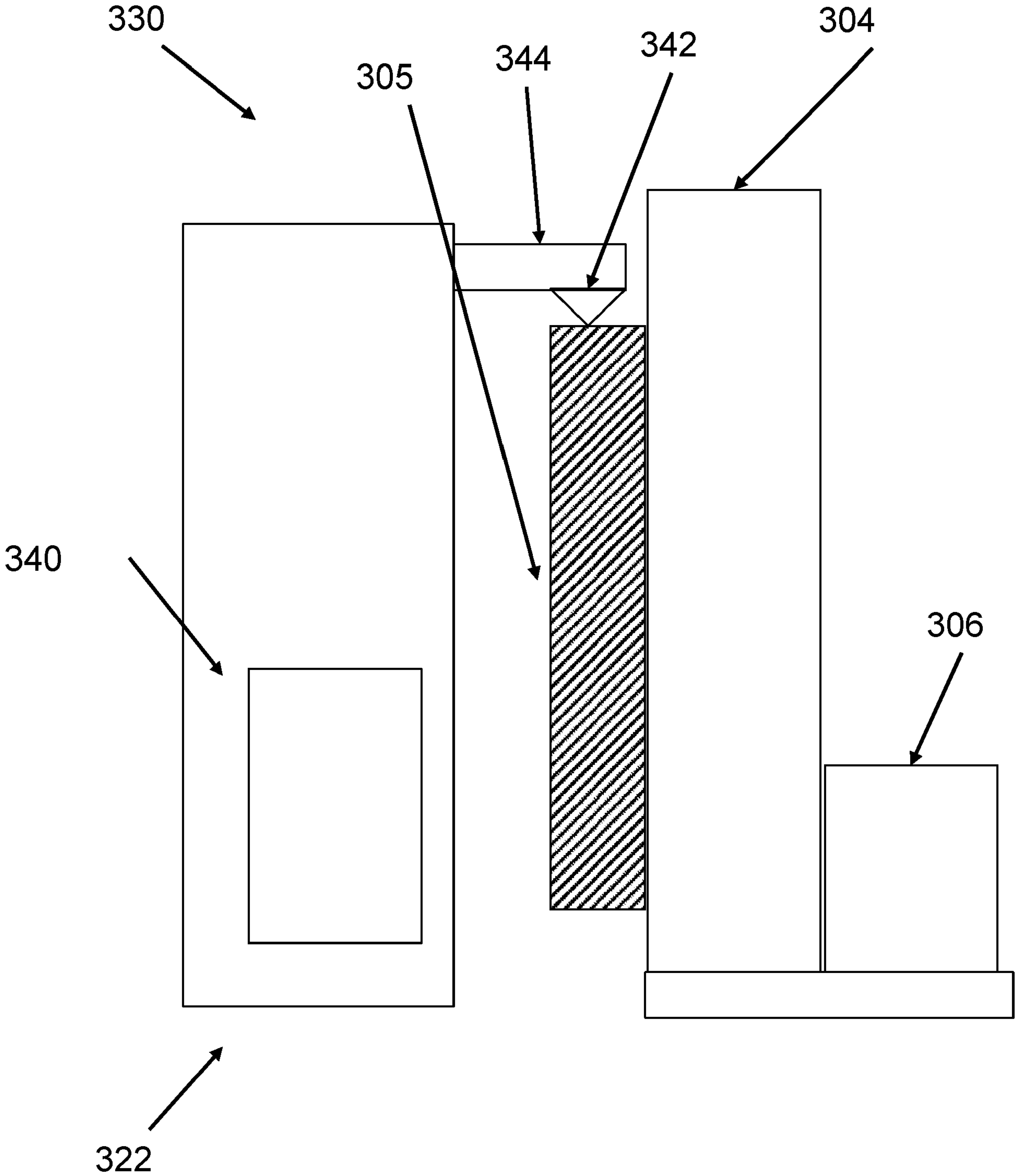

Fig. 3

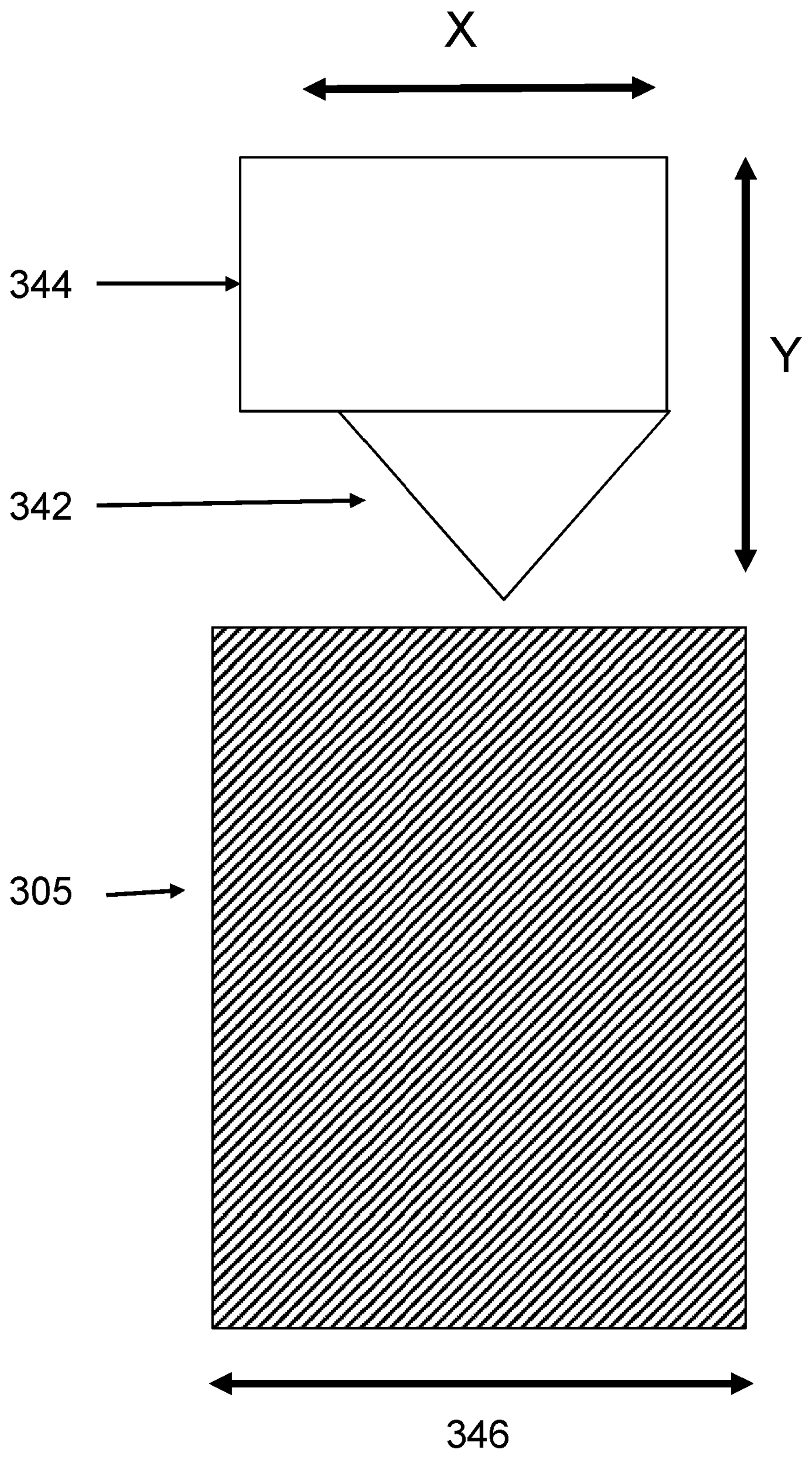

Fig. 4a

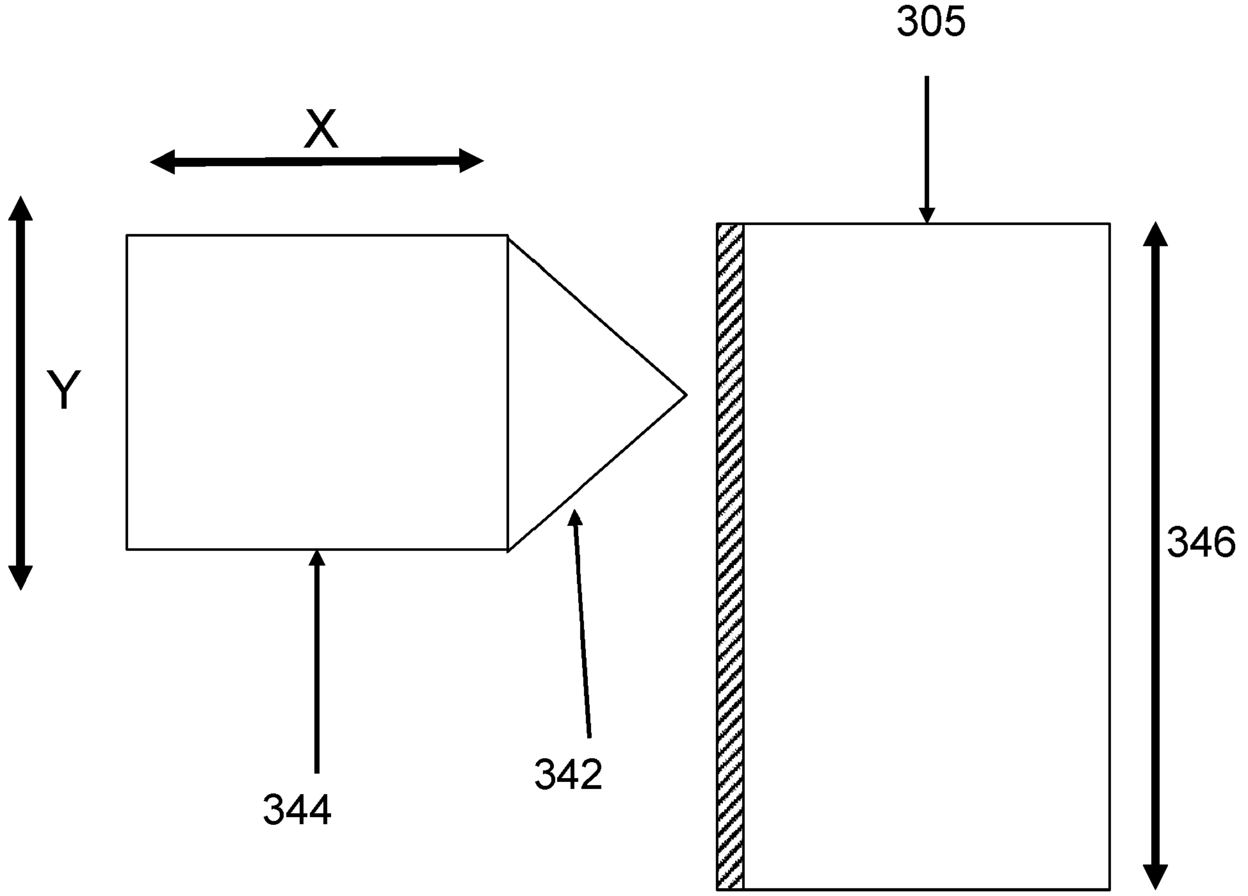

Fig. 4b

Support structure for radiotherapy or imaging device

The present disclosure is related to radiotherapy or medical imaging devices, and in particular rotor and stator electrical connection systems for such devices.

Background

Many medical apparatuses for radiotherapy or imaging include a radiation delivery system on a rotatable gantry that is able to rotate about a patient. This enables up to 360-degree radiation delivery to the patient. Such apparatuses include an electrical brush and slip-ring system that is used to transmit power and other signals from a stationary part of the apparatus (such as a power source and control system) to the rotatable gantry.

Owing to the nature of the purpose of the slip ring and brush system, the slip ring is required to have a large diameter (for example 2 metres or larger). This is because the rotatable gantry must have a large enough bore to receive a patient, and must be large enough so that the patient has enough space in the bore to move and/or feel comfortable.

Due to the large diameter required, it is difficult to manufacture the slip ring as a single piece. It is also logistically more difficult to transport and install such a large single-piece slip ring. As a result, large slip rings for medical apparatuses as described above may be made in multiple pieces, that can be connected together to form the ring.

One issue with a multi-piece slip ring is that the brush-contacting surfaces of the slip ring sections may not be perfectly aligned when connected, for example due to mechanical tolerances or other faults in the connection. This causes a discontinuity and means that the surface of the slip ring is not smooth. Such a discontinuity can result in temporary loss of contact between the brush and the surface of the slip ring which leads to connectivity issues. Additionally, a surface that is not smooth can lead to the brushes wearing down more quickly and thus having a shorter service life.

Embodiments of the present disclosure seek to address these and other problems encountered in the prior art.

<u>Summary</u>

In a first aspect, there is disclosed a support structure for a radiotherapy or medical imaging device. The support structure comprises a stationary member and a gantry rotatable relative to the stationary member. The gantry is configured to rotate around a rotation axis and comprises a slip ring having a bearing surface. The support structure further comprises at least one machining tool mounted on the stationary member; wherein the at least one machining tool is positionable to contact the bearing surface of the slip ring such that rotation of the gantry around the rotation axis causes the machining tool to machine the bearing surface. In other words, the machining tool is configured such that it is capable of being positioned in contact the bearing surface of the slip ring such that rotation of the gantry around the rotation axis causes the machining tool to machine the bearing surface.

This enables a slip ring bearing surface to be machined or smoothed in-situ without the need for further machinery such as a lathe. The rotation of the rotatable gantry is exploited to rotate the slip ring (rather than requiring a lathe to rotate the slip ring for machining). In this sense, the support structure acts as a lathe for machining the slip ring surface, without requiring a separate apparatus for performing the machining

Where reference is made to a bearing surface of a slip ring, the skilled person would appreciate that this refers to the electrically conductive surface of the slip ring. In a rotor and stator electrical connection system, electrically conductive brushes are in electrical contact with the bearing surface so that electrical signals can be transmitted to and from the rotor and stator via the slip ring and brushes.

Where reference is made to the act of ‘machining’ the bearing surface, it would be understood that this refers to the act of removing material from the bearing surface in order to produce a smooth bearing surface. For example, raised portions of the bearing surface may be removed during the act of machining to leave a continuous and smooth surface. Machining involves the use of a machining tool, such as a cutting tool to contact the surface (or at least contact the raised portions) and ‘cut’ the surface by removing material from the surface.

In some embodiments, the slip ring comprises a plurality of arcuate sections connected end-to-end. This is advantageous because it is easier to manufacture slip rings in multiple sections, particular when the slip ring diameter is large. Slip rings used in support structures for radiotherapy or medical imaging devices are typically at least 1 metre in diameter, making such slip rings difficult to make as a single piece. It is therefore easier to manufacture as smaller sections that can be assembled to form the slip ring. However, imperfections in the connections between sections leads to a slip ring surface that is not smooth, so the support structure with the machining tool as described above is particularly advantageous for smoothing multi-section slip rings.

In some embodiments, the slip ring has a diameter of at least 1 metre. In these embodiments, it is particularly useful to use the support structure and rotatable gantry to machine the slip ring, as otherwise the process of machining would require a very large lathe to support the slip ring, and would require enough power to rotate such a large, heavy slip ring. In the present disclosure however, the gantry to which the slip ring is mounted is already configured to rotate about a rotation axis (for example for rotating about a patient during a medical treatment), and thus is already capable of rotating the slip ring without requiring an additional, separate, powerful drive system for rotating the slip ring during machining.

In some embodiments, the at least one machining tool is a cutting tool. In other words, the machining tool is a tool such as those used on a lathe for cutting into metallic materials to produce a smooth surface.

In some embodiments the bearing surface is a curved surface around the circumference of the slip ring. In other words, the slip ring is a drum-type slip ring. In other embodiments, the bearing surface is a planar surface perpendicular to the rotation axis, meaning that the slip ring is a platter-type slip ring.

In some embodiments, the at least one machining tool is mounted on the stationary member via one or more respective tool positioning systems, wherein the tool positioning systems are configured to adjust a position of the respective machining tool relative to the bearing surface. In some embodiments, the one or more tool positioning systems are configured to move the respective tool in a perpendicular direction relative to the bearing surface. This enables the cutting tool to be bought into contact with the bearing surface for machining the bearing surface, and then machining tool can be removed from contact with the bearing surface after machining and for normal operation of the support structure (for example in a medical treatment). This also enables control of the depth of the cut into the surface, which may be dynamically changed during machining. Additionally or alternatively, the one or more tool positioning systems are configured to move the respective tool in a lateral direction relative to the bearing surface. This enables the cutting tool to machine the slip ring across the width of the surface of the slip ring, in order to machining different portions of the slip ring

In some embodiments, the support structure further comprises a controller configured to control the tool positioning system. The controller may be configured to control the position of the machining tool relative to the bearing surface and specifically a depth of the tool and/or tool position along the surface of the slip ring.

In some embodiments, the stationary member comprises at least one brush holder suitable for mounting electrical brushes, and wherein the at least one machining tool is removably mounted in the at least one brush holder. This allows machining tools to be temporarily mounted on the stationary member of the support structure (for machining), after which they can be removed and replaced with brushes (for normal operation of the support structure, for example during medical treatment). Additionally, this enables in-situ slip ring machining for support structures that do not have dedicated tool positioning systems, meaning that in-situ machining capability can easily be retrofitted to support structures without the need for specialist apparatus (only the machining tool is required).

In some embodiments, the support structure further comprises a rotary drive system configured to rotate the gantry about the rotation axis during machining of the bearing surface and during medical treatment. The negates the need for a separate drive system for rotating the gantry during machining. Instead, the drive system used primarily for rotating the gantry during normal operation (during a medical treatment) can also be employed for rotating the slip ring during machining.

In a second aspect, there is provided a method for machining a bearing surface of a slip ring of a support structure as described above. The method comprises adjusting a position of the at least one machining tool on the stationary member such that the machining tool is configured to contact at least a portion of the bearing surface when the slip ring rotates, and The method further comprises causing rotation of the slip ring. The rotation of the slip ring with the machining tool positioned in this way means that the slip ring bearing surface will be machined to be made smooth. In some embodiments, the slip ring comprises a plurality of arcuate sections and the method further comprises assembling the arcuate sections to form the slip ring.

Brief description of the drawings

Specific embodiments are described below by way of example only and with reference to the accompanying drawings in which:

Figure 1a illustrates a gantry comprising a slip ring for use in embodiments of the present disclosure;

Figure 1b illustrates a side-view of the gantry of Figure 1a;

Figure 1c illustrates a side view of a support structure comprising a stationary member and a gantry in accordance with embodiments of the present disclosure;

Figure 2a illustrates a slip ring for use in embodiments of the present disclosure;

Figure 2b illustrates a slip ring for use in embodiments of the present disclosure;

Figure 3 illustrates a support structure in accordance with embodiments of the present disclosure;

Figure 4a illustrates a machining tool and a slip ring for use in embodiments of the present disclosure; and

Figure 4b illustrates a machining tool and a slip ring for use in embodiments of the present disclosure.

Detailed description of the drawings

Application of the present invention – large bore slip rings that are optionally formed of multiple sections, or large bore slip rings for which it is difficult to smooth a surface on a conventional lathe.

Figure 1a depicts a medical device 120 comprising a gantry used in some embodiments of the present disclosure. The arrangement described provides one specific example of a gantry used in the present disclosure and it will be understood that other arrangements are possible. In the specific example shown, the figure shows a cross-section through a medical device 120 comprising a radiation source 100 and a detector 102 attached to a gantry 104. The gantry is rotatable about a rotation axis passing through the centre of the gantry and orthogonal to the plane of the drawing (in other words, the rotation axis extends orthogonally out of the page). The radiation source 100 and the detector 102 are fixed to the gantry 104 and rotate with the gantry. In the example shown, the gantry 104 comprises a circular support track 106. The radiation source 100 and the detector are arranged diametrically opposed to one another. In some examples, the gantry is annular and further comprises a central bore 107. The device 120 is suitable for delivering imaging or therapeutic radiation to a patient received through the bore 107. The radiation source 100 may be a linear accelerator for generating a beam of therapeutic radiation.

In the specific example shown, the device also comprises a patient support surface 110. The support surface 110 may be moved longitudinally relative to the gantry 104, for example to aid positioning of a patient lying on the support surface. In other words, the support surface 110 is configured to move in an axial direction position the subject 108, parallel to the rotation axis . During treatment, the gantry rotates on the circular support track 106 causing the radiation source 100 to rotate around a patient laying on the support surface 110 to deliver a radiation dose to a radiation isocentre in the patient from different angles. This allows the radiation does received by healthy tissue to be spread around a larger region of the healthy tissue, whilst building up a prescribed dose of radiation at a target region.

The gantry 104 further comprises a slip-ring 105 concentric with the gantry 104 and mounted to the gantry. The slip ring is fixed to the gantry and thus rotates with the gantry. The slip ring is annular in shape and comprises a bore with a diameter that is at least as big as the diameter of bore 107 of the gantry. This is because the bore must be large enough to receive a patient on the patient support surface. The slip ring may have a diameter of at least 1 metre, and optionally has a diameter greater than 1.5 metres, optionally greater than 2 metres. In some embodiments of the present disclosure, the slip ring comprises one or more arcuate sections connected end-to-end. In other words, the arcuate sections are connected in series to form the circular slip ring 105.

Figure 1b depicts a side view of the medical device 120. From this view, it can be seen that the radiation source 100 is disposed on a support arm 114, which connects the radiation source 100 to the gantry 104. The detector 102 is disposed on a support arm 116, which connects the detector 102 to the gantry 104. In the example depicted in Figure 1b, the slip ring 105 is be disposed on the opposite side of the gantry to the radiation source 100, detector 102 and support table 110. However, in other examples the slip ring may be disposed on the same side of these components (i.e. of the front of the gantry) or may disposed within the gantry itself. In alternative examples, this slip ring may be disposed in any configuration that causes it to be concentric with the gantry.

Figure 1c depicts an example medical device 120 in accordance with the configuration of Figure 1b. In the example depicted in Figure 1c, the device 120 further comprises a stationary member 122 that does not rotate but remains stationary whilst the gantry 104 rotates around the rotation axis. The stationary member comprises brushes 136 and 138 that are mounted on the stationary member and that are configured to maintain contact with a bearing surface on the outer surface of the slip ring 105 as the slip ring rotates. The brushes and the bearing surface of the slip ring are electrically conductive and the brushes are positioned to be in electrical contact with the slip ring. The brushes are configured to transmit electrical signals to the slip ring through the electrical contact. Alternatively or additionally, the brushes may be configured to receive electrical signals from the slip ring. The electrical signals are communicated between a control system module 140 which is part of the stationary member 122 and one or more of the components fixed on the gantry 104, for example the radiation source 100 or the detector 102. The communication between the stationary member 122 and the rotatable gantry 104 is enabled by the electrical connection between brushes 136 and 138 and the slip ring 105. In other words, the stationary member and rotatable gantry can be considered as a stator and a rotor respectively in an electrical connection system. In this example, the stationary member 122 comprises two brushes contacting the slip ring 105, however any number of one or more brushes may be used for bringing the stationary member into electrical contact with the rotatable gantry.

In general, the stationary member and rotatable gantry can be considered as a support structure 130 for the medical device 120. In other words, a support structure for a medical device comprises the stationary member 122 and the rotatable gantry 104 with slip ring 105.

The control system module 140 may be able to control some or all of the functions of the medical device 120. For example, the control system module may be able to control the radiation source via control signals transmitted through the brushes 136 and 138 to the slip ring 105. In some examples, the control system may be able to receive feedback signals from the gantry. For example, the control system module may be able to receive data signals from detector 102, the data signals transmitted through the slip ring 105 to brushes 136 and 138 connected to the control system. In some examples, the electric signals may comprise power signals transmitted to the gantry, for example to supply power to the radiation source 100 or to the detector 102. In some examples, there may be a plurality of control system modules within the housing or connected to the radiotherapy device. In these examples, each control system module may be dedicated to a different function of the radiotherapy device.

Slip ring

With respect to Figure 2a, a slip ring suitable for use in embodiments of the present disclosure is illustrated.

As described above, it is essential that contact is maintained between the sip ring bearing surface and the brushes to avoid a break in communication between the stationary member and the gantry. In order to maintain contact, the slip ring bearing surface must be continuous, smooth and devoid of irregularities. Similarly, a smooth bearing surface is important for maximising the surface life of the brushes.

A known way of achieving a smooth bearing surface is to form the slip ring out of a single piece of electrically conductive material, such as copper, constructed as a single seamless ring (either platter slip ring, with a planar bearing surface parallel to the plane of rotation, or drum slip ring with a curved bearing surface around an inner or outer circumference of the slip ring that is orthogonal to a radial direction of the ring).

Whilst this method works well for slip rings used in small connection systems, it is much more difficult to manufacture a slip ring out of a single piece of material for larger slip rings (for example with diameters of at least than 1 metre), such as those used in medical devices with a radiation source mounted on a rotatable gantry, which needs to have a large enough bore to receiving a patient therethrough. However it is impractical to build a slip ring of this diameter out of a single piece of material. Furthermore, a slip ring of this size would not have the required fault tolerances needed for a complex and high precision medical system, and would also be expensive and difficult to manufacture.

One solution to these issues is to build large slip rings out of individual arcuate sections that can be connected together end-to-end to form the entire ring. Multiple smaller sections can be manufactured far more easily than a single, large ring. Furthermore, each section can be more easily manufactured with the required mechanical tolerances. An example of a such a slip ring is illustrated in Figure 2a.

This slip ring is an example of a slip ring 105 used in the device 120 of Figures 1a – 1c. The slip ring 200a shown here is a ‘drum’ slip ring with a curved bearing surface 205 on the outer circumference. The bearing surface is electrically conductive and is suitable for contacting brushes such as those described with reference to Figure 1c. The slip ring 200a comprises arc-shaped sections 210, 220, 230 and 240. An end of each section is placed adjacent to an end of another segment to form a circular ring. In other words, the slip ring 200a comprises arcuate sections 210, 220, 230 and 240 that are connected end-to-end to form the slip ring. It may thus be said that the arcuate sections are connected in series. Adjacent sections are connected at connection interfaces 215, 225, 235 (not shown), and 245.

An alternative slip ring that may be used in the device 120 is depicted in Figure 2b. The slip ring 200b is a ‘platter’ slip with a planar bearing surface 205 that lies in the plane of rotation (orthogonal to the rotation axis). Slip ring 200b is similar to slip ring 200a in that it is comprised of four arcuate sections 210, 220, 230, 240 that are connected end-to-end, with adjacent sections being connected at interfaces 215, 225, 235 and 245. It would be appreciated that either type of slip ring, a drum-type (such as slip ring 22a) or a platter-type (such as slip ring 200b) may be used in the device 120 and in the embodiments disclosed herein.

As the slip ring (i.e. slip ring 200a or 200b) rotates about its central axis (depicted by the line X-X), brushes that are fixed to the stationary member and that are in contact with the bearing surface effectively travel around the circumference of the slip ring and across the bearing surface. This is because, while the brushes remain stationary, the slip ring rotates. Therefore, from the reference frame of the slip ring, the brushes travel around the circumference of the slip ring. As described above, it is important that the surface of the slip ring is continuous and smooth in order to maximise the service life of the brushes and to ensure that the brushes remain in constant electrical contact with the bearing surface. However, mechanical tolerances, errors in assembling the slip ring, or other manufacturing or assembly faults may lead to discontinuities at the connections between adjacent sections of the slip ring. Such a discontinuity may be a ‘step’, where the bearing surface of one segment is raised with respect to the bearing surface of another segment. Other discontinuities may also be envisaged, such as raised portions of the surface in other places (not necessarily at the connection between adjacent sections). Such discontinuities need to be ‘smoothed out’ to ensure that brushes maintain contact with the slip ring. This can be performed by machining the bearing surface using a lathe, which involves removing the slip ring from the device, mounting the slip ring on a lathe and using a lathe cutting tool to machine the surface to smooth the surface and remove the discontinuity. This is often difficult and impractical, particularly for large-diameter slip rings (for example 1 metre diameter or greater) which are heavy and require a sufficiently large lathe.

Embodiments of the present disclosure seek to find a practical and effective solution to the problem of ensuring a continuously smooth bearing surface on large diameter slip rings

Figure 3 illustrates a support structure 330 for a radiotherapy or imaging apparatus in accordance with embodiments of the present disclosure. Support structure 330 is similar to the support structure 130 depicted in Figure 1c, and comprises a rotatable gantry 304 and a stationary member 322. The support structure 330 is suitable for use in medical devices such as radiotherapy or medical imaging apparatuses, and the gantry 304 is suitable for support a radiation source (such as radiation source 100) and/or radiation detector (such as detector 102). The gantry is rotatable about a rotation axis (horizontal and lying in the plane of the drawing, and passing through the centre of the gantry), thereby allowing radiotherapeutic or imaging radiation to be delivered to a patient through 360 degrees. The gantry further comprises a slip ring 305. In the specific example illustrated in Figure 3, the slip ring is a drum-type slip ring, such as slip ring 200a. However, a platter-type slip ring such as slip ring 200b may equally be used.

Stationary member 322 is similar to stationary member 122 of Figure 1c, and comprises a control system 340. However, instead of depicting brushes mounted on the stationary member as depicted in Figure 1c, the stationary member 322 comprises a machining tool 342 mounted on the stationary member 322 via a tool positioning system 344. The stationary member 322 may also comprise brushes similar to those depicted in Figure 1c, but these are not illustrated here. Additionally, whilst only one machining tool is depicted here, any number of machining tools may be employed and mounted to the stationary member such that they can be positioned to contact the bearing surface.

The machining tool is configured to be positioned to contact the bearing surface of the slip ring 305. This allows the machining tool to ‘machine’ the bearing surface in order to smooth out the surface and remove any discontinuities (such as at connections between adjacent slip ring sections). In this way, a separate lathe for smoothing out the surface is no longer required, since the slip ring can be machined in-situ. Machining the slip ring is carried out by positioning the machining tool so that the machining tool is configured to come into contact with at least a portion of the slip ring surface, and then causing rotation of the slip ring by causing rotation of the gantry 304. It is noted that the machining tool may be positioned such that it does not contact the slip ring through the whole circumference (as the slip ring is rotated through 360 degrees), but may instead only contact a portion of the surface, for example such that the tool is only able to come into contact with raised portions of the surface that need to be removed through machining. Alternatively, the machining tool may be positioned to contact the surface through the whole circumference of the ring (for machining the ring around the entire circumference).

In some embodiments, rotation of the gantry is caused using a rotary drive system 306. The rotary drive system may be part of the support structure 330 and may have a primary use of rotating the gantry when a medical treatment is carried out using the support structure. For example, the rotary drive system may be configured to rotate the gantry comprising a radiation source in order to deliver radiation to a patient during a medical treatment (such as radiotherapy or imaging). However, the rotary drive system may have a secondary use of rotating the gantry during machining of the slip ring. In other words, the same rotary drive system can be used to rotate the gantry during machining and during a medical treatment.

In more detail, the machining tool may be a cutting tool suitable for machining a bearing surface (wherein the bearing surface is made of copper, for example). The cutting tool may be a lathe cutting tool that would conventionally be used on a lathe, but is instead mounted on the stationary member for machining the bearing surface in-situ.

With reference to positioning the machining tool, in the specific example depicted in Figure 3 the machining tool 342 is mounted on the stationary member via tool positioning system 344. The tool positioning system is configured to move the machining tool and in particular to position the machining tool to be in contact with the slip ring surface. The tool positioning system is described in more detail below with reference to Figures 4a and 4b.

In some embodiments, the tool positioning system is controlled by control system 340, which sends control signals to the tool positioning system to move and position the machining tool with respect to the slip ring.

In some embodiments, the machining tool is mounted in a brush holder on the stationary member. In other words, a brush holder that is primarily used for holding brushes (such as brushes 136 and 138 in Figure 1c) may instead be used to support the machining tool when the slip ring is machined. The machining tool may be removably mounted in the brush holder during machining of the slip ring, and the machining tool may then be removed and replaced with the brushes after machining is finished, so that the support structure can then be used under normal operation (i.e. with the brushes in place to transmit electrical signals across the stationary member and rotatable gantry). In some embodiments, the stationary member comprises a plurality of brush holders, and respective machining tools may be removably mounted in each holder for machining the slip ring.

With reference to Figure 4a, a close-up view of the slip ring 305, machining tool 342, and tool positioning system 344 is shown. As described above, the slip ring 305 is a drum-type slip ring with a curved bearing surface around the outer circumference of the ring. The tool positioning system 344 is configured to move the tool 342 in at least two directions (depicted by arrows X and Y) in order to bring the tool into contact with various portions of the bearing surface.

A first direction, indicated by arrow X, is a lateral direction along the surface of the slip ring that is parallel to the rotation axis of the gantry. Movement in this direction enables the cutting tool to machine the slip ring across the width of the surface of the slip ring (indicated by arrow 346). It would be appreciated however that in some embodiments the width of the cutting tool may be at least as wide as the slip ring and so movement in the X direction may not be necessary. The cutting tool my even be wider than the width of the slip ring to ensure the entire width of the slip ring is machined.

A second direction, indicated by arrow Y, is a radial direction that is perpendicular to the surface of the slip ring. The radial direction is orthogonal to the rotation axis of the gantry. Movement in this direction enables the cutting tool to be bought into contact with the bearing surface (or for bring the tool away from contact) and enables control of the depth of the cut into the surface, which may be dynamically changed during machining (i.e. as the slip ring is rotating).

Movement in a third direction, orthogonal to X and Y (not shown in the Figure) may also be achieved using the tool positioning system. However, this may not be necessary since an equivalent effect (accessing a different portion around the circumference of the surface) may also be achieved by rotating the slip ring.

It would therefore be appreciated that the tool positioning system can control movement of the cutting tool at least in a direction perpendicular to the cutting surface, and may optionally control movement in a lateral direction, and may further optionally control movement in a tangential direction.

Figure 4b illustrates the position and movement of the cutting tool 342 for use with a platter-type slip ring 305, with a planar bearing surface lying in a plane of rotation (indicated by the diagonally striped portion of the slip ring). In this specific example, lateral movement across the width of the bearing surface is in the radial (Y) direction (orthogonal to the rotation axis), whilst perpendicular (depth) movement relative to the plane of the bearing surface is parallel to the rotation axis (along the X direction). It would be appreciated that movement in the Y direction may not be necessary in order to access different portions across the width of the surface of the slip ring, particularly if the cutting tool is at least as wide as the bearing surface width indicated by arrow 346).

Other considerations

The figures and description herein generally refer to a slip ring comprising two or more sections connected end-to-end, that is to say, connected in series. However, it would be appreciated by the skilled person that embodiments of the present disclosure additionally extend to slip rings comprised of a single section (for example a single strip formed into a ring with opposite ends of the strip connected together), or even to slip rings formed as a single piece (i.e. with no connections along the bearing surface). Even in these embodiments, the disclosed embodiments may be used to machine the surfaces of such slip rings to remove discontinuities or raised portions.

Features of the above aspects can be combined in any suitable manner. It will be understood that the above description is of specific embodiments by way of aspect only and that many modifications and alterations will be within the skilled person’s reach and are intended to be covered by the scope of the appendant claims.

Claims

1. A support structure for a radiotherapy or medical imaging device, the support structure comprising:

   a stationary member;

   a gantry rotatable relative to the stationary member, wherein the gantry is configured to rotate around a rotation axis and comprises a slip ring having a bearing surface; and

   at least one machining tool mounted on the stationary member;

wherein the at least one machining tool is positionable to contact the bearing surface of the slip ring such that rotation of the gantry around the rotation axis causes the machining tool to machine the bearing surface, and wherein the stationary member comprises at least one brush holder suitable for mounting electrical brushes, and wherein the at least one machining tool is removably mountable in the at least one brush holder.

2. The support structure of claim 1, wherein the slip ring comprises a plurality of arcuate sections connected end-to-end.

3. The support structure of any preceding claim, wherein the slip ring has a diameter of at least 1 metre.

4. The support structure of any preceding claim, wherein the at least one machining tool is a cutting tool.

5. The support structure of any preceding claim, wherein the bearing surface is a curved surface around the circumference of the slip ring.

6. The support structure of any one of claims 1 to 4, wherein the bearing surface is a planar surface perpendicular to the rotation axis.

7. The support structure of any preceding claim wherein the at least one machining tool is mounted on the stationary member via one or more respective tool positioning systems, wherein the tool positioning systems are configured to adjust a position of the respective machining tool relative to the bearing surface.

8. The support structure of claim 7, wherein the one or more tool positioning systems are configured to move the respective tool in a perpendicular direction relative to the bearing surface.

9. The support structure of claim 7 or 8, wherein the one or more tool positioning systems are configured to move the respective tool in a lateral direction relative to the bearing surface.

10. The support structure of any one of claims 7 to 9, further comprising a controller configured to control the tool positioning system.

11. The support structure of any preceding claim, further comprising a rotary drive system configured to rotate the gantry about the rotation axis during machining of the bearing surface and during medical treatment.

12. A method for machining a bearing surface of a slip ring of a support structure of any preceding claim, the method comprising:

adjusting a position of the at least one machining tool on the stationary member such that the machining tool is configured to contact at least a portion of the bearing surface when the slip ring rotates; and

causing rotation of the slip ring.

13. The method of claim 12, wherein the slip ring comprises a plurality of arcuate sections and wherein the method further comprises assembling the arcuate sections to form the slip ring.