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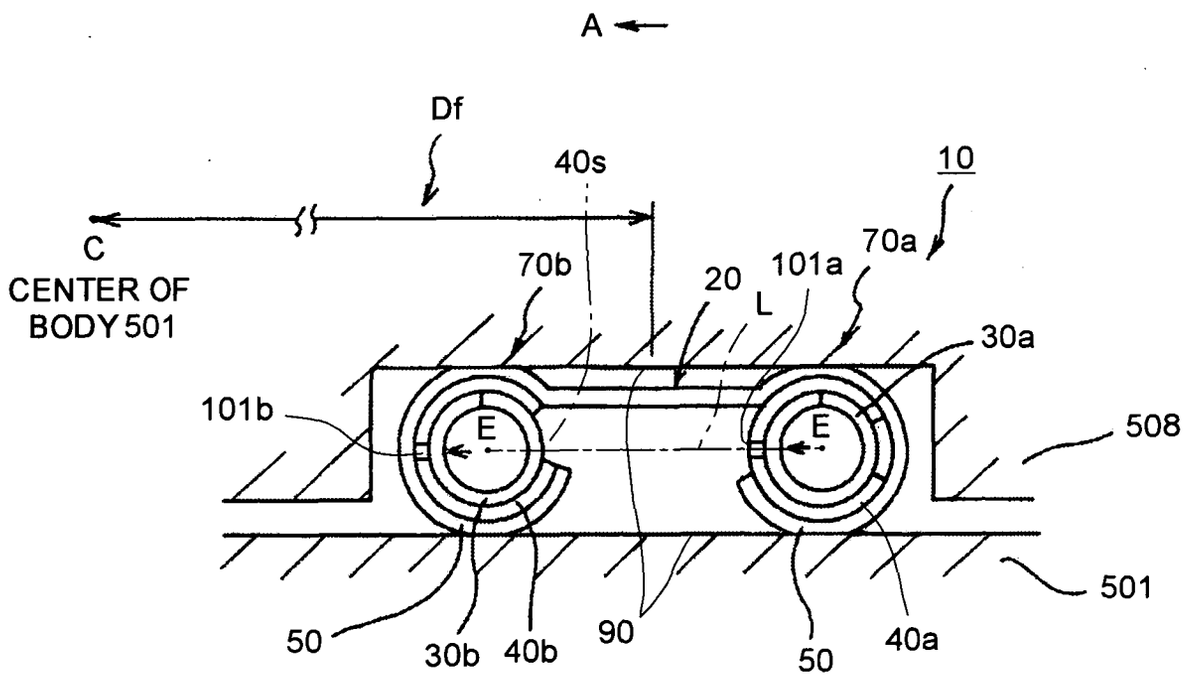
(54) Metal gasket, method of manufacturing metal gasket, and radioactive-material container

(57) A metal gasket includes a coil spring (30a, 30b) that forms a ring, an inner cover (40a, 40b) that covers the coil spring (30a, 30b), and an outer cover (50) that covers the inner cover (40a, 40b). The inner cover (40a, 40b) has a hole (101a, 101b) for draining water from the metal gasket.

FIG.3



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Description

BACKGROUND OF THE INVENTION

1) Field of the Invention

[0001] The present invention relates to a technology for sealing a radioactive-material container.

2) Description of the Related Art

[0002] A nuclear fuel assembly that is at the end of a nuclear fuel cycle and finishes its combustion is called a recycle fuel assembly. The recycle fuel assembly is cooled at a cooling pit of a nuclear power plant for a long period of time because the recycle fuel assembly contains highly radioactive materials such as fission product (FP) and requires thermal cooling. Then, the recycle fuel assembly is contained in a radioactive-material container, and conveyed to a reprocessing facility to be stored. Since the radioactive-material container contains highly radioactive materials, a strict care should be paid on its sealing for a storing period of 40 years to 60 years. Generally, the radioactive-material container is sealed by using a metal gasket between a lid and a body. An example of a structure for securing the sealing of the metal gasket is a single-ring-type metal gasket that suppresses a leak by forming a solid lubricating clad between an inner cover and an outer cover (see Japanese Utility Model Application Laid-Open, H5-75154).

[0003] When containing the recycle fuel assembly in the radioactive-material container, a containing process is conducted in a pool. Therefore, after containing the recycle fuel assembly, it is necessary to remove water inside the radioactive-material container by vacuum drying. However, the conventional metal gasket formed by a double structure, where the outer cover is configured to grasp a ring-shaped coil spring, the water collects inside the inner and the outer rings and it is hard to drain the water to the outside. Moreover, since the conventional metal gasket is configured to wind a plate-shaped inner cover around the coil spring, it is necessary to wind the inner cover in such a manner that an opening faces the outside when manufacturing. Consequently, it is difficult to have the openings of both inner rings faced the inside to make it easy to remove the water inside the metal gasket.

SUMMARY OF THE INVENTION

[0004] It is an object of the present invention to solve at least the problems in the conventional technology.

[0005] The metal gasket according to one aspect of the present invention includes a coil spring that forms a ring; an inner cover that covers the coil spring; and an outer cover that covers the inner cover. The inner cover has a hole for draining water from the metal gasket.

[0006] The metal gasket according to another aspect of the present invention includes a first coil spring that forms a first ring and a second coil spring that forms a second ring, the first ring and the second ring arranged concentrically with a different hoop diameter; a first inner cover that covers the first coil spring; a second inner cover that covers the second coil spring; and an outer cover that covers the first inner cover and the second inner cover. The first inner cover has a hole for draining water from the metal gasket.

[0007] The metal gasket according to still another aspect of the present invention includes an inner cover that is formed by winding a plate material having two edges in such a manner that the two edges have an overlap, where the inner cover forms a ring and functions as a spring; and an outer cover that covers the inner cover. The inner cover has a hole for draining water from the metal gasket.

[0008] The metal gasket according to still another aspect of the present invention includes a first inner cover that is formed by winding a first plate material having two first edges in such a manner that the two first edges have an overlap making a first circle, where the first inner cover forms a first ring and functions as a spring; a second inner cover that is formed by winding a second plate material having two second edges in such a manner that the two second edges have an overlap making a second circle, where the second inner cover forms a second ring that is concentric to the first ring and functions as a spring; and an outer cover that covers the first inner cover and the second inner cover. The first inner cover has a first hole and the second inner cover has a second hole, for draining water from the metal gasket.

[0009] The method of manufacturing a metal gasket, according to still another aspect of the present invention includes making a hole for draining water from the metal gasket in a plate material; forming a ring with a coil spring; forming an inner cover by winding the plate material around the ring; and winding an outer cover around the inner cover.

[0010] The method of manufacturing a metal gasket, according to still another aspect of the present invention includes making a first hole for draining water from the metal gasket in a first plate material; making a second hole for draining water from the metal gasket in a second plate material; forming a first ring with a first coil spring and a second ring with a second coil spring; forming a first inner cover by winding the first plate material around a surface of the first coil spring; forming a second inner cover by winding the second plate material around a surface of the second coil spring; and winding an outer cover around the first inner cover and the second inner cover.

[0011] The method of manufacturing a metal gasket, according to still another aspect of the present invention includes making a hole for draining water from the metal gasket in a plate material, the plate material having two edges; forming an inner cover by winding the plate material in such a manner that the two edges have an over-

lap to make a ring that functions as a spring; and winding an outer cover around the inner cover.

[0012] The method of manufacturing a metal gasket, according to still another aspect of the present invention includes making a first hole for draining water from the metal gasket in a first plate material, the first plate material having two first edges; making a second hole for removing water from the metal gasket in a second plate material, the second plate material having two second edges; forming a first inner cover by winding the first plate material in such a manner that the two first edges have an overlap making a first circle, where the first inner cover forms a first ring that functions as a spring; forming a second inner cover by winding the second plate material in such a manner that the two second edges have an overlap making a second circle, where the second inner cover forms a second ring that is concentric to the first ring and functions as a spring; and winding an outer cover around the first inner cover and the second inner cover.

[0013] The radioactive-material container according to still another aspect of the present invention includes a body that includes a cavity to accommodate a recycle fuel assembly; a lid that is arranged on an opening of the cavity; and the metal gasket according to the above aspects between the body and the lid.

[0014] The other objects, features, and advantages of the present invention are specifically set forth in or will become apparent from the following detailed descriptions of the invention when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is a cross section of a radioactive-material container according to a first embodiment of the present invention;

Fig. 2 is a partial enlarged-view of the radioactive-material container according to the first embodiment;

Fig. 3 is a schematic for illustrating a sealing structure of a metal gasket according to the first embodiment;

Fig. 4 is a cross section of the medal gasket according to the first embodiment;

Fig. 5 is a cross section of a metal gasket according to a modification of the first embodiment;

Fig. 6 is a perspective view of a coil spring of the metal gasket according to the first embodiment of the present invention;

Fig. 7 is a side view of the coil spring of the metal gasket according to the first embodiment;

Fig. 8 is a cross section of a metal gasket according to a second embodiment of the present invention; and

Fig. 9 is a cross section of a metal gasket according to a modification of the second embodiment.

DETAILED DESCRIPTION

[0016] Exemplary embodiments of a metal gasket, a method of manufacturing the metal gasket, and a radioactive-material container according to the present invention will be explained below in detail with reference to the accompanying diagrams. The present invention is not limited to the following embodiments, and the components of the following embodiments include components that a person skilled in the art assumes easily or substantially same components. An applicable scope of a metal gasket according to the present invention is not especially limited, and, for example, the metal gasket may be applied to a sealing part of a radioactive-material container, and a sealing part of a reactor container. The metal gasket is suited to an application that requires maintaining the sealing performance for decades in the comparatively-high-temperature environment, more especially a radioactive-material container that accommodates the recycle fuel assembly, is conveyed, and stores the recycle fuel assembly for a long period of time.

[0017] Fig. 1 is a cross section of a radioactive-material container 500 according to a first embodiment of the present invention. Fig. 2 is a partial enlarged-view of the radioactive-material container 500. The radioactive-material container 500 includes a body 501, which is made of stainless or carbon steel, an external cylinder 502, which composes an external surface of the radioactive-material container 500, a resin 503, which is a polymeric material that contains hydrogen and fills a space between the body 501 and the external cylinder 502, a bottom plate 505, which is welded to the bottom of the body 501 and in which a resin 504 is enclosed, and a lid 520, which is arranged on an opening 509o of a cavity 509. The opening 509o corresponds to a flange member 506, which is welded to the body 501. The lid 520 includes a primary lid 507 and a secondary lid 508. The flange member 506 may be formed to unite with the body 501. A basket 513 that accommodates the recycle fuel assembly is arranged inside the cavity 509 of the body 501. The primary lid 507 and the secondary lid 508 are fixed using bolts 510, 511 on the flange member 506, and a resin 512 is enclosed in the secondary lid 508.

[0018] The basket 513 is composed of a plurality of cells that is formed of boron/aluminum composite. The cavity 509 is filled with negative-pressure helium gas while a space between the primary lid 507. On the other hand, the secondary lid 508 is positive pressured, so that a pressure barrier is formed between the inside and the outside of the radioactive-material container 500. A hole 514 is arranged in the secondary lid 508 to measure the pressure of a space between the primary lid 507 and the secondary lid 508, and a pressure sensor 515 is arranged on the outlet of the hole 514.

[0019] A valve is arranged in the primary lid 507 to

replace the gas inside the radioactive-material container 500, and covered with a valve cover. To seal a gap between the primary lid 507 and the body 501 or a gap between the secondary lid 508 and the body 501, a metal gasket 20 that is heat resistant, corrosion resistant, and highly durable is used because the gaps must be sealed for a long period of time. Using the bolts 510, 511, the metal gasket 20 is fixed to a gasket gap 525 that is formed by machining. For example, when the secondary lid 508 and the body 501 are fixed, the metal gasket 20 is tightened and transformed, and a sealing function is exerted.

[0020] Fig. 3 is a schematic for illustrating a sealing structure 10 of a metal gasket 20 according to the first embodiment. A feature of the sealing structure 10 is that a hole for draining water is made in an inner cover. Various types of metal gaskets are applied to the present invention. For example, the metal gasket 20, shown in Fig. 4, is so-called double ring type and includes two coil springs 30a, 30b. The coil springs 30a, 30b have the different hoop diameters Df, are arranged concentrically, and covered with an outer cover 50. Other examples are the metal gasket 20', shown in Fig. 5, that includes an outer cover 50' with a flat upper part, and a single-type metal gasket (not shown). The coil springs 30a, 30b may be called a coil spring 30 or coil springs 30 in the following explanation for convenience.

[0021] The sealing structure 10 and the metal gasket 20 shown in Fig. 3 is arranged between the secondary lid 508 and the flange member 506 of the body 501, and may be arranged between the primary lid 507 and the flange member 506of the body 501. In the metal gasket 20, inner covers 40a, 40b respectively cover the coil springs 30a, 30b that are substantially circular, so that an outer ring 70a and an inner ring 70b are formed. Then an outer cover 50 covers the outer ring 70a and the inner ring 70b. The outer cover 50 has bolt holes and bolts penetrate the bolt holes to fix the metal gasket 20 on the gasket gap 525. The inner covers 40a, 40b may be called an inner cover 40 or inner covers 40 in the following explanation for convenience.

[0022] A water drain hole 101 a, which is a hole for draining water, is made where the inner cover 40a is not covered with the outer cover 50, namely, where the inner cover 40a is not disturbed by the outer cover 50, and is made in the inner cover 40a to face the center of the body 501. Therefore, the water drain hole 101 a is made only in the inner cover 40a. After the water drain hole 101 a is made in the inner cover 40a, the inner covers 40a, 40b are wound round the coil springs 30a, 30b respectively to have a ring section.

[0023] In the metal gasket 20, the hoop diameter is approximately 2 meters, the sectional diameters D of the outer ring 70a and the inner ring 70b are approximately 5.5 millimeters, the thickness of the outer cover 50 is 0.4 millimeter, and the thickness of the inner cover 40s is 0.4 millimeter. As a material of the outer cover 50, a soft metal, such as aluminum, silver, copper, and nickel, is used to ensure the seal performance. As a material of the inner cover 40 and the coil spring 30, a nickel alloy, such as Inconel (a registered trademark), which is corrosion resistant and oxidation resistant at high temperature, or stainless, is used to maintain the elasticity in a high-temperature environment. Nimonic (a registered trademark), which has a high Co content, or the like may be used to improve the durability at higher temperature.

[0024] As a material of the secondary lid 508, the primary lid 507, and the body 501, stainless steel or carbon steel is used to block off the radiation and maintain the mechanical strength. The secondary lid 508, the primary lid 507, and the body 501 make a contact with the outer cover 50, which is made of a soft metal. Therefore, for example, when the outer cover 50 makes a contact with the body 501, a voltage potential difference is caused by a contact between the different metals, so that the galvanic corrosion occurs and the air tightness is broken. To prevent the galvanic corrosion, SUS317 or SUS625, which contains molybdenum, is used as a material of the secondary lid 508 and the body 501.

[0025] SUS317 and SUS625 have a good weldability and are generally suited to an application that has a lot of parts to be welded, such as a radioactive-material container. SUS625, SUS314, SUS316, SUS326, and SUS345 may be used as an alternative to SUS 317 and SUS625. Instead of making the secondary lid 508 and the body 501 of SUS317 or the like, a sealing surface 90 may be made on the secondary lid 508 and the body 501 to have a bulge portion using the same material.

[0026] Another way to prevent the galvanic corrosion, aluminum may be used as a material of the outer cover 50. Aluminum has the higher corrosion potential than SUS317 or SUS 625, which is a material of the secondary lid 508 and the body 501. Therefore, when the outer cover 50 is made of aluminum, the outer cover 50 is corroded more easily than the secondary lid 508 and the body 501. However the outer cover 50 can be replaced more easily than the secondary lid 508 and the body 501, so that the secondary lid 508 and the body 501 can be protected from the galvanic corrosion. The same explanation is applied to a combination of the primary lid 507 and the body 510.

[0027] Fig. 6 is a perspective view of a coil spring of the metal gasket according to the first embodiment of the present invention. Fig. 7 is a side view of the coil spring of the metal gasket according to the first embodiment. The coil spring 30 is formed by winding a wire material closely. If the wire material is not wounded closely, when the medal gasket 20 is sealed and squashed, the spring coil 30 can not push back the inner cover 40 and the outer cover 50 with a uniform force and the seal performance can not be exerted for a certain distance in long-time usage.

[0028] Generally, to gain the higher seal pressure in the metal gasket 20, the coil spring 30 is required to have the larger wire diameter d, that is, to have the higher flexural rigidity. The wire diameter d of the coil spring 30

gets larger, winding the wire gets harder and the winding diameter D1 of the coil spring 30 gets larger. Consequently, when the metal gasket requires a high seal-pressure, the cross-sectional diameter D of the metal gasket 20 gets larger comparing to that of what requires a low seal-pressure. The flexural rigidity of the coil spring 30 indicates how hard to transform the coil spring 30 to the radial direction when force P is acted on the coil spring 30 to the radial direction.

[0029] After the radioactive-material container 500 is sunk in the pool and the recycle fuel assemblies are accommodated in the radioactive-material container 500, the radioactive-material container 500 is lifted up from the pool and the water is removed from the radioactive-material container 500 by vacuum drying. In this process, the water enters inside the coil springs 30a, 30b. Especially, the water enters inside the coil spring 30b easily because the inner cover 40b has an opening 40s inside the metal gasket 20. Even if the inner cover 40a does not have the opening, the water enters from a gap between the outer cover 50 and the inner cover 40a and collects inside the coil spring 30a or the water enters from a surface between the outer cover 50 and the inner cover 40a and collects inside. When the water is removed from the radioactive-material container 500, the water that collects inside the metal gasket 20 is removed. In the outer ring 70a, the water is removed from the water drain hole 101 a to the outside. In the inner ring 70b, the water is removed from the opening 40s and the inner cover 40b is required to have a hole for draining the water. However, the inner cover 40b is required to have a water drain hole 101b, which is a hole for draining the water from a gap between the inner cover 40b and the outer cover 50, in the cases of:

1) draining the water when the opening 40s is arranged on the comparatively upper side and the inner cover 40b has the shape that collects the water easily; and

2) draining the water that collect at the surface between the outer cover 50 and the inner cover 40b. The water drain holes 101 a, 101 b may be called a water drain hole 101 or water drain holes 101 in the following explanation for convenience.

[0030] In the production of metal gasket 20, after the water drain holes 101 are made in the inner covers 40, the inner covers 40 are wound round the coil springs30. Consequently, the water drain holes 101 can be made in the inner covers 40 without paying an attention not to damage the coil springs 30.

[0031] The water drain hole 101 a is made to face the center of the body 501, substantially corresponding to the direction of a line L that joins a center of the ring outer ring 70a to that of the outer ring 70b, because if the water drain hole 101 a faces obliquely downward, the opening of the water drain hole opening may be covered with the sealing surface 90 and may not work. Preferably, the angle between the direction that the water drain hole 101 faces and the line L is ±45 degrees.

[0032] Fig. 8 is a cross section of a metal gasket 200 according to a second embodiment of the present invention. Fig. 9 is a cross section of a metal gasket according to a modification of the second embodiment. The metal gasket 200 includes inner covers 210a, 210b and the inner covers 210a, 201b have a ring section, have the different hoop diameters, and are arranged concentrically. The hoop diameter of the inner cover 210a is larger than that of the inner cover 210b. An outer cover 50 covers the inner covers 210a, 210b and forms a double-ring. A metal gasket that is applied to the present invention is not limited to the type of the metal gasket 200, but may be a metal gasket 250 so-called a single type metal gasket. The metal gasket 250 includes an outer cover 260 and an inner cover 210c that has a water drain hole 230c, which is a hole for draining the water. Hereinafter, the inner cover 210a, the inner cover 210b, and the inner cover 210c may be called an inner cover 210 or inner covers 210 and the outer cover 220A and the outer cover 220C may be called an outer cover 220 for convenience.

[0033] As a material of the outer cover 220, a soft metal such as aluminum, silver, copper, and nickel is used to ensure the sealing performance. As a material of the inner cover 210, a nickel alloy such as Inconel (registered trademark), which is corrosion resistant and oxidation resistant at high temperature, is used to maintain the elasticity. Nimonic (registered trademark), which has a high Co content, may be used to improve the durability at higher temperature. The inner covers 210 are formed substantially circular and to have a ring section by winding a plate material while overlapping an edge of the plate material with another edge, so that the inner covers 210 works as a spring. When the metal gasket 200 or the metal gasket 250 is compressed by sealing, an overlapped part 210s slides and a diameter of the inner cover 210 gets smaller. Though the diameter of the inner cover 210 gets smaller, a contact surface with the inner cover 210 does not get larger, therefore, sealing can, be performed certainly.

[0034] Water drain holes 230a, 230a', and 230b are formed in the inner covers 210a and 210b. The water drain holes 230a and 230a' formed in the inner cover 210a is for draining the water from the metal gasket 200. The water drain hole 230b is for draining the water from a gap between the inner cover 210b and the outer cover 50. The inner covers 210 may have a plurality of holes for draining the water. The water drain holes 230a, 230b are made to face the center of the body 501 and arranged at substantially middle of the height of the metal gasket 200. If the water drain holes 230a, 230b are made below, the water drain holes 230a, 230b are disturbed by the outer cover 220A, therefore the outer cover 200A needs to have a hole for draining the water. If the water drain holes 230a, 230b are made close to a sealing surface, the water easily enters between the out-

er cover 220A and the sealing surface but it is hard to remove the water. Preferably, the water drain holes 230a, 230b are arranged to make an angle of at most 45 degrees to a line I, which joins a center of an outer ring 270a to a center of an inner ring 270b.

[0035] On the other hand, the inner ring 270b has the overlapped part 210s is arranged inside the metal gasket 200. Therefore, the water drain hole 230a' needs to be arranged where the water drain hole 230a' is not covered with the overlapped part 210s when the overlapped part 210s slides by sealing.

[0036] The metal gasket 250 is formed in the following order:

1) making the water drain hole 230c in the inner cover 210c that is plate-shaped;
2) overlapping the inner cover 210c with the outer cover 220c that is plate-shaped; and
3) winding the inner cover 210c and the outer cover 220 that are overlapped and have two edges in such a manner the two edges have an overlap and a cross section is a ring shape. The water drain hole 230c is made at substantially middle height of the metal gasket 250. If the inner cover 210c and the outer cover 250c are separate plates, the water drain hole 230c is made in the opposite surface of the overlapped part 210s.

[0037] According to the present invention, the seal performance can be sufficiently exerted for a long time by removing the water inside the metal gasket.

[0038] Although the invention has been described with respect to a specific embodiment for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art which fairly fall within the basic teaching herein set forth.

Claims

1. A metal gasket that is to be arranged between a body (501) of a radioactive-material container (500) to accommodate a recycle fuel assembly and a lid (520) that is arranged on an opening of a cavity (509) of the body (501), and maintains an air tightness of the cavity (509), comprising:

   a coil spring (30a, 30b) that forms a ring;
   an inner cover (40a, 40b) that covers the coil spring (30a, 30b); and
   an outer cover (50) that covers the inner cover (40a, 40b), wherein
   the inner cover (40a, 40b) has a hole (101a, 101b) for draining water from the metal gasket.

2. The metal gasket according to claim 1, wherein
   a part of the inner cover (40a, 40b) is not covered with the outer cover (50), and
   the hole (101a, 101b) is arranged in the part.

3. The metal gasket according to claim 2, wherein the part is an arc of the inner cover (40a, 40b) towards a center of the ring, formed by a center of the coil spring (30a, 30b) and angles of ±45 degrees with respect to a line that connects the center of the coil spring (30a, 30b) and the center of the ring.

4. A metal gasket that is to be arranged between a body (501) of a radioactive-material container (500) to accommodate a recycle fuel assembly and a lid (520) that is arranged on an opening of a cavity (509) of the body (501), and maintains an air tightness of the cavity (509), comprising:

   a first coil spring (30a) that forms a first ring and a second coil spring (30b) that forms a second ring, the first ring and the second ring arranged concentrically with a different hoop diameter (Df);
   a first inner cover (40a) that covers the first coil spring (30a);
   a second inner cover (40b) that covers the second coil spring (30b); and
   an outer cover (50) that covers the first inner cover (40a) and the second inner cover (40b), wherein
   the first inner cover (40a) has a hole (101a) for draining water from the metal gasket.

5. The metal gasket according to claim 4, wherein
   a part of the first inner cover (40a) is not covered with the outer cover (50), and
   the hole (101 a) in the first inner cover (40a) is arranged in the part of the first inner cover (40a).

6. The metal gasket according to claim 5, wherein the part is an arc of the first inner cover (40a) towards a center of the first ring, formed by a center of the first coil spring (30a) and angles of ±45 degrees with respect to a line that connects the center of the first coil spring (30a) and the center of the first ring.

7. The metal gasket according to any one of claims 4 to 6, wherein the second inner cover (40b) has a hole (101 b) for draining water from a gap between the second inner cover (40b) and the outer cover (50).

8. A metal gasket that is to be arranged between a body (501) of a radioactive-material container (500) to accommodate a recycle fuel assembly and a lid (520) that is arranged on an opening of a cavity (509) of the body (501), and maintains an air tightness of the cavity (509), comprising:

an inner cover (210a, 210b, 210c) that is formed by winding a plate material having two edges in such a manner that the two edges have an overlap, wherein the inner cover (210a, 210b, 210c) forms a ring and functions as a spring; and
an outer cover (50) that covers the inner cover (210a, 210b, 210c), wherein
the inner cover (210a, 210b, 210c) has a hole (230a, 230b, 230c) for draining water from the metal gasket.

9. A metal gasket that is to be arranged between a body (501) of a radioactive-material container (500) to accommodate a recycle fuel assembly and a lid (520) that is arranged on an opening of a cavity (509) of the body (501), and maintains an air tightness of the cavity (509), comprising:

a first inner cover (210a) that is formed by winding a first plate material having two first edges in such a manner that the two first edges have an overlap making a first circle, wherein the first inner cover (210a) forms a first ring and functions as a spring;
a second inner cover (210b) that is formed by winding a second plate material having two second edges in such a manner that the two second edges have an overlap making a second circle, wherein the second inner cover (210b) forms a second ring that is concentric to the first ring and functions as a spring; and
an outer cover (50) that covers the first inner cover (210a) and the second inner cover (210b), wherein
the first inner cover (210a) has a first hole (230a) and the second inner cover (210b) has a second hole (230a'), for draining water from the metal gasket.

10. The metal gasket according to claim 9, wherein
a first part of the first inner cover (210a) is not covered with the outer cover (50), and the first hole (230a) is arranged in the first part of the first inner cover (210a), and
a second part of the second inner cover (210b) is not covered with the outer cover (50), and the second hole (230a') is arranged in the second part of the second inner cover (50).

11. The metal gasket according to claim 10, wherein
the first part is an arc of the first circle towards a center of the first ring, formed by a center of the first circle and angles of ±45 degrees with respect to a line that connects the center of the first circle and the center of the first ring, and
the second part is an arc of the second circle towards a center of the first circle, formed by a center of the second circle and angles of ±45 degrees with respect to the line.

12. The metal gasket according to any one of claims 9 to 11, wherein the second inner cover (210b) has a third hole (230b) for draining water from a gap between the second inner cover (210b) and the outer cover (50).

13. A method of manufacturing a metal gasket, comprising:

making a hole (101a, 101b) for draining water from the metal gasket in a plate material;
forming a ring with a coil spring (30a, 30b);
forming an inner cover (40a, 40b) by winding the plate material around the ring; and
winding an outer cover (50) around the inner cover (40a, 40b).

14. The method according to claim 13, wherein the winding the outer cover (50) includes winding the outer cover (50) around the inner cover (40a, 40b) in such a manner that a part of the inner cover (40a, 40b) where the hole (101a, 101b) is formed is not covered with the outer cover (50).

15. The method according to claim 14, wherein the part is an arc of the inner cover (40a, 40b) towards a center of the ring, formed by a center of the coil spring (30a, 30b) and angles of ±45 degrees with respect to a line that connects the center of the coil spring (30a, 30b) and the center of the ring.

16. A method of manufacturing a metal gasket, comprising:

making a first hole (101a) for draining water from the metal gasket in a first plate material;
making a second hole (101b) for draining water from the metal gasket in a second plate material;
forming a first ring with a first coil spring (30a) and a second ring with a second coil spring (30b);
forming a first inner cover (40a) by winding the first plate material around a surface of the first coil spring (30a);
forming a second inner cover (40b) by winding the second plate material around a surface ,of the second coil spring (30b); and
winding an outer cover (50) around the first inner cover (40a) and the second inner cover (40b).

17. The method according to claim 16, wherein the winding the outer cover (50) includes winding the outer cover (50) around the first inner cover (40a)

and the second inner cover (40b) in such a manner that a part of the first inner cover (40a) where the first hole (101a) is formed is not covered with the outer cover (50).

18. The method according to claim 17, wherein the part is an arc of the first inner cover (40a) towards a center of the first ring, formed by a center of the first coil spring (30a) and angles of ±45 degrees with respect to a line that connects the center of the first coil spring (30a) and the center of the first ring.

19. A method of manufacturing a metal gasket, comprising:

making a hole (230a, 230b, 230c) for draining water from the metal gasket in a plate material, the plate material having two edges;
forming an inner cover (210a, 210b, 210c) by winding the plate material in such a manner that the two edges have an overlap to make a ring that functions as a spring; and
winding an outer cover (50, 220c) around the inner cover (210a, 210b, 210c).

20. A method of manufacturing a metal gasket, comprising:

making a first hole (230a) for draining water from the metal gasket in a first plate material, the first plate material having two first edges;
making a second hole (230a') for removing water from the metal gasket in a second plate material, the second plate material having two second edges;
forming a first inner cover (210a) by winding the first plate material in such a manner that the two first edges have an overlap making a first circle, wherein the first inner cover (210a) forms a first ring that functions as a spring;
forming a second inner cover (210b) by winding the second plate material in such a manner that the two second edges have an overlap making a second circle, wherein the second inner cover (210b) forms a second ring that is concentric to the first ring and functions as a spring; and
winding an outer cover (50) around the first inner cover (210a) and the second inner cover (210b).

21. The method according to claim 20, wherein the winding the outer cover (50) includes winding the outer cover (50) around the first inner cover (210a) and the second inner cover (210b) in such a manner that a first part of the first inner cover (210a) where the first hole (230a) is formed and a second part of the second inner cover (210b) where the second hole (230a') is formed are not covered with the outer cover (50).

22. The method according to claim 21, wherein

the first part is an arc of the first circle towards a center of the first ring, formed by a center of the first circle and angles of ±45 degrees with respect to a line that connects the center of the first circle and the center of the first ring, and

the second part is an arc of the second circle towards a center of the first circle, formed by a center of the second circle and angles of ±45 degrees with respect to the line.

23. The method according to any one of claims 20 to 22, further comprising making a third hole (230b) for removing water from a gap between the second inner cover (210b) and the outer cover (50) in the second inner cover (210b).

24. A radioactive-material container comprising:

a body (501) that includes a cavity (509) to accommodate a recycle fuel assembly;
a lid (520) that is arranged on an opening of the cavity (509); and
the metal gasket according to any one of claims 1 to 12 arranged between the body (501) and the lid (520).

FIG.1

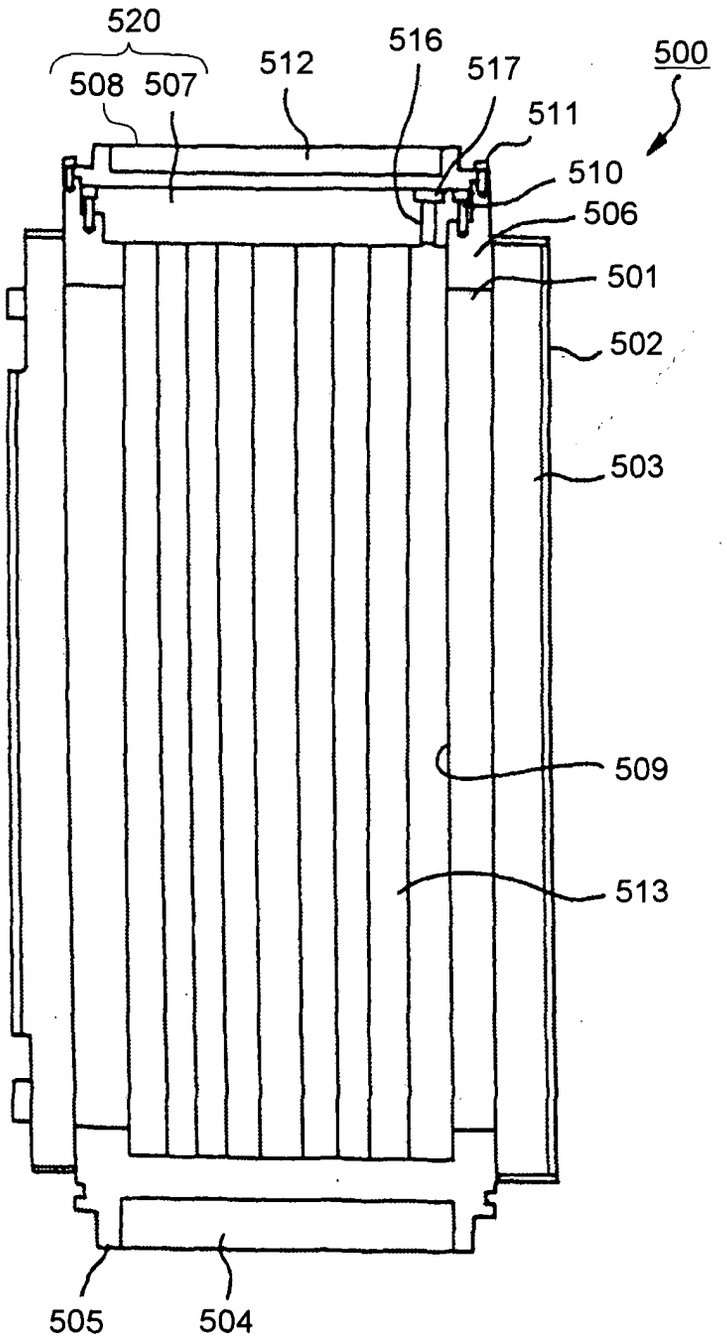

520
508
507
512
516
517
500
511
510
506
501
502
503
509
513
505
504

FIG.2

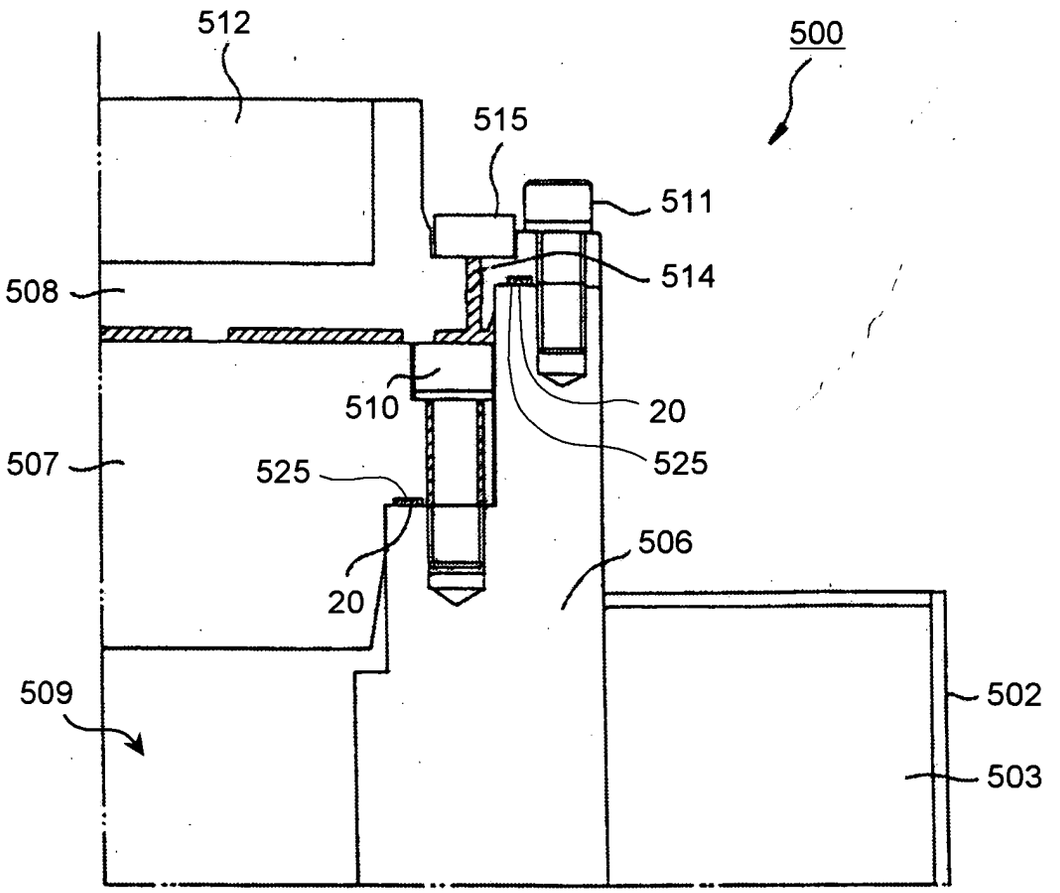


FIG.3

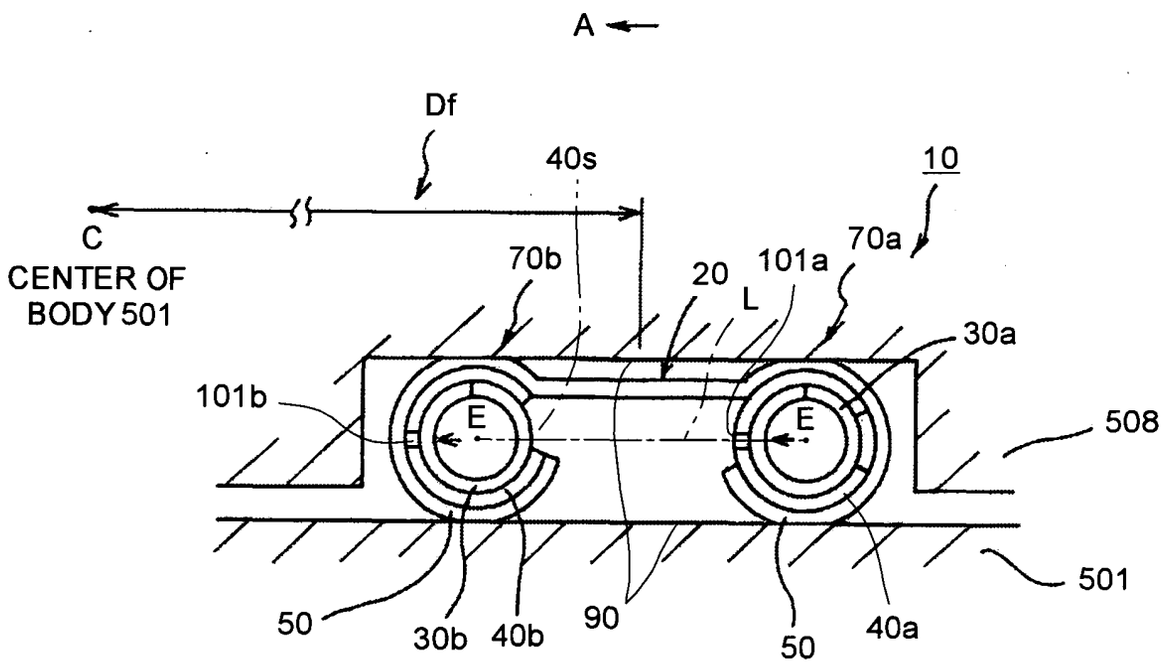

A
Df
40s
10
C
CENTER OF
BODY 501
70b
20
101a
70a
L
30a
101b
E
E
508
501
50
30b
40b
90
50
40a

FIG.4

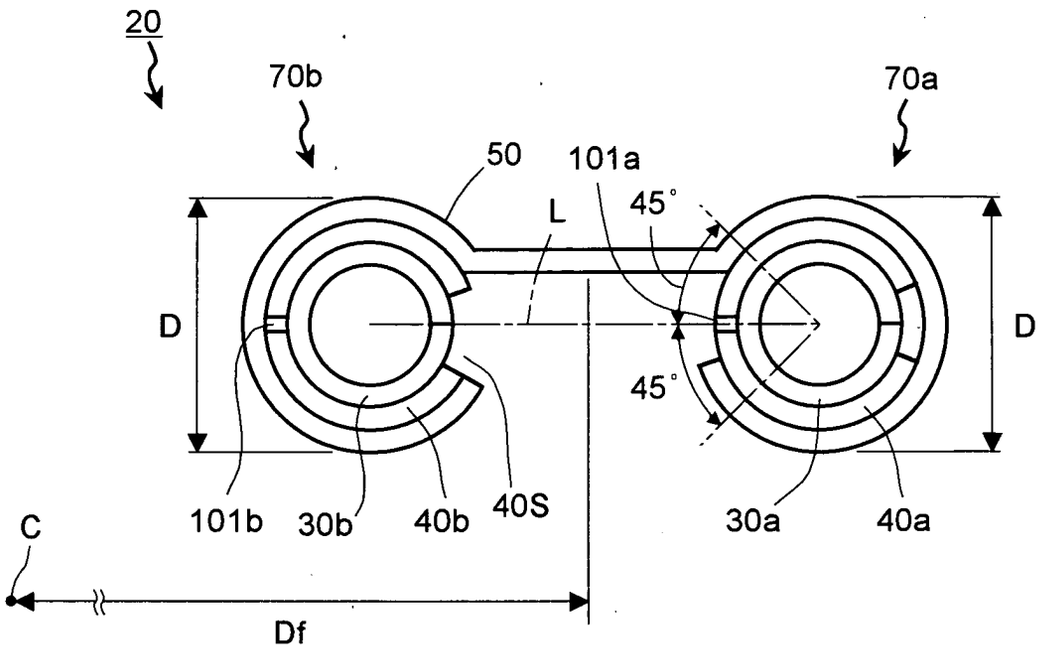

20
70b
70a
50
101a
L
45°
D
D
45°
C
101b
30b
40b
40S
30a
40a
Df

FIG.5

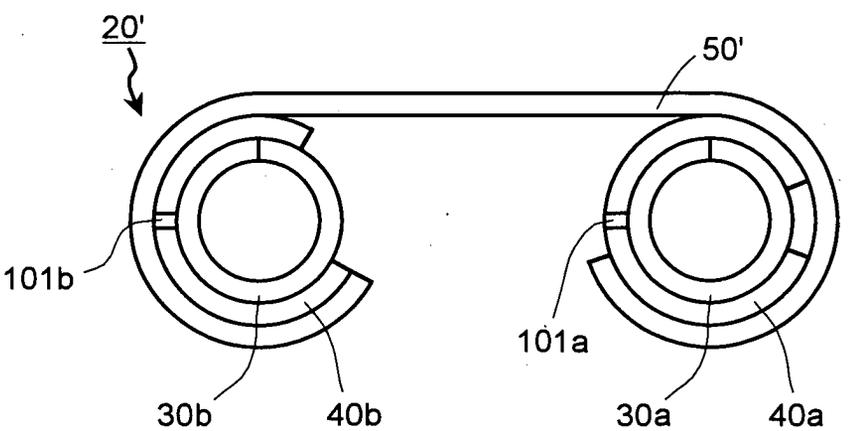

20'
50'
101b
101a
30b
40b
30a
40a

FIG.6

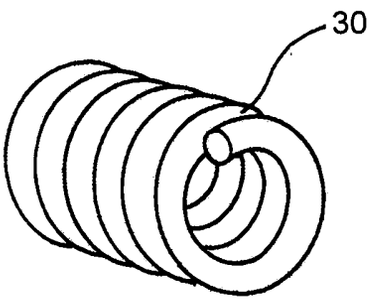


FIG.7

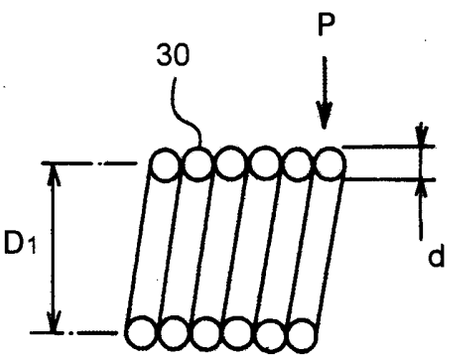


FIG.8

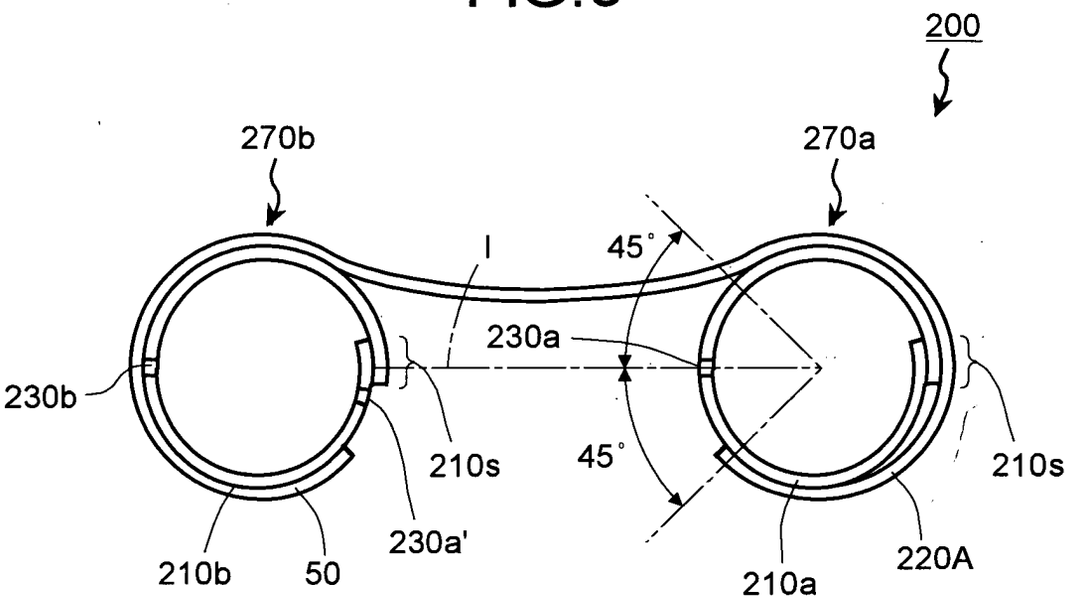
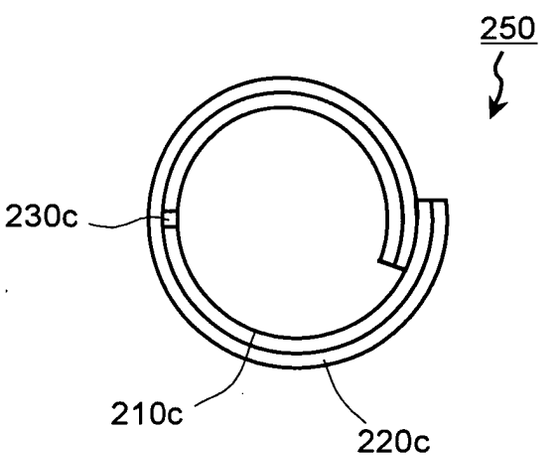

200
270b
270a
l
45°
230a
230b
210s
45°
210s
230a'
210b
50
210a
220A

FIG.9


250
230c
210c
220c

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 00 7344

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	GB 2 001 738 A (APPLICATIONS MEC & ROBINETTERIE IND) 7 February 1979 (1979-02-07) * abstract; figures 1-3 *	1,2,4,5, 7,13,14, 16,17 9,10,12, 20,21,23	G21F5/12 B65D53/02 F16J15/08 F16J15/12 F16J15/32 F16L23/20
X	US 4 561 662 A (DE VILLEPOIX ET AL) 31 December 1985 (1985-12-31) * abstract * * column 2, line 53 - line 62; figures 1,2 *	1,2,13, 14	
X	US 3 917 294 A (ABBES ET AL) 4 November 1975 (1975-11-04) * abstract; figures 1,2 *	1,2,13, 14	
X	GB 1 356 727 A (COMMISSARIAT A LENERGIE ATOMIQUE) 12 June 1974 (1974-06-12) * claim 1; figures 1-6 *	1,2,13, 14	
X	US 5 653 450 A (DE VILLEPOIX ET AL) 5 August 1997 (1997-08-05) * abstract; figures 1-4 *	1,2,13, 14	TECHNICAL FIELDS SEARCHED (Int.Cl.7) G21F B65D F16J F16L
X	US 4 114 907 A (ABBES ET AL) 19 September 1978 (1978-09-19) * abstract; figure 1 *	1,2,13, 14	
X Y	US 6 098 989 A (CAPLAIN ET AL) 8 August 2000 (2000-08-08) * the whole document *	8,19 9,10,12, 20,21,23	
A	GB 1 539 504 A (YOSHIDA KOGYO KK) 31 January 1979 (1979-01-31) * the whole document *	1-24	

-/--

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 February 2005	Deroubaix, P

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EUROPEAN SEARCH REPORT

Application Number
EP 04 00 7344

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	DE 100 03 908 A1 (GNS GESELLSCHAFT FUER NUKLEAR-SERVICE MBH) 2 August 2001 (2001-08-02) * the whole document * -----	1-24	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 February 2005	Deroubaix, P

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D : document cited in the application
L : document cited for other reasons
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& : member of the same patent family, corresponding document

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2001738 A	07-02-1979	FR 2398940 A1	23-02-1979
		AT 379877 B	10-03-1986
		AT 540878 A	15-07-1985
		BE 869234 A1	25-01-1979
		BR 7804797 A	28-02-1979
		CA 1105438 A1	21-07-1981
		CH 626144 A5	30-10-1981
		DE 1404442 A1	13-11-1969
		DE 2832607 A1	08-02-1979
		ES 472046 A1	16-02-1979
		IT 1104923 B	28-10-1985
		JP 1400299 C	28-09-1987
		JP 60179573 A	13-09-1985
		JP 62004584 B	30-01-1987
		JP 1300289 C	31-01-1986
		JP 54067156 A	30-05-1979
		JP 60022226 B	31-05-1985
		NL 7807429 A ,B,	30-01-1979
		SE 439352 B	10-06-1985
		SE 7808048 A	27-01-1979
		SU 772498 A3	15-10-1980
		US 4194749 A	25-03-1980
US 4561662 A	31-12-1985	FR 2557662 A1	05-07-1985
		CA 1249850 A1	07-02-1989
		DE 3472149 D1	21-07-1988
		EP 0148088 A2	10-07-1985
		ES 295773 U	16-06-1987
		JP 1925862 C	25-04-1995
		JP 6056211 B	27-07-1994
		JP 60159472 A	20-08-1985
US 3917294 A	04-11-1975	FR 2232235 A6	27-12-1974
		BE 814989 A4	02-09-1974
		DE 2424366 A1	02-01-1975
		GB 1437052 A	26-05-1976
		IT 1050511 B	10-03-1981
		JP 1196062 C	12-03-1984
		JP 50021162 A	06-03-1975
		JP 57041628 B	03-09-1982
		LU 70157 A1	09-10-1974
		ZA 7403147 A	28-05-1975
GB 1356727 A	12-06-1974	FR 2151186 A5	13-04-1973
		BE 787875 A1	18-12-1972
		DE 2241273 A1	08-03-1973

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 00 7344

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The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 1356727 A		IT 969544 B	10-04-1974
		JP 48029952 A	20-04-1973
		JP 51046220 B	08-12-1976
		LU 65934 A1	15-01-1973
		ZA 7205627 A	30-05-1973
US 5653450 A	05-08-1997	FR 2729447 A1	19-07-1996
		DE 69607864 D1	31-05-2000
		DE 69607864 T2	07-12-2000
		EP 0723098 A1	24-07-1996
		JP 9021489 A	21-01-1997
US 4114907 A	19-09-1978	FR 2364386 A1	07-04-1978
		BE 857804 A1	16-12-1977
		BR 7705989 A	20-06-1978
		CA 1115306 A1	29-12-1981
		CH 613263 A5	14-09-1979
		DE 2740802 A1	16-03-1978
		ES 462083 A1	01-12-1978
		GB 1548110 A	04-07-1979
		IT 1083150 B	21-05-1985
		JP 53034051 A	30-03-1978
		NL 7709381 A	13-03-1978
		SE 429258 B	22-08-1983
		SE 7709641 A	10-03-1978
		ZA 7704979 A	26-07-1978
US 6098989 A	08-08-2000	FR 2765298 A1	31-12-1998
		DE 69817469 D1	02-10-2003
		DE 69817469 T2	24-06-2004
		EP 0887577 A1	30-12-1998
		ES 2205406 T3	01-05-2004
		JP 11063269 A	05-03-1999
GB 1539504 A	31-01-1979	JP 53045738 U	19-04-1978
		JP 57044072 Y2	29-09-1982
		JP 53052636 U	06-05-1978
		JP 57007748 Y2	15-02-1982
		FR 2365684 A1	21-04-1978
		HK 13080 A	21-03-1980
		MY 25480 A	31-12-1980
		US 4123071 A	31-10-1978
DE 10003908 A1	02-08-2001	NONE	

EPO FORM P0459

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