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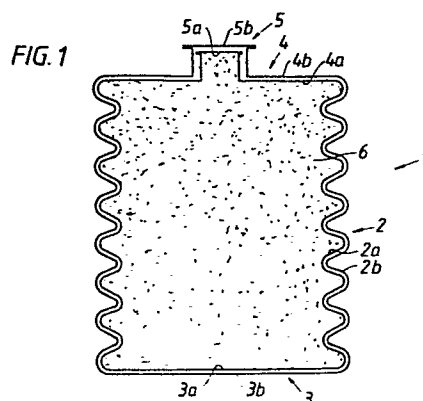
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54 **Method for treating radioactive material and container for enclosing such material.**

57 A container (1) for enclosing particulate or piece-formed radioactive material (6) which shall be converted into a solid body by isostatic pressing at a high temperature and a high pressure. The container may have a corrugated sheath (2) and suitably a plane lid (4) and a plane bottom (3). The corrugation makes possible axial compression of the container (1) prior to the pressing. Instead of the corrugated sheath (2) the container may have a cylindrical sheath (side wall) and bellows projecting into the sheath and joining the sheath of the container to a lid and a bottom. The bellows make it possible to insert the lid and the bottom by gas pressure, so that the material (6) present in the container is axially compressed.



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5 Method for treating radioactive material and
container for enclosing such material

The invention relates to a method for treating radioactive material according to the prior art portion of
10 claim 1 and a container for carrying out that method.

During reprocessing of nuclear fuel, separated high-level waste material must be treated and stored so as to prevent spreading into the biosphere. The first stage is to transform the waste into solid state and, for example, convert
15 in into a solid, crystalline material having good chemical resistance and being capable of resisting leaching by water. One way of achieving this is to compress, at a high temperature and a high pressure, a mixture of waste and
20 a resistant material in particulate form into a massive, solid body where the active material becomes permanently bound. A method of achieving such a solid body is disclosed in US Patent 4,172,807. Radioactive metal scrap or radioactive ashes may be treated in a similar manner.

25

A problem when transforming the waste into solid state is the contamination of the equipment used in the process. In the method according to the above-mentioned patent, containers may be filled with waste material in particulate

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form and sealed in a relatively simple manner. The equipment used for the filling and the sealing is relatively simple and may therefore be cleaned in a simple manner prior to any necessary repair work. The furnace
5 equipment for the hot pressing, on the other hand, is complicated and much more difficult to clean after a possible contamination.

The invention relates, on the one hand, to a method of
10 enclosing radioactive particulate or piece-formed material in a redundant gas-tight container and converting the material into a solid body by compression at a necessary high temperature and a necessary high pressure, and on the other hand to a container for enclosing the above-
15 mentioned material. The material to be contained may consist of a mixture of radioactive material and a material resistant to leaching by water. A risk of contamination of a furnace and its gas supply system may arise if pressure gas should leak into the capsule during the
20 pressing and, during the decompression after the pressing, blow out radioactive material from the container. The container is suitably made as a multi-layer container to make it redundant, thus in all essentials eliminating the risk of leakage. The container is built up of two or more
25 capsules, arranged one inside the other, of different materials, for example of titanium and stainless steel. When the material to be contained possesses such properties that it cannot be packed into high density when filling the container, problems will often occur during the
30 pressing because of great distortion during the compression. A long capsule may be bent to such an extent that it will get into contact with the walls of the furnace space or with heating elements in the furnace, resulting in the furnace being damaged and in difficulties
35 in removing the pressed container. Distortion problems arise at a fill factor of about 60 % and are accentuated

with decreasing fill factor. The difficulties in achieving such a high fill factor as 60 % are especially great when it is a question of enclosing pieces of cladding tubes.

5 According to the invention, the distortion problems are reduced and the compression is facilitated by enclosing the material to be compressed in a container of such a shape that an axial compression of the container is facilitated. The container may be made with a corrugated
10 sheath with a substantially plane lid and plane bottom, or with a cylindrical sheath with a lid and/or bottom which is/are joined to the sheath by a bellows projecting into the sheath. This bellows or these bellows make possible an axial insertion of the lid and the bottom and
15 an axial compression of the contained material. Also containers with a cylindrical side wall and a corrugated lid and bottom can be used. The material contained in the container is converted in a known manner into a solid body by compression at a high temperature, for example by iso-
20 static pressing in a pressure furnace under the influence of a gaseous pressure medium, or by pressing in a closed cavity with talcum or a similar material as a surrounding pressure medium and with a punch projecting into the cavity as a pressure-generating member. The latter method
25 of pressing is disclosed in EP-patent application 80100788.1.

The filling density may be increased prior to the hot pressing by an axial compression of the container in cold
30 condition. When enclosing tubular pieces of cladding material, which may have as low a fill factor as 10-15 %, this precompaction prior to the hot pressing is particularly desirable. This compression may be carried out between press tables or between pistons in a hydraulic press
35 or isostatically in a pressure chamber under the influence of a gaseous or liquid pressure medium. This latter method of pressing is possible for a container with a corrugated

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sheath side wall because of its great radial stiffness but small axial stiffness. The compression before the hot pressing to a density exceeding 70 % of the theoretical density is desirable. The axial compression of the material in the capsule results in a smaller radial compression of the sheath during the final hot pressing into a solid body than what would otherwise be the case. This contributes effectively to reduce the distortion during the hot pressing. During the compression before the hot pressing the container is suitably placed in a container with axial guide means preventing bending of the container during its axial compression.

The corrugated sheath and the bellows also facilitate the axial compression during the hot pressing. During the pressing in the pressure furnace a somewhat greater axial compression is obtained than with a container of a conventional design.

The invention will be described in greater detail with reference to the accompanying drawing, in which:

Figure 1 shows an example of a container according to the invention with a corrugated sheath,

Figure 2 shows another example of such a container with a smooth sheath and with a lid and a bottom which are joined to the sheath by bellows,

Figures 3 and 4 show further embodiments of containers according to the invention with a corrugated lid and bottom.

The container 1 according to Figure 1 is constructed with a corrugated sheath 2, with a plane bottom 3 and with a plane lid 4. The opening of the lid 4 is gas-tightly sealed by the lid 5. The container 1 is built up of two sheet-metal capsules arranged one inside the other, the

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sheaths, bottom and lids of said capsules being designated 2a, 2b, 3a, 3b, 4a, 4b and 5a, 5b. The container 1 is filled with a radioactive material 6. The material in the inner capsule may be titanium, and in the outer capsule
5 stainless steel.

The container 11 according to Figure 2 is constructed with a cylindrical sheath 12, a plane bottom 13 which is joined to the sheath 12 by a bellows 14, projecting into the con-
10 tainer 11, and a lid 15 which is joined to the sheath 12 by a bellows 16 projecting into the container 11. The opening of the lid 15 is sealed by a lid 17. The container 11 is built up of two sheet-metal capsules arranged one inside the other, the sheaths, bottoms, bellows and
15 lids of which are designated 12a, 12b, 13a, 13b, 14a, 14b, 16a, 16b, 15a and 15b. The container 11 is filled with a radioactive material 6.

The container 19 of Figure 3 is composed of two bottle-
20 shaped capsules 20 and 21. The inner capsule 20 may consist of, for example, titanium, the outer of, for example, stainless steel. The inner capsule 20 is made with a relatively small neck 22 with a flange 23 and is sealed by a lid 24 which, after the filling, is gas-tightly joined to
25 the flange 23 by welding. The capsule 21 is formed with an opening 25 with an inclined flange 26. A lid composed of parts 27 and 28 is adapted to the opening 25. Part 27 of this lid is formed with a flange 29 which, when sealing the capsule 21, is gas-tightly joined to the flange 26 by
30 welding. The space between the neck 22 and the lid 27, 28 is filled with a supporting metal block 30, which prevents too great a deformation of the lid part 27 during the pressing. The bottom portions of the capsule parts 20 and 21 as well as their upper end portions are constructed
35 with annular corrugations 31, 32 and 33, 34, respectively. These facilitate an axial compression of the capsule during the initial stage of the pressing and provide a

certain axial compaction which eliminates, or at least reduces, the distortion of the capsule during the pressing. The capsule is supported on a supporting ring 36.

- 5 Figure 4 shows the container according to Figure 3 after the pressing. The contents 35, for example scrap of cladding tubes, have been pressed to practically full density.
- 10 Containers of the kind described above may have a length of between 2000 and 3000 mm and a diameter of 500-600 mm. The capsules 20 and 21 and their respective lids are bonded together after the pressing.

CLAIMS

1. Method for treating radioactive particulate or piece-
5 formed material (6) by enclosing the material in a
gas-tight container (1) and compressing the material
(6) into a solid body at a necessary temperature and
a necessary pressure, c h a r a c t e r i s e d in
that the material (6) is enclosed in a container (1)
10 with a corrugated sheath (2) and that the material (6)
is converted into a solid body by compression at a
high temperature.
2. Method for treating radioactive particulate or piece-
15 formed material (6) by enclosing the material in a
gas-tight container (11) and compressing the material
(6) into a solid body at a necessary temperature and
a necessary pressure, c h a r a c t e r i s e d in
that the material (6) is enclosed in a container (11)
20 with a cylindrical sheath (12) with a lid (15) and/or
a bottom (13) which are joined to the sheath (12) by
bellows (14, 16), and that the container after filling
of the material (6) is converted into a solid body by
a compression at a high temperature.
- 25 3. Method according to claim 1 or 2, c h a r a c t e r -
i s e d in that the conversion into a solid body
takes place by isostatic pressing (HIP).
- 30 4. Method according to any of claim 1 to 3, c h a r a c -
t e r i s e d in that the containers (1, 11) after
filling of the material (6) is compressed axially at

room temperature prior to the final compression.

5. Method according to claim 4, c h a r a c t e r i s e d
in that the compression is carried out so that the
5 material (6) in the containers (1, 11) is densified to
40 % or more of the theoretically possible density.
6. Method according to claim 4 or 5, c h a r a c t e r -
i s e d in that the compression is carried out
10 mechanically.
7. Method according to claim 4 or 5, c h a r a c t e r -
i s e d in that the compression is carried out
isostatically in a pressure chamber under the in-
15 fluence of a gaseous or liquid pressure medium.
8. Container (1, 11, 19) for enclosing particulate or
piece-formed material (6, 35), especially radioactive
material, which shall be converted into a solid body
20 by isostatic pressing at a high temperature,
c h a r a c t e r i s e d in that the walls of said
container are provided with at least one corrugated
wall portion (2, 14, 16, 31, 32, 33, 34).
- 25 9. Container according to claim 8, c h a r a c t e r -
i s e d in that the said container (1) has a
bellows-like side wall (2).
10. Container according to claim 8, c h a r a c t e r -
30 i s e d in that said container (11) has a cylindri-
cal sheath (12) with a lid (15) and/or a bottom (13)
which are joined to the sheath (12) by bellows (14, 16)
projecting into said cylindrical sheath (12).
- 35 11. Container according to claim 8, c h a r a c t e r -
i s e d in that said container (11) has a cylindri-
cal sheath with a bottom and/or lid portion provided

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with annular corrugations (31, 32, 33, 34).

12. Container according to any of claim 8 to 11,
5 c h a r a c t e r i s e d in that the container (1,
11, 19) is built up from at least two capsules (2a, 2b,
12a, 12b, 20, 21), one within the other.

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FIG. 1

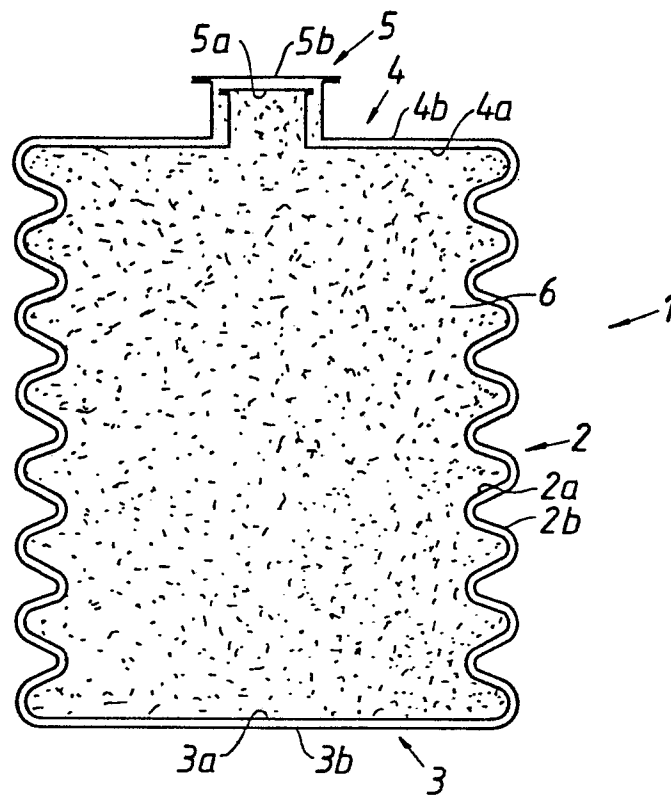


FIG. 2

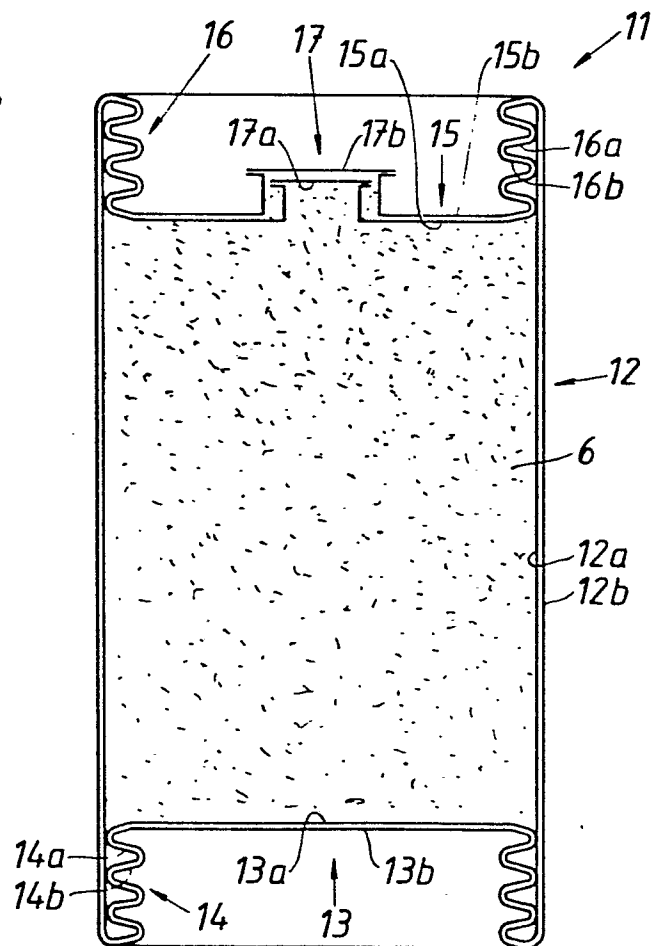


FIG. 3

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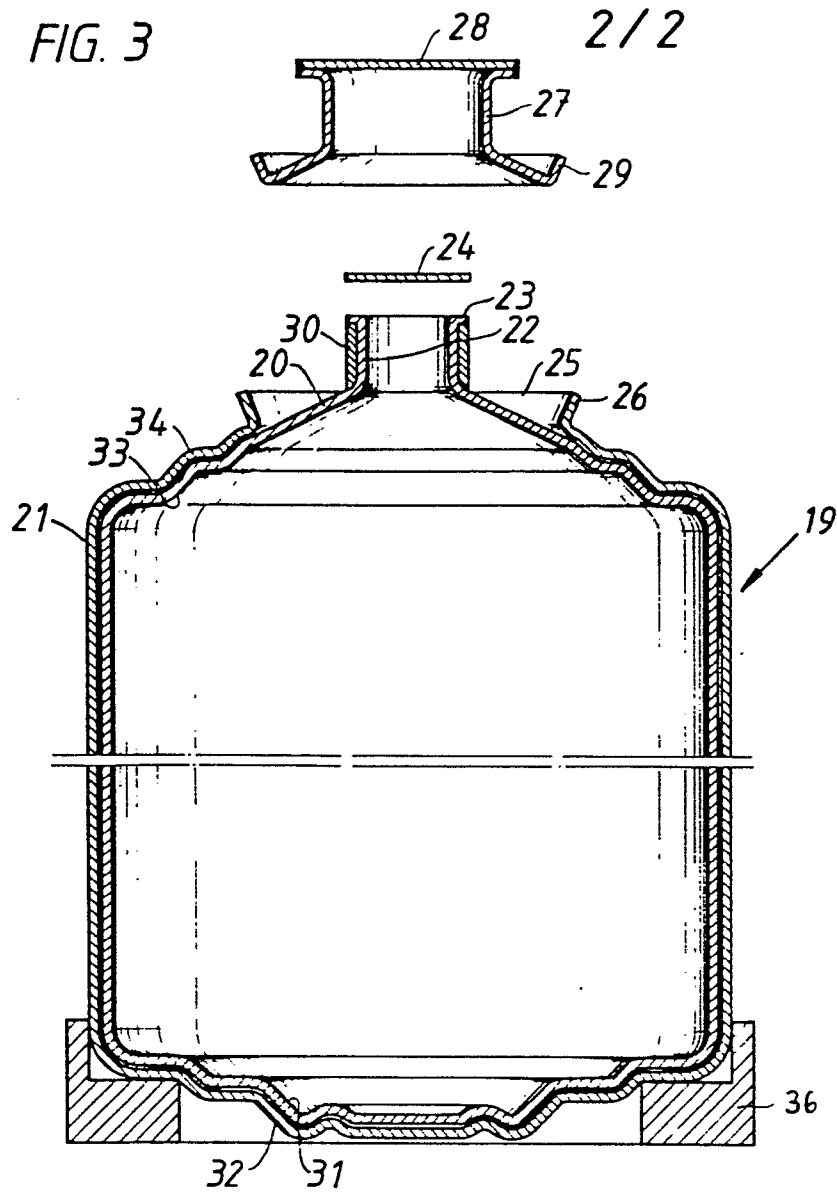
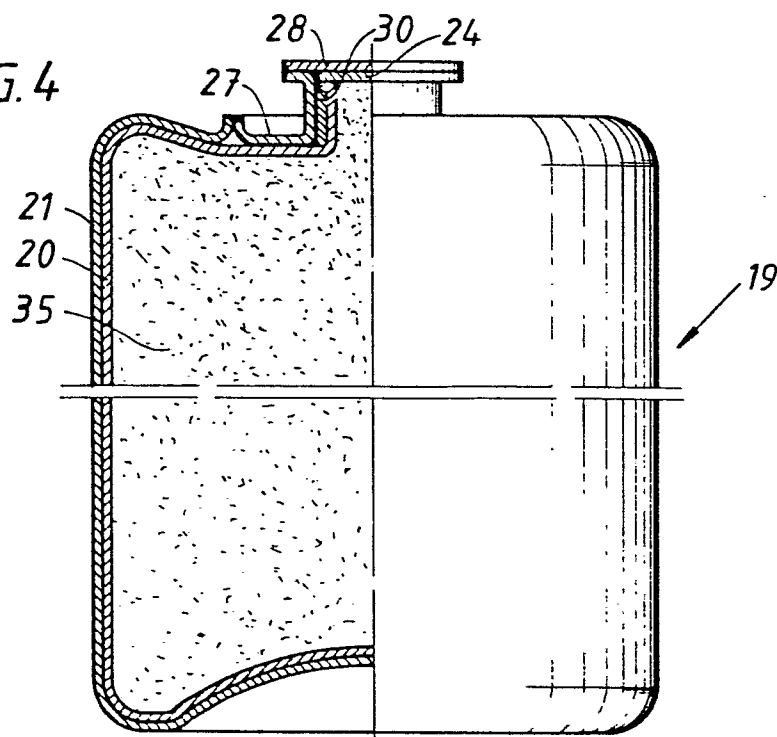


FIG. 4





European Patent
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EUROPEAN SEARCH REPORT

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Application number
EP 81 10 3570

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	<u>US - A - 3 160 502 (QUARTULLO)</u> * Claims 1,6; figures 1,2 * --	1,4,6, 8,9	C 21 F 9/36
A	<u>FR - A - 2 375 696 (ASEA)</u> & US - A - 4 209 420 --		
A	<u>FR - A - 2 375 695 (ASEA)</u> & GB - A - 1 590 108 -----		TECHNICAL FIELDS SEARCHED (Int. Cl. 3) C 21 F 9/34 9/36 B 22 F 3/12 B 65 D 1/40 1/44 7/42 7/46
			CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
The present search report has been drawn up for all claims			& member of the same patent family. corresponding document
Place of search		Date of completion of the search	Examiner
The Hague		10-11-1981	NICOLAS