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(54) **Elhasználódott nukleáris üzemanyag tárolására szolgáló tároló-furatlyukak rendszere és az elhasználódott nukleáris üzemanyag tárolásának módszere**

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(54) **The system of storage boreholes for storage of a spent nuclear fuel and a method of the storage of the spent nuclear fuel**

System für Lagerbohrlöcher zur Lagerung eines verbrauchten Kernbrennstoffes und Verfahren zur Lagerung des verbrauchten Kernbrennstoffes

Système de forage de stockage pour le stockage d'un combustible nucléaire épuisé et procédé de stockage de combustible nucléaire utilisé

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Description

Field of the invention

[0001] The invention is directed to the system of storage boreholes for storage of the spent nuclear fuel or high activity wastes and a method of this storage.

Background of the invention

[0002] According to the existing state of the art the spent nuclear fuel or high activity wastes, hereinafter only "spent nuclear fuel", intended for disposal is stored into the so called deep repositories. The spent nuclear fuel is before its storage in these deep repositories placed into special storage containers. At present, there are used two basic principles of deep repositories - vertical or horizontal storage boreholes and eventually a combination of them.

[0003] The method of the storage into vertical storage boreholes assumes the storage of the spent nuclear fuel in storage containers into boreholes with filling of the intermediate space between the container and the rock with a bentonite buffer layer.

[0004] The vertical boreholes are described in the international patent application WO 2008032018, where the spent nuclear fuel is stored in solid barrels in the 3-5 km deep vertical borehole. This solution does not enable a back removal of the fuel.

[0005] The Chinese patent CN 101971268 describes storage of a spent nuclear fuel into a vertical borehole by means of cables reaching upto the bottom of the borehole. Storage containers are stored in the space bounded by these cables.

[0006] A Russian patent RU 2212720 describes storage of the spent nuclear fuel into 100 m deep vertical boreholes in special repositories equipped with a steel lining with a concrete filling including concentric steel casings.

[0007] A drawback of these solutions is the impossibility or difficulty to remove the stored fuel and a high volume of the excavated rock.

[0008] The method of storage of the spent nuclear fuel to a horizontal storage borehole is described in the Canadian patent CA 1106626, where the fuel is stored into the longitudinal groove made in the bottom of a horizontal tunnel.

[0009] Another known method is described in the patent application US 2010/0234663, where on the base of a vertical borehole, there is drilled a plenty of longitudinal horizontal boreholes, into which the radioactive fuel is stored in special containers. The back removal of storage containers is carried out by means of secondary longitudinal boreholes by a special mechanism including a connector of the container, removing mechanism connectable to the container and a drill pipe.

[0010] The Japanese patent JP2008073572 describes a method of storage of the spent nuclear fuel into a hor-

izontal borehole and its back removal by means of a parallel horizontal borehole located under the level of the storage borehole. Both parallel boreholes are mutually interconnected with perpendicular removing openings.

[0011] A drawback at horizontal boreholes is the unsuitability for back removal of the already stored fuel or financial and mechanical demand, respectively, of eventual removing. The next drawback of these systems is the unsuitability of placing these boreholes in heterogeneous rock mass due to the stability of the borehole from the time of building upto the end of the storage period.

[0012] The drawback of both types of methods is a difficult handling at storage, demanding requirements for area and character of the rock mass and unsuitability of methods for back removal of stored fuel.

Description of the invention

[0013] An object of the present invention is the system according to claim 1 of storage boreholes for storage of a spent nuclear fuel 3DD - Three dimensional disposal and the method according to claim 7 of storage of the spent nuclear fuel into storage boreholes, which eliminates the above given drawbacks of the existing state of the art.

[0014] The system of storage boreholes for storage of a spent nuclear fuel is formed of at least one horizontal corridor, from which at least one storage system comes out, which system consists of a guide characterization borehole and of an angling storage borehole made in its centre line, where storage containers are located.

[0015] The guide characterization borehole and the angling storage borehole are boreholes with an identical angle ranging from 20 to 30 degrees, while the guide characterization borehole exceeds by its length the storage borehole. The diameter of the guide characterization borehole is in the range from 0.1 to 0.2 m, preferably 0.12 m and the diameter of the angling storage borehole is in the range from 0.5 to 2 m, preferably 1.3 m. The guide characterization borehole can be filled with a marking material e.g. a mixture of a sand with a colour pigment in the red or green colour for easy localization of the storage borehole in case of a back removal of the stored spent nuclear fuel. The building process of the system proceeds so that first the characterization borehole is drilled, which serves for a detail verification of rock quality for storage. Consequently, the storage borehole is drilled in the centre line of the characterization borehole.

[0016] For back removal of storage containers, it is possible to build an access working e.g. a handling gallery intersecting the remaining sections of the characterization boreholes, along which the borehole for removal of containers with the stored spent nuclear fuel will be drilled. The access mine working can be constructed also with a long time delay from For back removal of storage containers, it is possible to build an access working e.g. a handling gallery intersecting the remaining sections of the characterization boreholes, along which the borehole

for removal of containers with the stored spent nuclear fuel will be drilled. The access mine working can be constructed also with a long time delay from the time of storage of the spent nuclear fuel into storage boreholes. The guide characterization borehole serves for localization of the storage borehole and the consequent drilling of the borehole to remove the container with the stored spent fuel. The system preferably includes more horizontal corridors arranged parallelly in the spacing from 40 to 60 m, preferably 55 m, where at regular sections from 20 to 40 m, preferably 30 m, storage systems are built, which consist of a guide characterization borehole and an angling storage borehole.

[0017] The method of storage of the spent nuclear fuel to the system insists in the storage of at least one storage container into the angling storage borehole (preferably more storage containers) by means of a handling mechanism. The handling mechanism, by which the transport of individual components of the storage system to the bottom of the storage borehole takes place, can be a material handling truck moving by gravity on a rope.

[0018] The storage container can be located in a super-container, which includes an external overwrap with engineering barriers including a buffer. The cohesion of the super-container is secured by an external basket with a cover, which is a cylindrical vessel of a perforated sheet, while openings of the perforation form 60% of the overwrap surface of the super-container. In the external basket of the super-container there are vertically over the circumference located the individual parts of the buffer e.g. bentonite blocks (moulds) and in the centre, there is located the storage container.

[0019] According to another variant, the storage container can be placed into a storage borehole on a bearing buffer segment. In this case, there is first the bearing buffer segment placed by means of the hydraulics on the bottom of the storage borehole and consequently the storage container with the spent nuclear fuel is put on it. The bearing buffer segment is preferably formed by a bentonite block and in its section it has a form of a part of an annular space limited with a section of a circle with the angle from 110 to 130 degrees, preferably 120 degrees. The whole process is finished then by running in and consequent hydraulic storage of two filling buffer segments into the place of storage, and/or by spraying of the free space around the storage container with a sprayed buffer, which is eventually gradually compacted by a special compacting mechanism. The filling buffer segments are preferably formed of bentonite blocks and have in the section the shape of a part of an annular space limited with a section of a circle with an angle ranging from 110 to 120 degrees. The sum of angles of sections of a circle of the bearing buffer segment and filling buffer segments is ≤ 360 degrees. The buffer is a material of group clay, bentonit, having the ability to carry off the heat from the radioactive waste to the surrounding rocks, to inhibit fading of radionuclides, at the same time to protect the storage container against mechanical pressure

influences. The remaining free space between the segments, the storage container and the wall of the storage borehole is consequently filled with a sprayed buffer. The sprayed buffer is of the group clay, bentonit.

[0020] Behind the storage container, there will be placed a distance block formed of a buffer, behind which another storage container is stored in the same way. The distance block is preferably formed of circular bentonite block.

[0021] For back removal of storage containers, it is possible to built, independently of horizontal corridors and storage systems, an access working (handling gallery). The access mining work can be constructed in undisturbed rocks also in a large time delay from the time of storage of the spent nuclear fuel to storage boreholes. The guide characterization borehole serves for localization of the storage borehole. When the handling gallery locks on the marking material of the guide characterization borehole, it is built along it an access removing borehole to the lowest stored storage container. The removal then consists of releasing of pressure conditions around the storage container for example by drilling or washover and consequent catching of the storage container into a suitable instrument and its withdrawal to the handling gallery and its loading on the transport mean and transport out of the mine.

[0022] The advantage of this method is the lower demand on the area in the underground part of the deep repository, easy handling using the gravity forces at building of the borehole and storage of the spent nuclear fuel, but also the possibility of its back removal. The selected angle is sufficient for movement of the storage mechanism by action of the horizontal component of the gravity force and at the same time it reduces loading of the handling rope by transmission of the vertical component into the underlying rock.

[0023] The advantage of the system of storage boreholes according to the invention is, that the angle of the storage borehole ensures a stabile position of storage containers even in case, that they will be at the back removal released from the pressure locking of the buffer. Another advantage is the possibility to build an access working in heterogeneous rock mass and the possibility of a back removal of the fuel in a large time delay after closing of the deep repository.

Brief description of the drawings

[0024] Further the preferred embodiments of the invention are described in reference on the accompanying drawings in which:

Fig. 1 shows a cross section of a horizontal corridor with a handling mechanism and a longitudinal section of the guide characterization borehole and the angling storage borehole, in which the storage containers and a distance block are, including the access mine working,

Fig. 2 shows a cross section of the angling storage borehole, where the storage container is placed on the bearing buffer and the space between the storage container and the wall of the storage borehole is filled with two filling buffer segments, and Fig. 3 shows a cross section of the angling storage borehole, where the storage container is placed on the bearing buffer segment and the space between the storage container and the wall of the storage borehole is filled with a sprayed buffer, and Fig. 4 shows a plan view of the spatial layout of the system with parallel arranged horizontal corridors and with storage systems.

Examples

Example 1

[0025] The system of storage boreholes for storage of the spent nuclear fuel shown in Fig. 1 consisting of a horizontal corridor 3, from which starts a storage system consisting of an angling guide characterization borehole 1 and of an angling storage borehole 2 with identical angle of 30 degrees. The guide characterization borehole 1 has a diameter of 0.12 m, with its length it exceeds the storage borehole 2 and it is filled with a marking material, in this case a mixture of sand with a colour red pigment.

[0026] The storage borehole 2 has a diameter of 1.3 m and inside it, there are placed storage containers 6 and between them is placed a distance block 7. The storage system includes an access mine working, which is the handling gallery 10. In this variant, the storage container 6 is placed inside a super-container.

Example 2

[0027] The system of storage boreholes for storage of the spent nuclear fuel is carried out as in the example 1 except that the storage container 6 is placed on the bearing buffer segment 5. The space between the storage container 6 and the wall of the storage borehole 2 is filled with two filling buffer segments 8a, 8b, as shown on the Fig. 2.

Example 3

[0028] In another variant, the storage container 6 is placed on the bearing buffer segment 5 and the space between the storage container 6 and the wall of the storage borehole 2 is filled with a sprayed buffer 9, as shown on the Fig. 3. The sprayed buffer (9) is eventually gradually compacted by a special compacting mechanism.

Example 4

[0029] In the spatial layout of the system according to the invention, as shown in the Fig. 4, horizontal corridors 3 are arranged parallelly with spacing of 55 m and from

them, in regular sections per 30 m, there start storage systems consisting of a guide characterization borehole 1 and of an angling storage borehole 2, built in its centre line.

Industrial utility

[0030] The method of storage of the spent nuclear fuel to the system of storage boreholes according to the invention enables a long-term storage of the spent nuclear fuel or of high active wastes, which is easy to handle, undemanding in terms of a structure of the underlying rock, and enables back removal of the fuel.

Claims

1. A system of storage boreholes for storage of spent nuclear fuel consisting of at least one horizontal corridor (3), from which starts at least one storage system **characterized in, that** said storage system consists of an angling guide characterization borehole (1) and an angling larger diameter storage borehole (2) made in the centre line of said guide characterization borehole (1), with an identical angle below the horizontal level, wherein the guide characterization borehole (1) exceeds with its length the storage borehole (2), and wherein in said storage borehole (2) is placed at least one storage container (6) for receiving spent nuclear fuel.
2. The system of the claim 1, **characterized in, that** the angle ranges from 20 to 30 degrees.
3. The system of any of claims 1 to 2 **characterized in, that** the guide characterization borehole (1) has a diameter ranging from 0.1 to 0.2 m, preferably 0.12 m, and the storage borehole (2), has a diameter ranging from 0.5 to 2 m, preferably 1.3 m.
4. The system of any of claims 1 to 3, **characterized in, that** the guide characterization borehole (1), is filled with a marking material, preferably a mixture of sand and a colour pigment of red or green colour.
5. The system of claim 1, **characterized in, that** storage systems, starting from the horizontal corridor (3), are apart from each other in regular spacing from 20 to 40 m, preferably 30 m, and horizontal corridors are arranged parallelly with spacing from 40 to 60 m, preferably 55 m.
6. The system of any of claims 1 to 5, **characterized in, that** it includes an access mine working intersecting the remaining sections of the characterization boreholes (1), which is the handling gallery (10).
7. The method of storage the spent nuclear fuel into

the system of storage boreholes of claim 1, **characterized in, that** into the angling storage borehole (2) there will be placed, by means of a handling mechanism (4), at least one storage container (6).

8. The method of claim 7, **characterized in, that** the handling mechanism (4) is a material handling truck moving by gravity on a rope.
9. The method of claim 7, **characterized in, that** between each adjacent storage container there will be placed at least one distance block (7).
10. The method of claims 7 to 9, **characterized in, that** the storage container (6) is placed inside a super-container.
11. The method of claim 7, **characterized in, that** the storage container (6) is placed on a bearing buffer segment (5), prior put on the bottom of the storage borehole (2) while the space between the storage container (6) and the wall of the storage borehole (2) will be consequently filled with two filling buffer segments (8a, 8b) and/or with a sprayed buffer (9).
12. The method of claim 11, **characterized in, that** the bearing buffer segment (5), filling buffer segments (8a, 8b), and the sprayed buffer (9) are of the group clay, bentonite.
13. The method of claims 11, **characterized in, that** the bearing buffer segment (5) has in the cross section a shape of a part of the annular space limited by a section of circle with an angle from 110 to 130 degrees, preferably 120 degrees.
14. The method of claims 11 and 12, **characterized in, that** filling buffer segments (8a, 8b) have in the section a shape of a part of the annular space limited by a section of circle with an angle ranging from 110 to 120 degrees, while the sum of angles of sections of the circle of the bearing buffer segment (5) and filling buffer segments (8a, 8b) is ≤ 360 degrees.

Patentansprüche

1. Ein System von Lagerbohrlöchern für Lagerung des abgebrannten Kernbrennstoffes bestehend aus mindestens einem waagerechten Korridor (3), wovon mindestens ein Lagerungssystem beginnt, **dadurch gekennzeichnet, dass** das genannte Lagerungssystem aus einem schrägen charakteristischen Führungsbohrloch (1) und einem schrägen Lagerbohrloch (2) mit größerem Durchmesser gefertigt in der Mittellinie vom genannten charakteristischen Bohrloch (1) mit einem identischen Winkel unter der waagerechte Ebene besteht, worin das

charakteristische Führungsbohrloch (1) mit seiner Länge das Lagerbohrloch (2) überschreitet und worin im genannten Lagerbohrloch (2) mindestens ein Lagerbehälter (6) für Aufnahme vom abgebrannten Kernbrennstoff platziert ist.

2. Das System des Anspruchs 1 **dadurch gekennzeichnet, dass** der Winkel im Bereich von 20 bis 30 Grad liegt.
3. Das System des jeden von den Ansprüchen 1 bis 2 **dadurch gekennzeichnet, dass** das charakteristische Führungsbohrloch (1) einen Durchmesser zwischen 0,1 und 0,2 m, vorzugsweise 0,12 m, hat und das Lagerbohrloch (2) einen Durchmesser zwischen 0,5 und 2 m, vorzugsweise 1,3 m, hat.
4. Das System des jeden von den Ansprüchen 1 bis 3 **dadurch gekennzeichnet, dass** das charakteristische Führungsbohrloch (1) mit Markierungsmaterial, vorzugsweise mit einem Gemisch von Sand und einem Farbpigment der roten oder grünen Farbe, gefüllt ist.
5. Das System des Anspruchs 1 **dadurch gekennzeichnet, dass** die vom waagerechten Korridor (3) beginnenden Lagerungssysteme in regelmäßigen Abständen von 20 bis 40 m, vorzugsweise 30 m, voneinander getrennt sind und die waagerechten Korridore mit Abständen von 40 bis 60 m, vorzugsweise 55 m, angeordnet sind.
6. Das System des jeden von den Ansprüchen 1 bis 5 **dadurch gekennzeichnet, dass** es einen Zugangsabbauraum enthält, der die übrigen Abschnitte des charakteristischen Bohrlochs (1) durchschneidet, das die Handhabungsrundgang (10) ist.
7. Die Methode der Lagerung des abgebrannten Kernbrennstoffes ins System der Lagerbohrlöcher des Anspruchs 1 **dadurch gekennzeichnet, dass** mindestens ein Lagerbehälter (6) in das schräge Lagerbohrloch (2) mit Hilfe von einem Handhabungsmechanismus (4) gestellt wird.
8. Die Methode des Anspruchs 7 **dadurch gekennzeichnet, dass** das Handhabungsmechanismus (4) ein Materialtransportwagen ist, der sich durch Schwerkraft am Seil bewegt.
9. Die Methode des Anspruchs 7 **dadurch gekennzeichnet, dass** mindestens ein Distanzstück (7) zwischen jeden nebeneinanderliegenden Lagerbehälter gestellt wird.
10. Die Methode der Ansprüche 7 bis 9 **dadurch gekennzeichnet, dass** der Lagerbehälter (6) in einen

Supercontainer gestellt wird.

11. Die Methode des Anspruchs 7 **dadurch gekennzeichnet, dass** der Lagerbehälter (6) auf ein tragendes Puffersegment (5) gestellt wird, früher auf den Boden des Lagerbohrloches (2) gelegt wird, während der Raum zwischen dem Lagerbehälter (6) und der Wand des Lagerbohrloches (2) folglich mit zwei füllenden Puffersegmenten (8a, 8b) und/oder mit einem gesprühten Puffer (9) gefüllt wird.
12. Die Methode des Anspruchs 11 **dadurch gekennzeichnet, dass** das tragende Puffersegment (5), die füllenden Puffersegmente (8a, 8b) und der gesprühte Puffer (9) aus der Gruppe Ton, Bentonit gefertigt sind.
13. Die Methode des Anspruchs 11 **dadurch gekennzeichnet, dass** das tragende Puffersegment (5) im Querschnitt eine Form von einem Teil des ringförmigen Raumes hat, der durch einen Abschnitt des Kreises mit einem Winkel von 110 bis 130 Grad, vorzugsweise 120 Grad, begrenzt ist.
14. Die Methode der Ansprüche 11 und 12 **dadurch gekennzeichnet, dass** die füllenden Puffersegmente (8a, 8b) im Querschnitt eine Form von einem Teil des ringförmigen Raumes haben, der durch einen Abschnitt des Kreises mit einem Winkel von 110 bis 120 Grad begrenzt ist, während die Summe der Winkel von Abschnitten des Kreises des tragenden Puffersegment (5) und der füllenden Puffersegmente (8a, 8b) < 360 Grad beträgt.

Revendications

1. Un système de puits de stockage destiné au stockage de combustible nucléaire usagé constitué par au moins un couloir horizontal (3), à partir duquel commence au moins un système de stockage, est **caractérisé en ce que** ledit système de stockage est constitué d'un guide d'orientation de caractérisation du puits de forage (1) et d'un puits de forage de stockage orienté de grand diamètre (2) réalisé dans la ligne médiane dudit guide de caractérisation du puits de forage (1), avec un angle identique en dessous du plan horizontal, dans lequel le guide de caractérisation du puits de forage (1) dépasse par sa longueur le puits de forage de stockage (2), et dans lequel est placé dans ledit puits de forage de stockage (2) au moins un conteneur de stockage (6) destiné à la réception du combustible nucléaire usagé.
2. Le système de la revendication 1 est **caractérisé en ce que** l'angle est compris entre 20 et 30 degrés.

3. Le système de n'importe laquelle des revendications 1 à 2 est **caractérisé en ce que** le guide de caractérisation du puits de forage (1) a un diamètre compris entre 0,1 et 0,2 m, de préférence 0,12 m, et le puits de forage de stockage (2) a un diamètre compris entre 0,5 et 2 m, de préférence 1,3 m.
4. Le système de n'importe laquelle des revendications 1 à 3 est **caractérisé en ce que** le guide de caractérisation du puits de forage (1) est rempli d'un matériau de marquage, de préférence un mélange de sable et de pigment de couleur rouge ou verte.
5. Le système de la revendication 1 est **caractérisé en ce que** les systèmes de stockage, commençant à partir du couloir horizontal (3) sont séparés les uns des autres à distance régulière de 20 à 40 m, de préférence 30 m, et les couloirs horizontaux sont disposés en parallèle avec un espacement de 40 à 60 m, de préférence 55 m.
6. Le système de n'importe laquelle des revendications 1 à 5 est **caractérisé en ce qu'il** comprend une mine d'accès coupant les sections restantes de la caractérisation des puits de forage (1), constituées par la galerie de manutention (10).
7. La méthode de stockage du combustible nucléaire usagé dans le système des puits de forage de stockage de la revendication 1 est **caractérisée en ce qu'est** placé dans le puits de forage de stockage orienté (2), au moyen d'un mécanisme de manutention (4), au moins un conteneur de stockage (6).
8. La méthode de la revendication 7 est **caractérisée en ce que** le mécanisme de manutention (4) est un chariot de manutention se déplaçant par gravité avec une corde.
9. La méthode de la revendication 7 est **caractérisée en ce qu'est** placé entre chaque conteneur de stockage adjacent au moins un bloc d'espacement (7).
10. La méthode des revendications 7 à 9 est **caractérisée en ce que** le conteneur de stockage (6) est placé à l'intérieur d'un super conteneur.
11. La méthode de la revendication 7 est **caractérisée en ce que** le conteneur de stockage (6) est placé sur un palier de segment amortisseur (5), au préalable disposé à l'arrière du puits de forage de stockage (2) tandis que l'espace situé entre le conteneur de stockage (6) et la paroi du puits de forage de stockage (2) sera ultérieurement rempli avec deux segments amortisseur (8a, 8b) et/ou un dispositif amortisseur pulvérisé (9).

12. La méthode de la revendication 11 est **caractérisée en ce que** le palier de segment amortisseur (5), les segments amortisseur de remplissage (8a, 8b), et le dispositif amortisseur pulvérisé (9) sont constitués d'un type d'argile, la bentonite. 5
13. La méthode des revendications 11 est **caractérisée en ce que** le palier de segment amortisseur (5) a dans la section transversale la forme de l'espace annulaire limité par une section circulaire dotée d'un angle compris entre 110 et 130 degrés, de préférence 120 degrés. 10
14. La méthode des revendications 11 et 12 est **caractérisée en ce que** les segments amortisseur de remplissage (8a, 8b) ont dans la section transversale la forme de l'espace annulaire limité par une section circulaire dotée d'un angle compris entre 110 et 120 degrés, la somme des angles des sections circulaires du palier de segment amortisseur (5) et des segments amortisseur de remplissage (8a, 8b) étant $\leq$ 360 degrés. 15
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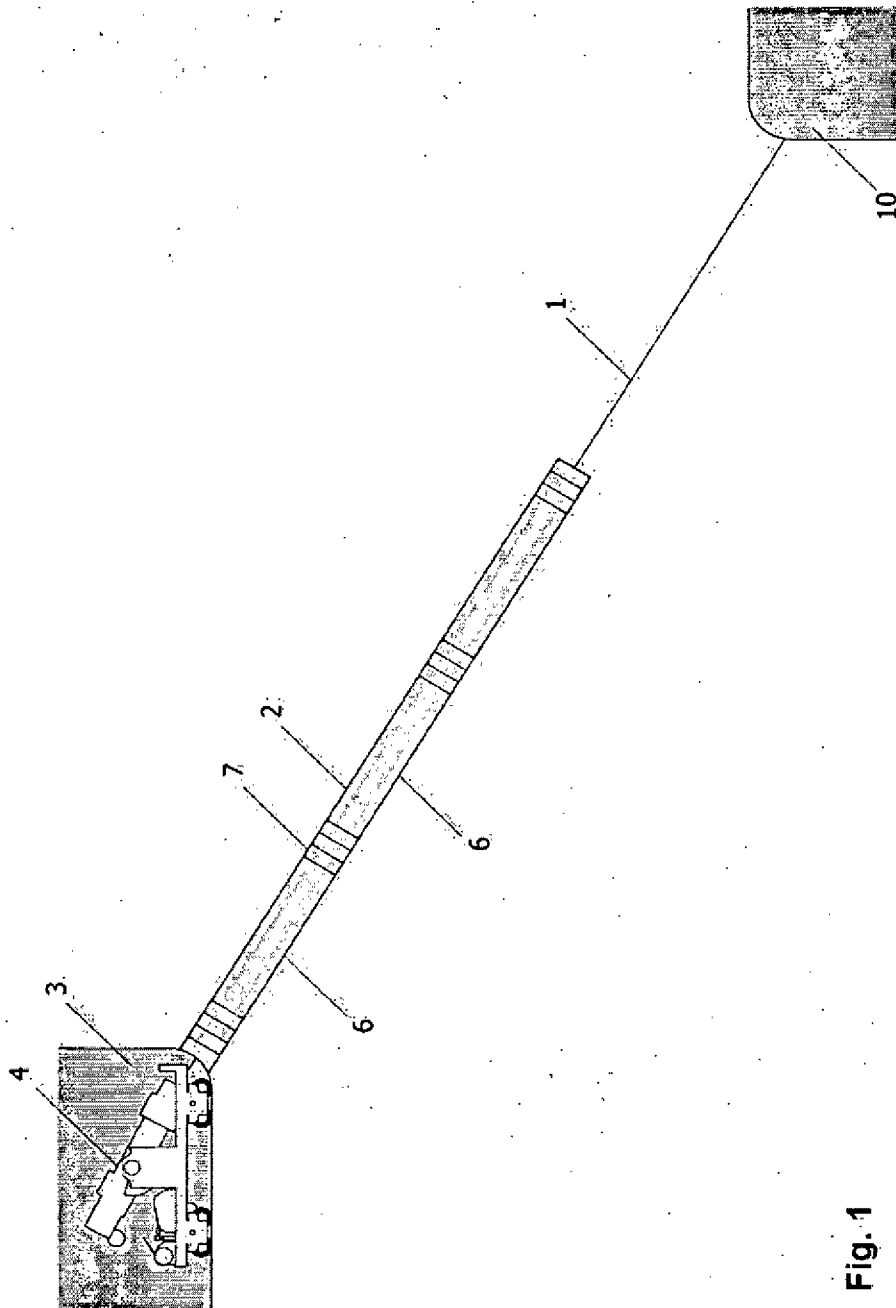


Fig. 1

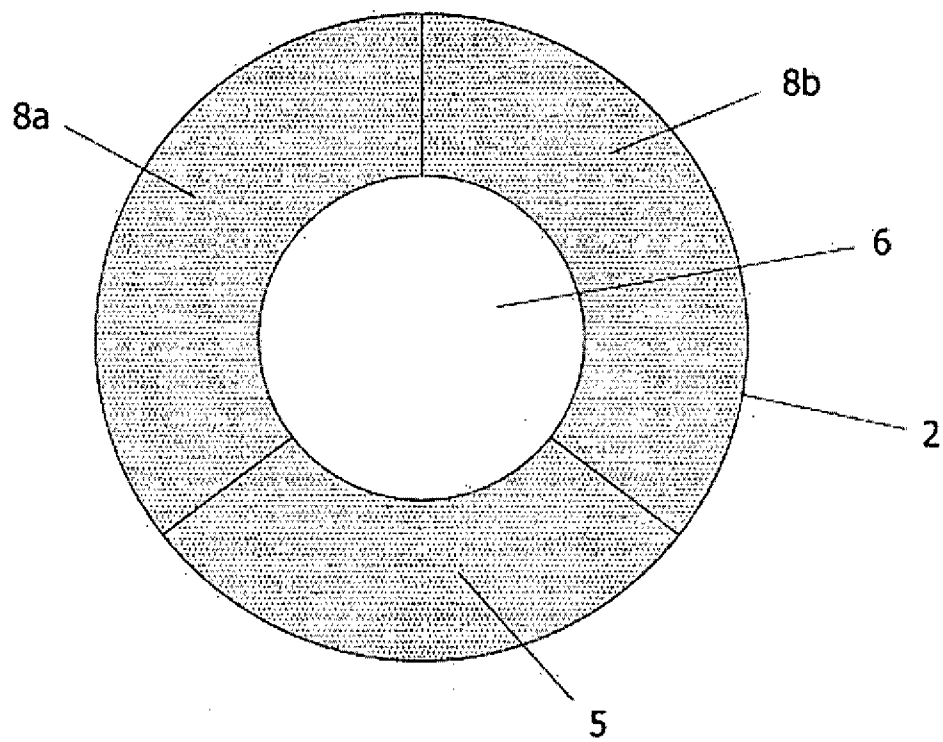


Fig. 2

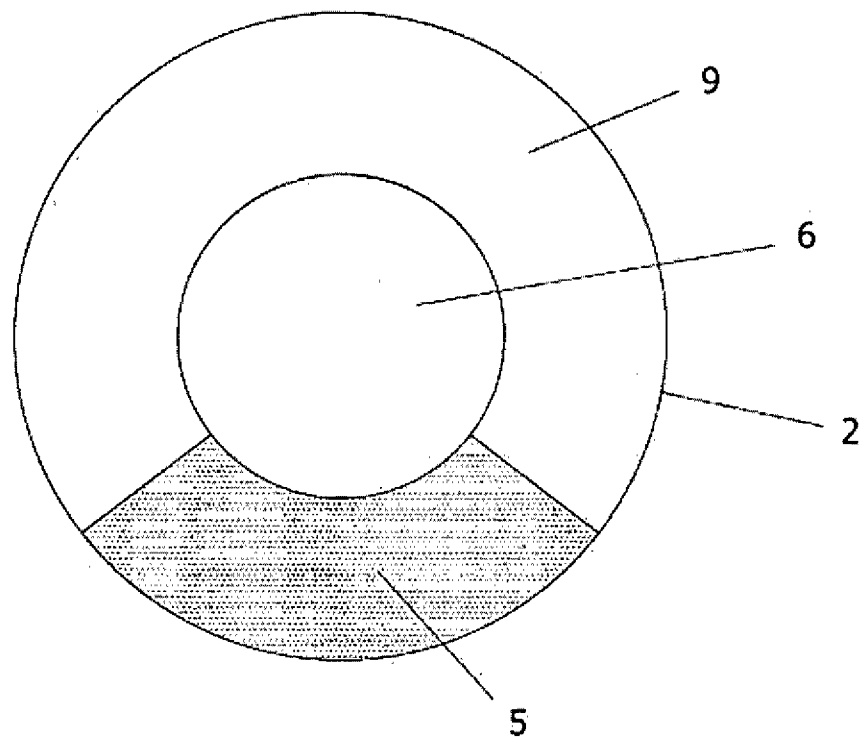


Fig. 3

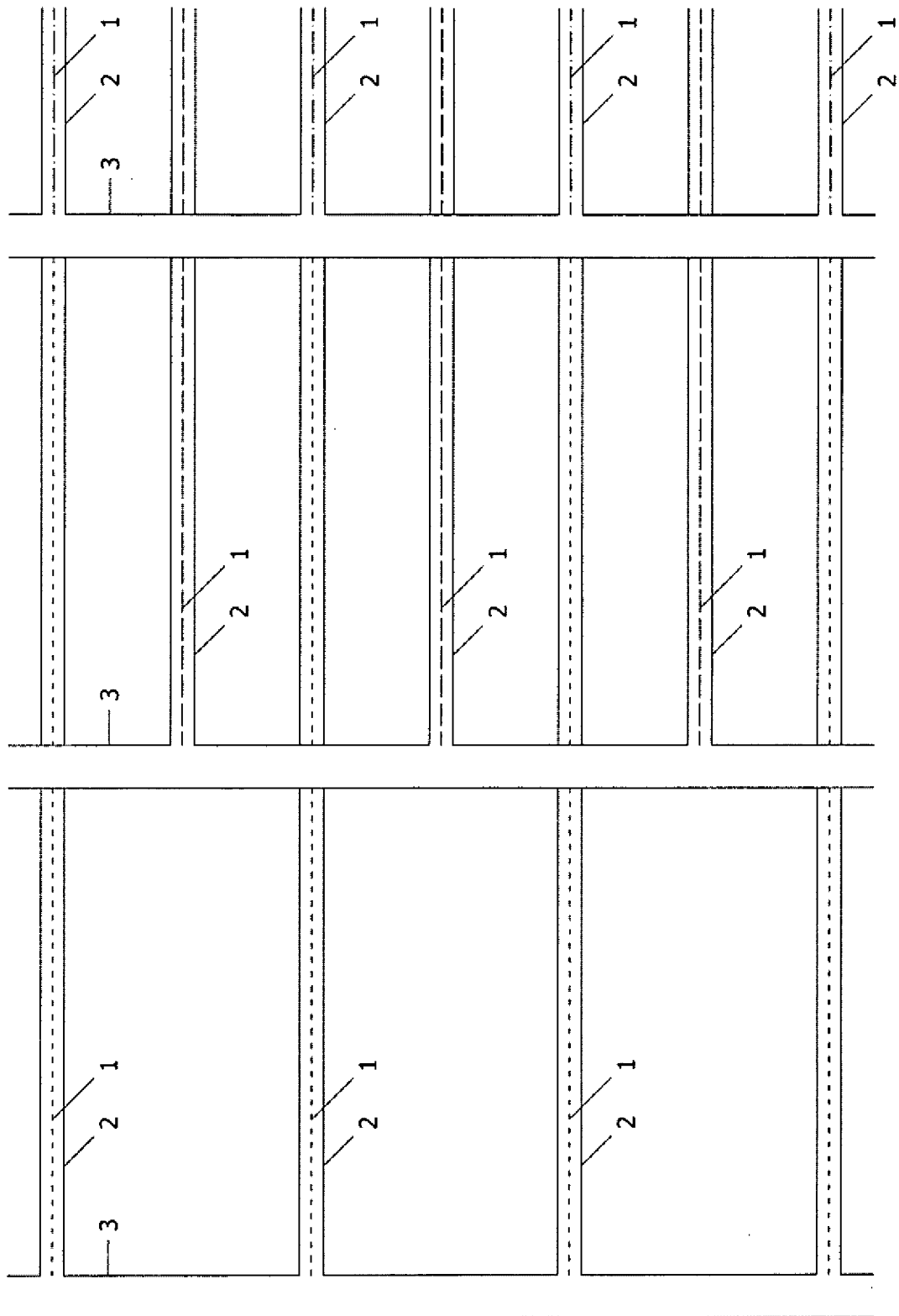


Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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ELHASZNÁLÓDOTT NUKLEÁRIS ÜZEMANYAG TÁROLÁSÁRA SZOLGÁLÓ TÁROLÓ-
FURATLYUKAK RENDSZERE ÉS AZ ELHASZNÁLÓDOTT NUKLEÁRIS ÜZEMANYAG
TÁROLÁSÁNAK MÓDSZERE

Szabadalmi igénypontok

1. Elhasználódott nukleáris üzemanyag tárolására szolgáló tároló-furatlyukak rendszere, amely a következőkből áll: legalább egy vízszintes folyosó (3), amelyből legalább egy tárolórendszer indul ki **azzal jellemezve, hogy** a jelzett tárolórendszer egy ferde jellemző vezető-furatlyukkal (1) és egy ferde nagyobb átmérőjű, a jelzett jellemző vezető-furatlyuk (1) közepében kialakított, a vízszintes alatti azonos szögben lévő tároló-furatlyukból (2) áll, ahol a jellemző vezető-furatlyuk (1) hosszával túllépi a tároló-furatlyuk (2) hosszát, és ahol a jelzett tároló-furatlyukban (2) az elhasználódott nukleáris üzemanyag fogadására szolgáló legalább egy tárolótartály (6) van elhelyezve.
2. Az 1. igénypont szerinti rendszer **azzal jellemezve, hogy** a szög
20 - 30 fok közötti tartományban van.
3. Az 1. - 2. igénypont valamelyike szerinti rendszer **azzal jellemezve, hogy** a jellemző vezető-furatlyuk (1) 0,1 - 0,2 m-es - célszerűen 0,12 m-es - átmérővel rendelkezik, és a tároló-furatlyuk (2),
0,5 - 2,0 m-es - célszerűen 0,13 m-es - átmérővel rendelkezik.



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4. Az 1. - 3. igénypont valamelyike szerinti rendszer **azzal jellemezve, hogy** a jellemző vezető-furatlyuk (1) jelölőanyaggal - célszerűen homokkal és piros vagy zöld színű színezőanyaggal - van megtöltve.
5. Az 1. igénypont szerinti rendszer **azzal jellemezve, hogy** a vízszintes folyosótól (3) kezdődő tárolórendszerek 20 - 40 m-es - célszerűen 30 m-es - távolságban vannak egymástól, és a vízszintes folyosók párhuzamosan vannak elhelyezve 40 - 60 m-es - célszerűen 55 m-es - távolságban.
6. Az 1. - 5. igénypont valamelyike szerinti rendszer **azzal jellemezve, hogy** az olyan hozzáférési aknát foglal magában, amely a jellemző furatlyukak (1) maradék szakaszait átmetszi, amely a kezelő aknafolyosó (10).
7. Az elhasználódott nukleáris üzemanyag 1. igénypont szerinti, tároló-furatlyukak rendszerébe való betárolásának módszere **azzal jellemezve, hogy** a ferde tároló-furatlyukba (2) egy kezelőszerkezet (4) segítségével legalább egy tárolótartály (6) lesz behelyezve.
8. A 7. igénypont szerinti módszer **azzal jellemezve, hogy** a kezelőszerkezet (4) egy kötélén nehézségi erő által mozgatott anyagszállító kocsi.
9. A 7. igénypont szerinti módszer **azzal jellemezve, hogy** a szomszédos tárolótartályok mindegyike közé legalább egy távtartó blokk (7) kerül.

10. A 7. - 9. igénypont szerinti módszer **azzal jellemezve, hogy** a tárolótartály (6) egy befoglalótartályba lesz helyezve.
11. A 7. igénypont szerinti módszer **azzal jellemezve, hogy** a tárolótartály (6) egy tartó pufferszelvényre (5) van helyezve, korábban a tároló-furatlyuk (2) alsó részére állítva, melynek során a tárolótartály (6) és a tároló-furatlyuk (2) fala közötti tér következőképpen két kitöltő pufferszelvénnel (8a, 8b) és/vagy befűjt pufferrel (9) lesz kitöltve.
12. A 11. igénypont szerinti módszer **azzal jellemezve, hogy** a tartó pufferszelvény (5), a kitöltő pufferszelvények (8a, 8b) és a befűjt puffer (9) agyag, bentonit csoportba tartozik.
13. A 11. igénypont szerinti módszer **azzal jellemezve, hogy** a tartó pufferszelvény (5) keresztmetszete a kör alakú tér egy részének a kör 110 - 130 fok közötti - célszerűen 120 fokos - szögű körszelete által korlátozott alakjával rendelkezik.
14. A 11. és 12. igénypont szerinti módszer **azzal jellemezve, hogy** a kitöltő pufferszelvények (8a, 8b) szakasza a kör alakú tér egy részének a kör 110 - 120 fok közötti szelete által korlátozott alakjával rendelkezik, míg a tartó pufferszelvény (5) és a kitöltő pufferszelvények (8a, 8b) körszeleteinek összegzett szögei kisebbek, mint 360 fok.