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(54) **Apparatus and method for the retrieval of radioactive material from an enclosure vault**

Apparat und Verfahren zum Entfernen von radioaktivem Material aus einem unschlossenem Raum

Appareil et procédé pour récupérer du matériel radioactif d'un endroit fermé

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- **PATENT ABSTRACTS OF JAPAN vol. 1998, no. 05, 30 April 1998 (1998-04-30) & JP 10 020089 A (ISHIKAWAJIMA INSPECTION & INSTRUMENTATION CO; ISHIKAWAJIMA HARIMA), 23 January 1998 (1998-01-23)**
- **PATENT ABSTRACTS OF JAPAN vol. 1995, no. 11, 26 December 1995 (1995-12-26) & JP 07 214096 A (MORITA TOKUSHU KIKO KK), 15 August 1995 (1995-08-15)**

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Description

[0001] This invention regards an apparatus and a method for the retrieval of fragments of radioactive waste from an enclosed vault, more exactly by a remote controlled vacuum nozzle, which is remotely steered into the enclosed vault through an access hole, which then retrieves the radioactive waste by means of vacuum and subsequently transfers the waste to a collection hopper.

[0002] All storage and handling of radioactive material are governed by astringent health and safety requirements. Storage on an installation, for example a nuclear power plant or a drilling rig for exploration drilling, takes place in a shielded environment. Upon requirement the material will either be processed or transferred to a permanent storage location.

[0003] The nature of the material does not permit direct human access to the container or location where the radioactive material has been stored for the purpose of manual retrieval of the radioactive material. The radioactive material must be removed without any direct human contact, and therefore necessitates remote operation by mechanical manipulators with gripping apparatuses to retrieve the material from the closure it has been placed in. The manipulator must then move the material to another location where is can be exposed for further handling.

[0004] These operations that are time demanding and expensive, must be repeated until all of the material has been retrieved. There is also the risk that such mechanical manipulators can become trapped within the storage containers, as a majority of these containers exhibit entry holes of limited size. Such breakdowns can result in complex and costly operations, due to the strong requirements concerning manual work around or near such radioactive elements.

[0005] Using a submerged pump with telescopic pipes for the evacuation of liquid radioactive waste from a vessel is known from EP 0 730 094 A1 which illustrates a variable suction device, the vertical level of the pump being remote controlled by raising and lowering the pump along a framework. The driving means (motor, pump) are submerged in the radioactive waste.

[0006] JP 7 214 096 discloses a device for the suction of sludge from the bottom of an open water reservoir, the suction nozzle being positioned on the bottom surface of the reservoir by the remote control of a telescopic boom and by winding the hose onto or off a reel on the telescopic boom. The suction nozzle includes remote controlled driving means for the travelling of the suction nozzle horizontally on the bed and remote controlled devices for assisting the moving of the sludge towards the suction nozzle.

[0007] JP 10 020 089 discloses a device for the recovery of bottom sediment inside radioactive waste liquid tank. A suction pump is arranged above the fluid level inside the tank. The suction pump is allocated a suction hose, the free end of which is connected to a carriage being arranged to remotely travel horizontally along the bottom surface of the tank for the purpose of sucking in the clad. The clad is recovered by means of a filter and the fluid is returned to the tank through a discharge hose. The device is operated from inside the tank.

[0008] From GreyPilgrim LLC (USA) is known a manipulation system (EMMA) used during the Hanford Tank Initiative (HTI). A remotely operated serpentine hose system is disclosed, which is manipulated by several sets of cooperating cylinders, every set being interconnected at the circumference of rings, the cylinders being located substantially parallel and in the direction of the centre axis of the hose system. A suction nozzle being connected to an air-conveyance hose is attached to the free end of the manipulation system. By retraction and extension of the cylinders the suction nozzle can be moved in a three-axis system. A water-jet system is used to tear up affixed materials.

[0009] From the NIST "Robo-crane" is known a large gantry type crane, which can place its load within an unobstructed space by use of multiple lift cables.

[0010] US-A-4 924 898 discloses a pumping system for sludge comprising a vacuum pump and a three stage articulated boom. A sludge intake hose extends along the length of the articulated boom and beyond its free end to form an unsupported intake line section. A centrifugal booster pump is attached to the free end.

[0011] The object of the invention is to remedy at least one of the disadvantages of prior art.

[0012] According to the present invention there is provided apparatus for moving radioactive waste from a storage vault to another suitable container by means of a flowing fluid, which apparatus comprises a flexible tube, in use, inserted in the storage vault and connected to a suction device capable of maintaining a negative pressure in the tube, the suction device being located outside the storage vault, **characterized in** that the tube is provided with a plurality of elongated manoeuvring devices surrounding the circumference of the tube and extending in the longitudinal direction of the tube, said plurality of elongated manoeuvring devices comprising a first set of manoeuvring devices connected to a first actuator located outside the storage vault, the first set of manoeuvring devices being arranged to curve a lower portion of the tube and being attached close to the extremities of the lower tube portion's longitudinal extension. Further features are set out in claims 2 to 10 to which attention is hereby directed.

[0013] According to another aspect of the present invention there is provided a method of moving radioactive waste from a storage vault to another suitable container by means of a flowing fluid, a flexible tube being provided with a plurality of manoeuvring devices surrounding the circumference of the tube and extending in the longitudinal direction of the tube, is connected to a suction device capable of maintaining a negative pressure in the tube, the suction device being located outside the storage vault, **characterized in** that

the tube is inserted into the storage vault through a tube passage by spooling the tube off a tube reel,
a nozzle is moved to any location of the surface of the radioactive material by means of the control of the tube reel, the first and second actuators' movement of the manoeuvring devices and the motor's rotation of the nozzle,
a vacuum pump is sucking fluid and radioactive material into the tube through the nozzle,
the radioactive material is separated in a cyclone unit and is locked off the fluid flow by means of a lock, and
the radioactive material is deposited in a waste container.
Further steps of the method are set out in claims 12 and 13 to which attention is hereby directed.

[0014] This invention regards an apparatus and a method for the retrieval of fragments of radioactive waste from a storage vault with limited access, a remote controlled nozzle being arranged at the free end of a flexible tube suitable to be remotely steered into the enclosed storage vault through an access hole, preferably located in the ceiling of the vault, with the purpose of retrieving the radioactive waste by means of negative pressure, i.e. suction, and deposit the waste in a suitable storage location for further handling.

[0015] The principle of the apparatus and method is to use a flexible air-conveyance conduit as the backbone of a system of control cables, which can be used to create controlled curvature with the conduit, thus allowing the operator to place the nozzle anywhere in the horizontal plane within the reach of the conduit. The conduit assembly is flexible enough to be extended and retracted by use of a hose-reel upon which the non-deployed conduit is spooled. Upon remotely operated rotation of the hose-reel, the length of the conduit portion projecting into the storage vault is adjusted, thereby controlling the position of the nozzle in the vertical plane. The air-conveyance conduit is used to transport rapidly moving air from within the storage vault towards a vacuum system, which is connected to the apparatus. The airflow is used to transport radioactive material, which falls within fraction size range of which the nozzle is dimensioned, to a transport container, which is connected to the apparatus and the vacuum system, and located outside the storage vault. In this way the radioactive waste remains in a closed system even during the transfer from the storage vault to the transport container.

[0016] The apparatus comprises the following main components:

a. Agitator
b. Nozzle
c. Spoolable and manoeuvrable conduit
d. Conduit actuation system
e. Gator and guides
f. Hose outlet connector
g. Hose manoeuvring actuator system
h. Hose reel drive
i. Hose manoeuvring actuator drive
j. Control system
k. Hose reel

[0017] To the apparatus is preferably connected:

l. A transport container
m. A cyclone separator unit and lock device to be interconnected with 1)
n. A vacuum pump
o. Hoses to interconnect f) and m), 1) and m) and m) to n) .

[0018] The conduit, which under suitable remote control is to be guided into the radioactive material storage vault, comprises at a lower portion of the conduit a nozzle and an agitator. The nozzle is preferably rotatable about an axis, which substantially coincides with or is parallel to the centre axis of the tube.

[0019] The agitator is in its operative position arranged immediately in front of the nozzle and is by a suitable motion capable of fragmenting the waste adjacent the nozzle and possibly moving the fragments into the airstream towards the nozzle. The agitator may preferably be moved by one or more rotating, flexible shafts or by means of one or more hydraulic actuators. The agitator driving means, in the form of one or more motors, possibly a hydraulic pump, are preferably located outside the storage vault, thereby allowing simplified access in the event of maintenance. The agitator substantially follows the movement of the nozzle.

[0020] The nozzle's interior geometry exhibits less passage cross section and less curvature radii than that of any other location in the consecutive flow path of the waste, including for example the curvature of the conduit spooled onto the hose-reel.

[0021] The purpose of the nozzle geometry is to cause possible blockage of the material flow to occur before the materials leaves the nozzle.

[0022] The nozzle is preferably made of a plurality of sections by an axial split, the upper portion of two or more nozzle sections in a hinged way are connected to a nozzle basement.

[0023] In the event of a blockage within the nozzle, the nozzle can be opened using remote control, causing the interior cross section of the nozzle to extend and the stuck fragments to be liberated, thus falling out of the nozzle.

[0024] The lower portion of the tube may preferably also be provided with devices for cutting large fractions of the material to be sucked.

[0025] Furthermore, the lower portion of the tube may preferably be provided with a monitoring camera being interconnected with a monitoring system located together with the other control devices, thereby offering visual monitoring of nozzle, agitator etc.

[0026] The tube is deposited on a motorized reel in a spoolable manner, causing the lower tube portion to be locatable at any vertical level when the tube is lowered into a vault containing the radioactive material.

[0027] The conduit is provided with one or more tube

actuation sets in the form of control cable sets, which are integrated onto the outer surface of the tube. Each control cable set comprises three or more tensionable cables, which are located at equal intervals around the circumference of the tube. The cables are sheathed between the upper end portion of the tube, at the connection to the hose-reel, and the portion of the tube at which a curvature of the tube is required to start. The cables continue unsheathed between the lower end of the sheathing and the lower cable attachments defined by the tube portion of which the curvature is required to end. In the intermediate curvature portion suitable guides support the cables.

[0028] Upon tensioning of one or more neighbouring cables, the tube portion at the unsheathed section of the cable is retracted causing the tube to be bent in a controlled manner in the direction of the location on the tube of the tensioned cable(s).

[0029] By implementing multiple sets of cables, each set having different cable termination points and thereby multiple controllable curvature sections along the length of the tube, the tube can be curved in different ways to allow a simple sweeping motion of the nozzle along the surface of the waste, or more complex curvatures such as "S" shape, in order to manoeuvre the nozzle and the tube around obstacles such as columns, walls etc. which may exist within the vault.

[0030] The cable set(s) are tensioned from actuators located within the hose-reel where the cables, cable sheathes and conduit terminate. In the event of mechanical, electrical or hydraulic failure, depending on the type of actuators used, the conduit will assume a non-tensioned posture, thereby becoming straight and allowing retraction of the tube by rotation of the hose-reel, without exhibiting any bent shape which could cause the tube to become trapped within the vault.

[0031] The hose is connected to the vacuum system via the reel unit and rigid pipes or flexible hoses in a way to establish airflow into the nozzle of the tube. The vacuum unit is further, via a cyclone and a lock-device, interconnected with the transport container in which the waste being sucked from the storage vault is deposited in a continuous or batch process.

[0032] The following describes a non-limiting example of a preferred embodiment illustrated in the accompanying drawings, in which:

Fig. 1 is a view of the complete system according to the invention arranged in a schematic production facility;

Fig. 2 shows at a larger scale the lower portion of the tube and the nozzle of the apparatus;

Fig. 3 shows at a smaller scale an example of a curved tube in an operative position;

Fig. 4a shows at a larger scale an alternative embodiment of the nozzle in operative mode, the nozzle being blocked; and

Fig. 4b shows at equal scale the same nozzle in open mode, and stuck material has been liberated.

[0033] A flexible tube 1 comprises an end portion 2 with a nozzle 3. Evenly spaced along substantially all of the tube's 1 length are fitted and attached circular support rings 4a, 4b, 4c encircling the tube 1. Several manoeuvring devices in the form of control cables 7a are evenly distributed about the circumference of the tube 1 and are attached to a bottom plate 8 and are conveyed along the tube 1 and through the support rings 4a, 4b to a first actuator (not shown) integrated within a reel unit 5. The tube 1 is preferably also provided with a second set of manoeuvring devices in the form of control cables 7b, which are attached to the support ring 4b at a distance from the end portion 2 of the tube 1. The control cables 7b are in the same manner as described above conveyed along the tube 1 and through the support rings 4c and connected to a second actuator (not shown) integrated within the reel unit 5.

[0034] The nozzle 3 can be moved horizontally by the curving of the lower end portion 2 of the tube, the first actuator (not shown) retracting one or more of the control cables 7a causing the end portion 2 of the tube 1 being bent outwards, possibly by the second actuator (not shown) retracting one or more control cables 7b causing the tube 1 to curve upside the end portion 2.

[0035] The nozzle 3 is rotatable about an axis coinciding with the centre axis of the tube 1. The rotation is performed by means of a motor 4 and a transmission (not shown).

[0036] The end portion 2 includes a rotatable, mechanic agitator 9, which is capable of breaking radioactive waste 11 into fragments when the end portion 2 of the tube 1 is lowered to an accumulation of waste 11, thus forcing the agitator towards the waste 11.

[0037] The radioactive waste 11 is collected in a storage vault 13. The storage vault 13 includes a passage 15 allowing the tube 1 to pass through.

[0038] The reel unit 5 is located above the storage vault 13. The reel unit 5 comprises a reel 17 for the spooling of the tube 1. The reel includes a motor 19 and a control unit (not shown) for the vertical and horizontal positioning of the nozzle 3 relative to the surface of the waste 11.

[0039] The reel unit includes requisite connections between the tube 1 and a hose 21, which in the opposite end is connected to a cyclone unit 23 integrated in a container unit 25. A lock 27 is interconnecting the cyclone unit 23 and a transport container 28 through a pipe 29. The cyclone unit 23 is by means of a hose 31 connected to a vacuum pump (not shown).

[0040] In order to assure that no negative pressure occurs in the storage vault 13, exhaust air from the vacuum pump can be directed back to the storage vault 13 through a return hose 33 and appurtenant connectors

(not shown).

[0041] The apparatus according to the invention is located on or integrated in the structures 35 surrounding the storage vault 13.

[0042] In order to avoid blocking, the internal bore of the nozzle 3 exhibits smaller diameter and curvature radii than those of the consecutive tube and hose elements.

[0043] Fig. 4a and 4b exhibits an alternative embodiment of the nozzle 3, the nozzle 3 comprising two substantially uniform nozzle sections 3a, 3b, each of which upper portion is connected to a nozzle basement 3c in a hinged manner. In an operative mode the nozzle sections 3a, 3b are interlocked by means of a locking device (not shown) being releasable by means of remote control (not shown).

[0044] When the radioactive waste 11 is to be transferred from the storage vault 13 to a transport container 28, the tube 1 is lowered through the adapted passage 15 by means of the motor 19 of the reel unit 5 being controlled by a control unit (not shown) till the nozzle is located at correct level. The vacuum pump (not shown) is activated, thus obtaining suction in the nozzle 3. The waste 11 is sucked upwards through the tube 1 via the hose 21 to the cyclone unit 23 where the waste 11 is separated from the transportation air and further conveyed through the lock 27 and the pipe 29 to the transport container 28.

[0045] Any negative pressure in the storage vault 13 is avoided by returning exhaust air from the vacuum pump (not shown) to the storage vault 13 through the hose 33 and the appurtenant connectors (not shown).

[0046] The nozzle 3 may be moved horizontally along the entire area of the storage vault 13 by rotating the nozzle 3 by means of the motor 4 and by bending and moving the end portion 2 of the tube 1 in a desired direction by means of the actuators (not shown) and the cables 7a, 7b.

[0047] If the waste 11 clogs the tube 1 and inhibits further vacuum extraction, the agitator 9 can be activated into motion while it bears against the waste, thus breaking the waste 11.

[0048] Upon blocking in the alternative embodiment of the nozzle, as shown in figure 4a and 4b, the vacuum pump is stopped; the hose is retracted from the surface of the waste; and the locking device (not shown) is released by means of the remote control, thus causing the nozzle sections 3a, 3b to depart in a hinging manner and liberating the stuck material 11, which falls from the nozzle 3.

[0049] In enterprises dealing with radioactive waste, one or more handling processes are normally required. Due to health and environmental reasons, humans cannot handle the material manually. The access to the storage site of such materials also prevents manual handling. The storage medium is to a large extent enclosed in order to avoid contaminating radiation, and the access takes place through small tubular passages.

[0050] The apparatus and the method according to the invention make it possible to bring out the waste in one single operation, which lead to less intervention by the operator who is performing the process and assures that equipment, which may be an object of mechanic malfunction, are located outside the enclosure, thus offering the staff access to the equipment for repair and maintenance.

[0051] The apparatus may be supplemented by miscellaneous types of tools to allow different operations to be performed inside the storage vault, such as cutting and removing large components for easier removal from the vault.

Claims

1. Apparatus for moving radioactive waste (11) from a storage vault (13) to another suitable container (28) by means of a flowing fluid, which apparatus comprises a flexible tube (1), in use, inserted in Lhe storage vault (13) and connected to a suction device capable of maintaining a negative pressure in the tube (11), the suction device being located outside the storage vault (13), **characterized in that** the tube (1) is provided with a plurality of elongated manoeuvring devices (7a, 7b) surrounding the circumference of the tube (1) and extending in the longitudinal direction of the tube (1), said plurality of elongated manoeuvring devices comprising a first set of manoeuvring devices (7a) connected to a first actuator located outside the storage vault (13), the first set of manoeuvring devices (7a) being arranged to curve a lower portion (2) of the tube (1) and being attached close to the extremities ot the lower tube portion's (2) longitudinal extension.

2. Apparatus in accordance with claim 1, **characterized in that** the tube (1) comprises a second set of manoeuvring devices (7b) connected to a second actuator located outside the storage vault (13), the set of manoeuvring devices (7b) being attached close to the extremities of an arbitrary Lube portion's longitudinal extension, the random tube portion being suitable to be curved in a selected direction away from a rectilinear form.

3. Apparatus in accordance with claim 1 or 2, **characterized in that** the tube (1) is provided with a plurality of circumferential support rings (4a, 4b, 4c) attached to the tube (1) along a substantial portion of the length of the tube (1).

4. Apparatus in accordance with claim 3, **characterized in that** the manoeuvring devices (7a, 7b) are conveyed through recesses (4e) at the circumference of the support rings (4a, 4b, 4c).

5. Apparatus in accordance with claim 1, 2 , 3 or 4,

characterized in that a lower portion (2) of the tube (1) comprises a nozzle (3), the nozzle (3) being pivotal about the centre axis of the tube (1).

6. Apparatus in accordance with claim 5, **characterized in that** the cross sectional size and the curvature radii of the nozzle's (3) bore are less than those of the internal of the tube (1).

7. Apparatus in accordance with claim 5 or 6, **characterized in that** the nozzle (3) is provided with at least two nozzle sections (3a, 3b), an upper portion of which is interconnected in a hinged way and are arranged to be opened by remote control in order to increase the internal passage cross section of the nozzle (3).

8. Apparatus in accordance with any preceding claim, **characterized in that** the lower portion (2) of the tube (1) comprises an agitator (9) arranged adjacent the nozzle (3).

9. Apparatus in accordance with any preceding claim, **characterized in that** the lower portion (2) of the tube (1) is provided with one or more devices for cutting of the radioactive material (11).

10. Apparatus in accordance with any preceding claim, **characterized in that** the lower portion (2) of the tube (1) is provided with one or more video cameras for transfer of pictures to a monitoring system located outside the storage vault (13).

11. Method of moving radioactive waste (11) from a storage vault (13) to another suitable container (28) by means of a flowing fluid, a flexible tube (1) being provided with a plurality of manoeuvring devices (7a, 7b) surrounding the circumference of the tube (1) and extending in the longitudinal direction of the tube (1), is connected to a suction device capable of maintaining a negative pressure in the tube (11), the suction device being located outside the storage vault (13),
characterized in that
the tube (1) is inserted into the storage vault (13) through a tube passage (15) by spooling the tube (1) off a tube reel (17),
a nozzle (3) is moved to any location of the surface of the radioactive material (11) by means of the control of the tube reel (17), the first and second actuators' movement of the manoeuvring devices (7a, 7b) and the motor's (4) rotation of the nozzle (3),
a vacuum pump is sucking fluid and radioactive material (11) into the tube (1) through the nozzle (3),
the radioactive material (11) is separated in a cyclone unit (23) and is locked off the fluid flow by means of a lock (27), and
the radioactive material (11) is deposited in a waste container (28).

12. Method in accordance with claim 11, **characterized in that** the radioactive material (11) prior to being sucked into the tube (1) is fragmented by actuating the motion of an agitator (9).

13. Method in accordance with claim 11 or 12, **characterized in that** the radioactive material prior to being sucked into the tube (1) is cut by means of a tool being integrated in the lower portion of the tube (1).

Patentansprüche

1. Apparat zum Bewegen radioaktiven Abfalls (11) von einer Speicherkammer (13) zu einem anderen geeigneten Behälter (28) mittels eines fließenden Fluids, wobei der Apparat einen flexiblen Schlauch (1) umfasst, der im Betrieb in die Speicherkammer (13) reicht und mit einer Saugvorrichtung verbunden ist, die zum Aufrechterhalten eines Unterdrucks im Schlauch (1) eingerichtet ist, wobei die Saugvorrichtung außerhalb der Speicherkammer (13) angeordnet ist, **dadurch gekennzeichnet, dass** der Schlauch mit einer Vielzahl von den Umfang des Schlauchs (1) umgebenden und sich in Längsrichtung des Schlauchs (1) erstreckenden länglichen Manövriervorrichtungen (7a, 7b) ausgestattet ist, die Vielzahl von länglichen Manövriervorrichtungen umfassen einen mit einem außerhalb der Speicherkammer (13) angeordneten ersten Aktuator verbundenen ersten Satz von Manövriervorrichtungen (7a), wobei der erste Satz von Manövriervorrichtungen (7a) zum Krümmen eines unteren Teils (2) des Schlauchs (1) ausgebildet und benachbart der Extremitäten der Längserstreckung des unteren Schlauchteils (2) angebracht ist.

2. Apparat nach Anspruch 1, **dadurch gekennzeichnet, dass** der Schlauch (1) einen mit einem außerhalb der Speicherkammer (13) angeordneten zweiten Aktuator verbundenen zweiten Satz von Manövriervorrichtungen (7b) aufweist, wobei dieser Satz von Manövriervorrichtungen (7b) benachbart den Extremitäten der Längsausstreckung eines beliebigen Schlauchteils angebracht ist, und wobei der beliebige Schlauchteil geeignet ist, um in eine von einer geradlinigen Form abweichende, ausgewählte Richtung gekrümmt zu werden.

3. Apparat nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** der Schlauch (1) mit einer Vielzahl von Umfangsstützringe (4a, 4b, 4c) versehen ist, welche an dem Schlauch (1) längs eines wesentlichen Teils der Länge des Schlauchs (1) angebracht sind.

4. Apparat nach Anspruch 3, **dadurch gekennzeichnet, dass** die Manövriervorrichtungen (7a, 7b) durch Ausnehmungen (4e) im Umfang der Stützringe (4a, 4b, 4c) gefördert werden.

5. Apparat nach Anspruch 1, 2, 3 oder 4, **dadurch gekennzeichnet, dass** ein unterer Teil (2) des Schlauchs (1) eine Düse (3) umfasst, wobei die Düse (3) um die Zentralachse des Schlauchs (1) drehbar ist.

6. Apparat nach Anspruch 5, **dadurch gekennzeichnet, dass** die Querschnittsgröße und die Krümmungsradien der Bohrung der Düse (3) kleiner sind als diejenigen des Inneren des Schlauchs (1).

7. Apparat nach Anspruch 5 oder 6, **dadurch gekennzeichnet, dass** die Düse (3) mit mindestens zwei Düsenabschnitten (3a, 3b) ausgestattet ist, wobei deren oberer Teile in gelenkiger Weise verbunden und zum ferngesteuerten Öffnen ausgebildet sind, um den inneren Durchgangsquerschnitt der Düse (3) zu erweitern.

8. Apparat nach einem der voranstehenden Ansprüche, **dadurch gekennzeichnet, dass** der untere Teil (2) des Schlauchs (1) eine benachbart der Düse (3) angeordnete Rühreinrichtung (9) umfasst.

9. Apparat nach einem der voranstehenden Ansprüche, **dadurch gekennzeichnet, dass** der untere Teil (2) des Schlauchs (1) mit einer oder mehreren Vorrichtungen zum Abschneiden des radioaktiven Materials (11) versehen ist.

10. Apparat nach einem der voranstehenden Ansprüche, **dadurch gekennzeichnet, dass** der untere Teil (2) des Schlauchs (1) mit einer oder mehreren Videokameras zum Übertragen von Bildern an ein außerhalb der Speicherkammer (13) angeordnetes Überwachungssystem versehen ist.

11. Verfahren zum Bewegen radioaktiven Abfalls (11) aus einer Speicherkammer (13) zu einem anderen geeigneten Behälter (28) mittels eines fließenden Fluids, wobei ein flexibler Schlauch (1), der mit einer Vielzahl von Manövriervorrichtungen (7a, 7b), die den Umfang des Schlauchs (1) umgeben und sich in Längsrichtung des Schlauchs (1) erstrecken, versehen ist, mit einer Saugvorrichtung verbunden ist, die zum Aufrechterhalten eines Unterdrucks im Schlauch (1) eingerichtet ist, wobei die Saugvorrichtung außerhalb der Speicherkammer (13) angeordnet ist,
dadurch gekennzeichnet, dass
der Schlauch (1) durch einen Schlauchdurchgang (15) mittels Abspulen des Schlauchs (1) von einer Schlauchtrommel (17) in die Speicherkammer (13) eingeführt wird,
eine Düse (13) mittels der Steuerung der Schlauchtrommel (17), der Bewegung des ersten und zweiten Aktuators der Manövriervorrichtungen (7a, 7b) und der Rotation der Düse (3) durch den Motor (4) zu einer beliebigen Stelle an der Oberfläche des radioaktiven Materials (11) bewegt wird,
eine Vakuumpumpe Fluid und radioaktives Material (11) durch die Düse (3) in den Schlauch (1) saugt,
das radioaktive Material (11) in einer Zykloneinheit (23) getrennt und mittels einer Sperre (27) vom Fluid getrennt wird, und
das radioaktive Material (11) in einem Abfallbehälter (28) eingelagert wird.

12. Verfahren nach Anspruch 11, **dadurch gekennzeichnet, dass** das radioaktive Material (11) vor dem Einsaugen in den Schlauch (1) durch in Bewegung setzen einer Rühreinrichtung (9) fragmentiert wird.

13. Verfahren nach einem der Ansprüche 11 oder 12, **dadurch gekennzeichnet, dass** das radioaktive Material vor dem Einsaugen in den Schlauch (1) mittels eines in den unteren Teil des Schlauchs (1) integrierten Werkzeugs geschnitten wird.

Revendications

1. Appareil permettant de déplacer des déchets radioactifs (11) d'une chambre de stockage (13) à un autre récipient approprié (28) au moyen d'un écoulement de fluide, l'appareil comprenant un tube flexible (1) inséré, lors de l'utilisation, dans la chambre de stockage (13) et relié à un dispositif d'aspiration pouvant maintenir une pression négative dans le tube (1), le dispositif d'aspiration étant situé à l'extérieur de la chambre de stockage (13), **caractérisé en ce que** le tube (1) est muni d'une pluralité de dispositifs (7a, 7b) de manoeuvre allongés entourant la circonférence du tube (1) et s'étendant dans la direction longitudinale du tube (1), ladite pluralité de dispositifs de manoeuvre allongés comprenant un premier ensemble de dispositifs (7a) de manoeuvre relié à un premier actionneur situé à l'extérieur de la chambre de stockage (13), le premier ensemble de dispositifs (7a) de manoeuvre étant agencé de manière à courber une partie inférieure (2) du tube (1) et étant fixé à proximité des extrémités de l'extension longitudinale de la partie inférieure (2) du tube.

2. Appareil selon la revendication 1, **caractérisé en ce que** le tube (1) comprend un second ensemble de dispositifs (7b) de manoeuvre relié à un second actionneur situé à l'extérieur de la chambre de stockage (13), l'ensemble de dispositifs (7b) de manoeuvre étant fixé à proximité des extrémités de l'extension

longitudinale d'une partie de tube arbitraire, la partie de tube aléatoire étant appropriée pour être courbée dans une direction sélectionnée éloignée d'une forme rectiligne.

3. Appareil selon la revendication 1 ou 2, **caractérisé en ce que** le tube (1) est muni d'une pluralité d'anneaux de support circonférentiels (4a, 4b, 4c) fixés au tube (1) le long d'une partie importante de la longueur du tube (1).

4. Appareil selon la revendication 3, **caractérisé en ce que** les dispositifs (7a, 7b) de manoeuvre sont déplacés à travers des évidements (4e) prévus à la circonférence des anneaux (4a, 4b, 4c) de support.

5. Appareil selon la revendication 1, 2, 3 ou 4, **caractérisé en ce qu'**une partie inférieure (2) du tube (1) comprend une buse (3), la buse (3) étant apte à pivoter autour de l'axe central du tube (1).

6. Appareil selon la revendication 5, **caractérisé en ce que** la dimension de section transversale et les rayons de courbure de l'alésage de la buse (3) sont inférieurs à ceux de la partie interne du tube (1).

7. Appareil selon la revendication 5 ou 6, **caractérisé en ce que** la buse (3) est munie d'au moins deux sections (3a, 3b) de buse, dont une partie supérieure est interconnectée d'une manière articulée, ces dernières étant agencées de façon à être ouvertes au moyen d'une commande à distance, afin d'augmenter la section transversale de passage interne de la buse (3).

8. Appareil selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la partie inférieure (2) du tube (1) comprend un agitateur (9) agencé de manière adjacente à la buse (3).

9. Appareil selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la partie inférieure (2) du tube (1) est munie d'un ou de plusieurs dispositifs pour la découpe du matériau radioactif (11).

10. Appareil selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la partie inférieure (2) du tube (1) est munie d'une ou de plusieurs caméras vidéo pour le transfert d'images à un système de surveillance situé à l'extérieur de la chambre de stockage (13).

11. Procédé de déplacement de déchets radioactifs (11) d'une chambre de stockage (13) à un autre récipient approprié (28) au moyen d'un écoulement de fluide, un tube flexible (1), muni d'une pluralité de dispositifs (7a, 7b) de manoeuvre entourant la circonférence du tube (1) et s'étendant dans la direction longitudinale du tube (1), étant relié à un dispositif d'aspiration pouvant maintenir une pression négative dans le tube (1), le dispositif d'aspiration étant situé à l'extérieur de la chambre de stockage (13), **caractérisé en ce que**
le tube (1) est inséré dans la chambre de stockage (13) à travers un passage (15) de tube, le tube (1) étant déroulé d'une bobine (17) de tube,
une buse (3) est déplacée vers un emplacement quelconque de la surface du matériau radioactif (11) au moyen de la commande de la bobine (17) de tube, du mouvement des premier et second actionneurs des dispositifs (7a, 7b) de manoeuvre et de la rotation du moteur (4) de la buse (3),
une pompe à vide aspire le fluide et le matériau radioactif (11) dans le tube (1) à travers la buse (3),
le matériau radioactif (11) est séparé dans une unité cyclone (23) et est isolé de l'écoulement de fluide au moyen d'un dispositif (27) de verrouillage, et
le matériau radioactif (11) est déposé dans un récipient (28) pour déchets.

12. Procédé selon la revendication 11, **caractérisé en ce que** le matériau radioactif (11) est fragmenté par l'actionnement du mouvement d'un agitateur (9) avant d'être aspiré dans le tube (1).

13. Procédé selon la revendication 11 ou 12, **caractérisé en ce que** le matériau radioactif est coupé au moyen d'un outil intégré à la partie inférieure du tube (1) avant d'être aspiré dans le tube (1).

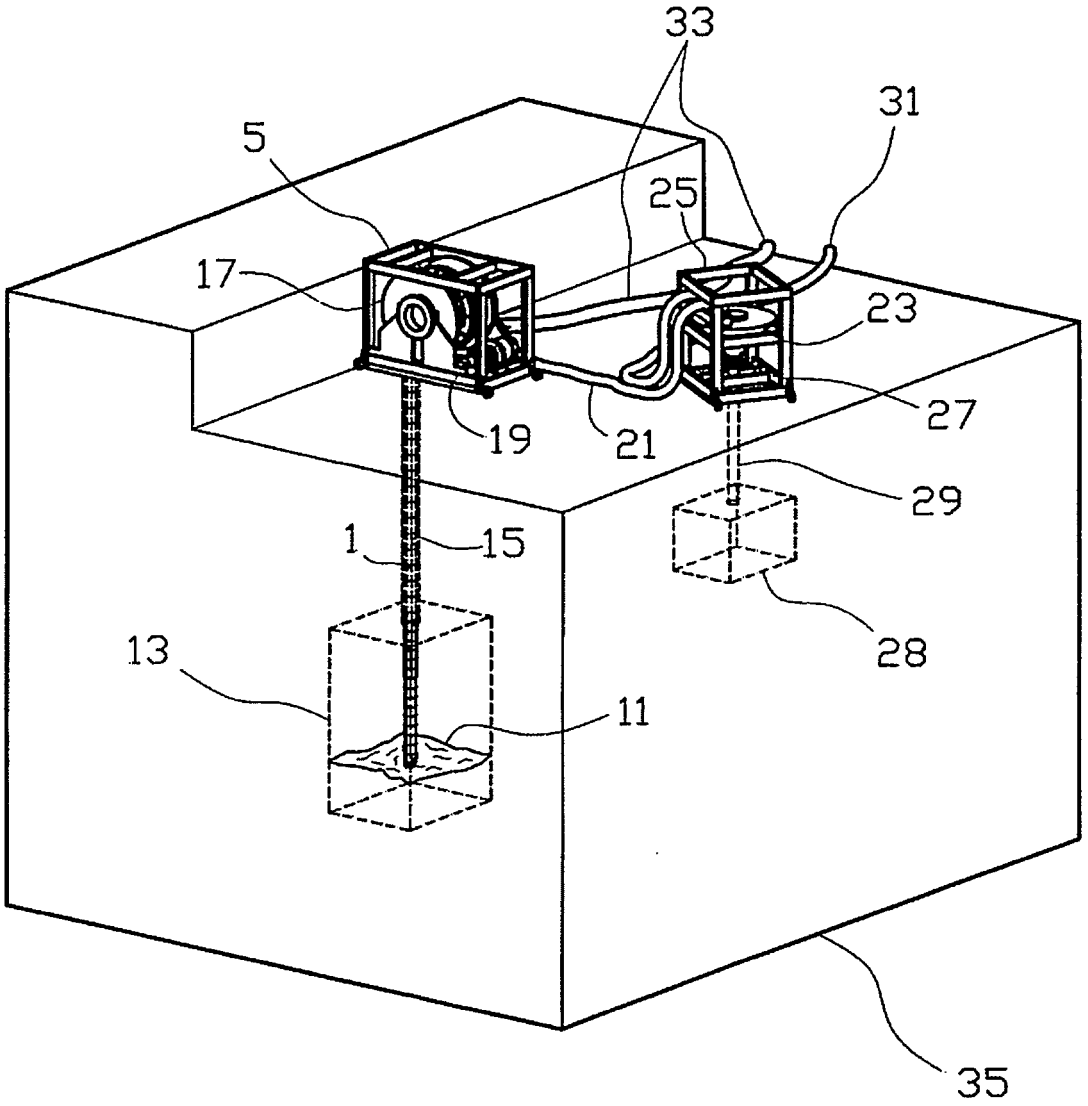

Fig. 1

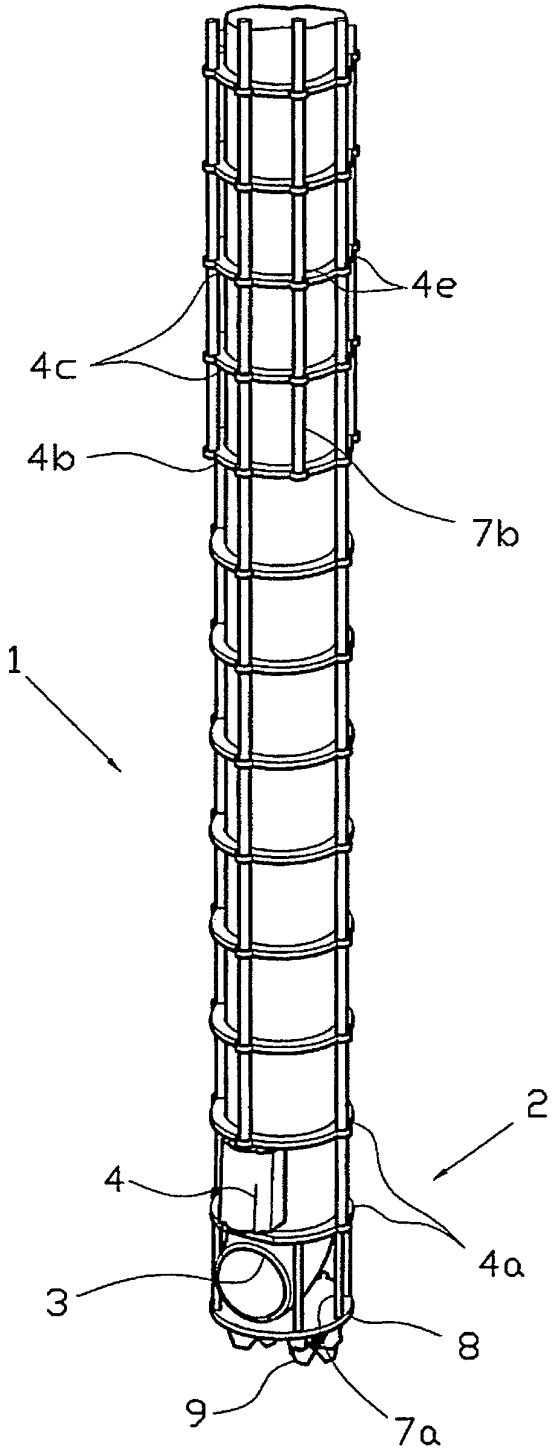

Fig. 2

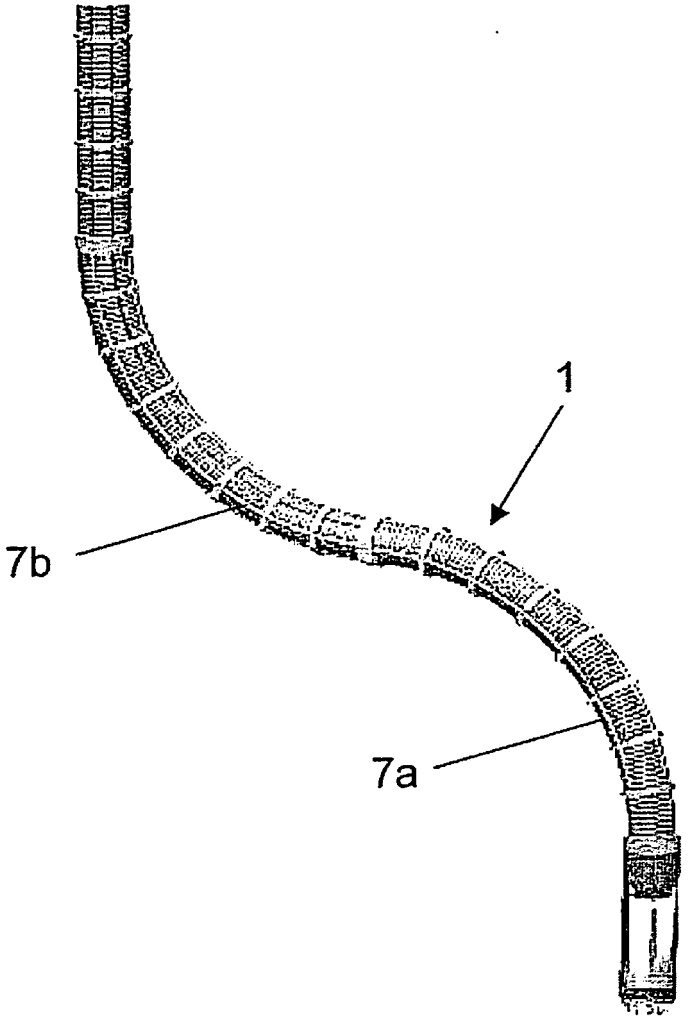

Fig. 3

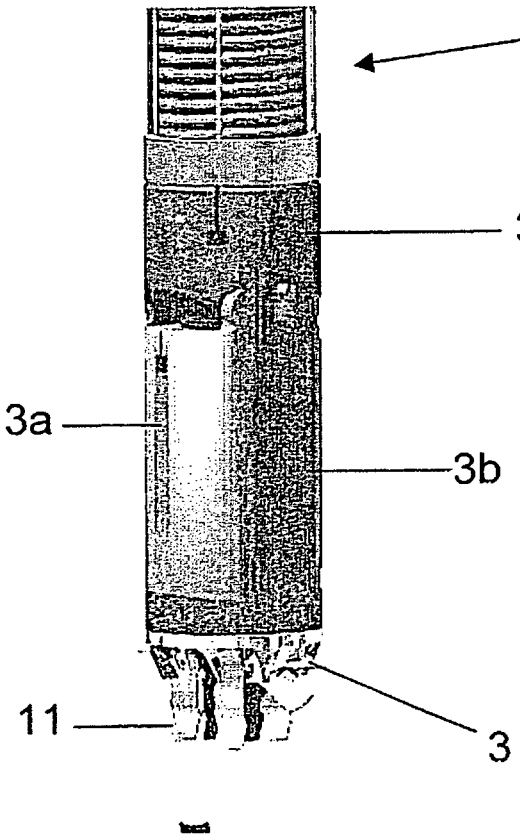

Fig. 4a

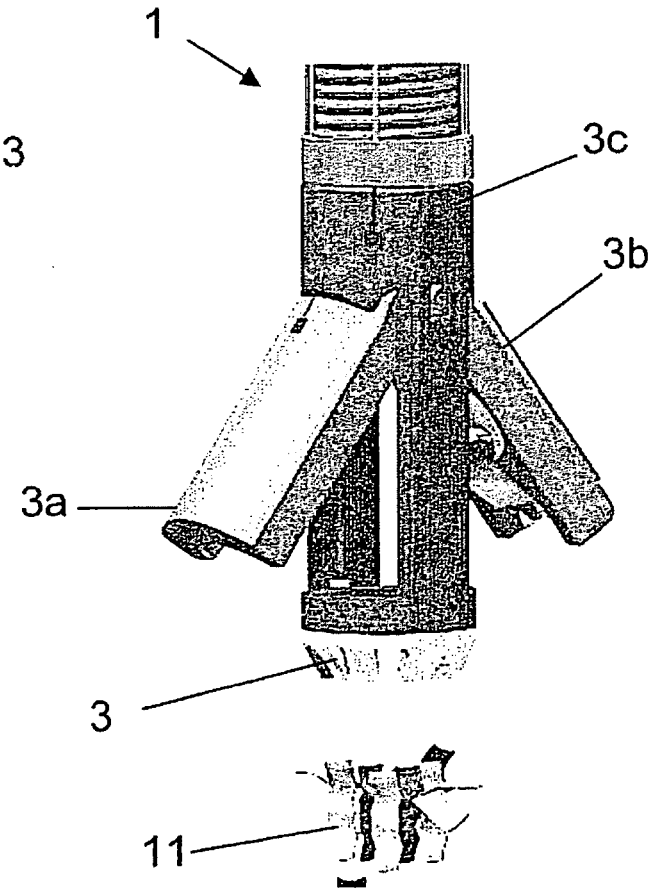

Fig. 4b

REFERENCES CITED IN THE DESCRIPTION

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