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(54) **SPACE MODULE FOR DISPOSAL OF RADIOACTIVE WASTE.**

(57) A space module for disposal of radioactive waste comprises a transportation stage (1) and a detachable emergency rescue stage (2) between which is located a protective screen (19) connected with them with the possibility of separation from one of the stages. The casing (11) of the detachable stage (2) is hollow and open on the side of the protective screen (19) and is mounted on the said screen (19) by its open part so as to form, together with it, a sealed cavity (21) for placing in it the container (5) with radioactive waste. The detachable stage (2) is provided with a system (18) intended for active cooling of the container and comprising reservoirs (49) with a cooling agent interconnected to each other and located in an annular gap between the container (5) and the casing (11), as well as fueling (51) and drainage (52) units. One of the reservoirs (49) has an outlet valve (53) provided with a nozzle (54).

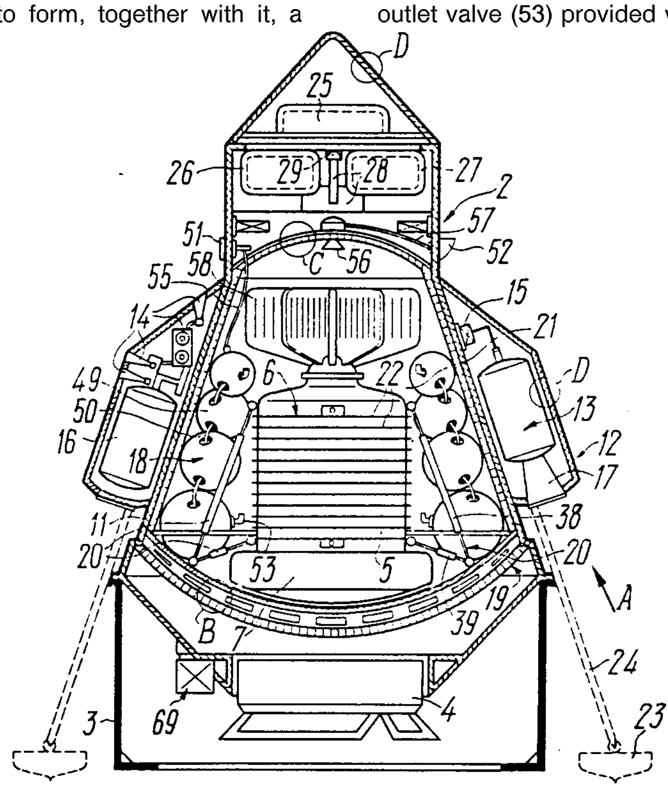


FIG. 2

Field of the Invention

The invention relates to the protection against radioactive radiation by burying radioactive wastes, and, more specifically, it deals with a space module for burying radioactive wastes in space.

State of the Art

At present, in view of ever growing use of nuclear power plants and instruments using radioactive isotopes,the amount of radioactive wastes increases, and their disposal is a very important problem.

It is widely known to protect against radioactive radiation of such wastes by burying them in soil or in the ocean. Thus low-activity liquid and gaseous wastes are discharged for dissolution in water into open water reservoirs or sea streams, or they are emitted into atmosphere after preliminary dilution with water or air. To dispose of industrial radioactive wastes of medium or high activity, they are concentrated and are then stored in special tightly sealed containers for a long time in stable geological structures at a depth of up to 2 km, e. g., in salt mines (cf. "Gotleben Project for Burial of Radioactive Wastes in FRG", Jr. Atomnaya tekhnika za rubezhom, No. 4, April, 1991. Energoatomizdat. p. 8-15.). The sealed containers are made of stainless steel in the form of cylindrical canisters of 0.61 m in diameter and 3 m long with a total weight of up 350 kg and with a residual waste heat release ranging between 60 and 150 kW and a dose rate of up to 40 Gy per hour.

This method for burying radioactive wastes does not, however, rules out their effect on biosphere of the Earth during a long-term storage. It calls for substantial technical and financial effort for the construction and operation of underground storage facilities and does not allow a reliable burial of radioactive wastes to be ensured (for hundreds and thousands of years) because they have a high specific activity and release much heat causing heating of the surrounding rocks and containers. This may result in a loss of tightness of the containers and even in their failure which is unsafe for the environment and may bring about serious ecological consequences. Accordingly various methods and devices have been under development which are aimed at ensuring reliable and ecologically safe burial of radioactive wastes for many hundreds and thousands of years.

known in the art are sealed containers "Castor" for transportation of radioactive wastes (cf. Development of a Transportation Container for Radioactive Wastes, Jr. Atomnaya tekhnika za rubezhom, No. 5, May, 1990. Atomenergoizdat. p. 35-37). The container is in the form of a hollow thick-walled cylinder having cooling ribs on its outer periphery. Moderator rods (neutron protection) are installed in the wall of the cylinder. The containers are closed by end covers provided with shock absorbers. Aluminum segments with passages for capsules containing wastes are provided inside the cylinder. The segments are rigidly attached to the container body. The charged container weighs up to 100 tons and is 5.8 m long and 2.5 m in diameter, with the total weight of the capsules of 8.4 tons and the weight of radioactive wastes proper of 1.9 tons. Heat release to the environment is 52 kW.

These containers are unsuitable for a long-term burial of radioactive wastes because a loss of tightness may occur as a consequence of ageing of the casing material during storage. The casing may also melt down in the event there is no adequate heat exchange with the environment (e. g., as a result of a collapse in underground storage facilities).

known in the art is a space module for burying radioactive wastes in space (Jr. Astronautics and Aeronautics. 1980. vol. 18. p. 26-35).

This prior art apparatus comprises:

an insertion stage having an engine module, control systems, and systems for communication with the Earth ;

a docking unit;

a detachable emergency rescue stage attached to the insertion stage and having jet engines on its body;

a container with radioactive wastes having a cooling means and a shock-absorber device.

The insertion stage of this prior art apparatus comprises an insertion space stage SOIS (Solar Orbit Insertion Stage). The detachable rescue stage is in the form of a landing module mating to a booster unit and having means for cooling the container during the launching and buoyancy support means (for splash landing). The container is placed in the front part of the landing module and, after the space module is inserted into a near-Earth orbit in a payload compartment of a reusable insertion spacecraft such as Space Shuttle, the container is separated from the landing module after unloading the module from the compartment by means of an on-board robot arm. After separation from the landing module, the container is docked to the insertion stage for subsequent transfer into space.

Thermal protection of the landing module is in the form of a carbon/carbon composite, and a shock absorber is in the form of a steel honeycomb structure.

The above-described space module for burying radioactive wastes cannot bring solution to the problem of reliable burial of wastes ecologically safe for the Earth because in case of emergency of a device used for inserting the module into an orbit (Space Shuttle), especially at the ascent trajectory after the starting, the device for inserting into orbit and the detachable stage cannot ensure rescue of the container with radioactive wastes so that the area of crash landing of the module will be contaminated because of destruction of the container as a result of a catastrophic failure (blow-up) of the device for inserting into orbit. In addition, the prior art apparatus cannot ensure a reliable cooling of the container with radioactive wastes in case of its emergency return to the Earth for a time which it takes on the Earth to enable the arrival of a search and rescue team and to ensure evacuation of the container from the landing (splash landing) spot. Cooling of the container cannot be ensured either in the path of its transfer by the insertion stage to a point of burial in space. The absence of such cooling will result in heating of radiation wastes with subsequent eventual destruction of the container and emergency leakage of a radioactive substance into the environment.

A tandem scheme of the prior art module, with the container being mated to the descent module which is mated to the insertion stage lowers reliability of the apparatus as a whole since it is necessary to separate the container from the landing module and to dock the container to the insertion stage after unloading the module from the payload compartment.

In addition, as the absorbed radioactive radiation dose rate acting upon the insertion stage increases when the container is docked thereto, instruments and equipment of the insertion stage are more likely to fail.

The need to dock the container and also an increase in the radiation dose acting upon the insertion stage lower payload weight (weight of radioactive wastes) because fuel reserve of the stage for stabilizing and orienting the module during docking has to be increased and additional redundancy (stand-by) equipment and instruments have to be installed in the insertion stage and have to be protected to enhance their radiation resistance by applying an appropriate covering and increasing weight of instruments and equipment.

Summary of the Invention

The invention is based on the problem of providing a space module for burying radioactive wastes in space which is so constructed as to ensure highly reliable and ecologically safe burial of such wastes in space at all phases of flight of the module and also rescue of the container and its intactness (non-destruction) in the event of an emergency during the insertion of the module into a near-Earth orbit from the Earth and upon a subsequent starting from this orbit to ensure ecological safety of the Earth.

This problem is solved by the fact that in a space module for burying radioactive wastes, comprising an insertion stage having an engine module a system for control and communication with the Earth, a detachable emergency rescue stage having jet engines on its body and installed in the insertion stage, a docking unit, and a container with radioactive wastes having cooling means and a shock absorber device, according to the invention, a protective shield is provided between, and connected the insertion stage and the detachable emergency rescue stage which is detachable from either of them and which has devices for a rigid attachment of the container and for positioning its center of gravity, the body of the detachable emergency rescue stage being hollow and open on the side of the protective shield and being mounted thereon with its open portion so as to define with the shield a tightly sealed space for the accommodation of the container with radioactive wastes, the detachable emergency rescue stage having a system for external active cooling of the container and at least two jet engines in the form of solid-propellant rocket engines having the outlets of their nozzles facing in the direction toward the insertion stage.

The provision of the detachable emergency rescue stage with a hollow body open on the side of the insertion stage and the provision of the protective shield defining with the body of the detachable emergency rescue stage a space for the accommodation of the container with radioactive wastes ensure:

enhanced reliability of the module owing to a reduced radiation effect upon the insertion stage and a less sophisticated design of the space module;

decreased absorbed radioactive radiation dose rate at which radioactive wastes act upon instruments and equipment of the insertion stage;

increased payload weight (weight of transported radioactive wastes).

As the container with radioactive wastes is mounted on the protective shield in combination with the use of means for rigid attachment and center of gravity positioning of the container, reliability of the space module and safety of its flight are improved, and the weight of payload inserted into orbit is increased owing to a less sophisticated design and a better control of the module movement due to a reduced eccentricity of the center of mass of the container with respect to the module body.

As a system for external cooling of the container is provided on the detachable emergency rescue stage, overheating and failure of the container are ruled out upon emergency return to the Earth and during the time which is needed for a search and rescue team to arrive and to evacuate the container.

The provision of solid-propellant rocket engines on the detachable emergency rescue stage ensures an urgent removal of the module to a safe distance in the event of failure of the device for inserting into orbit or of the insertion stage and also allows the module to be transferred to a descent trajectory for return to one of chosen areas on the Earth or to a low-altitude near-Earth orbit if a catastrophic failure of the device for inserting into orbit occurs during the final phase of insertion into orbit.

According to the invention, the protective shield of the space module has a load-bearing shell and thermal protection layers provided on either side of the load-bearing shell, at least one of the layers being made of a material having radiation protection properties.

The provision of thermal protection layers allows safety of transfer of the container to an orbit to be enhanced owing to a decrease in temperature load of the load-bearing shell both from a thermal flux from the container during insertion into orbit and during emergency descent of the module to the Earth and from an external aerodynamic heating during the emergency descent of the module to the Earth. The use in the thermal protection layer of a material having radiation protection properties allows the structural weight of the module to be reduced, concurrently with enhancement of reliability of the module (owing to a reduction in the radiation effect upon the insertion stage), with a respective increase in the weight of a payload owing to an optimum combination of thermal and radiation characteristics of the material.

Each device for rigid attachment and center of gravity positioning of the container in the space module preferably comprises two bars of different lengths, the longer bar being pivotally connected to the upper part of the container and to the protective shield and the shorter bar being connected to the lower part of the container and to the protective shield, and each bar being provided with a shock-absorber unit. This enhances reliability of the module owing to facilitated installation and center of gravity positioning of the container. Moreover, dimensions and configuration of the container may be changed. The provision of the shock-absorber unit for each bar reduces the impact load, hence improves ecologic safety of the module which cannot fail upon an emergency descent and crush landing on the Earth.

In accordance with one embodiment of the invention, the protective shield is concave on the side of the container, and the shock-absorber device of the container is installed on its lower part facing toward the protective shield and is in the form of a shock-absorber cushion having a convex outer side to match to the concave configuration of the protective shield. This facility enhances reliability of the container shock-absorber means, hence its ecological safety as the shock-absorber units of the bars for rigid attachment and center of gravity positioning of the container are combined with the redundancy shock-absorber cushion which will come into play as a second safety stage for absorbing the impact energy upon hitting the ground. The concavity of the shield (or its convexity to the outside) ensures centering of the impact load, uniform distribution and reduction of the module weight and also results in an increase in the capacity of the space for the accommodation of the container and in enhanced structural strength and ecological safety of the module.

According to the invention, the system for external active cooling of the container comprises two parts of which one is in the form of tanks containing a refrigerant which are located in an annular space between the container and the body and the other part comprises fill and discharge units built in the body of the detachable emergency rescue stage, at least one of the tanks having a discharge valve provided with a nozzle. This allows fire and explosion safety of the container and its cooling at the starting phase, during inserting into orbit and at emergency return of the container to the Earth to be ensured owing to ventilation of the container. Simplicity of the cooling system and its accommodation on the detachable emergency rescue stage and the possibility of the replenishing of the stock of refrigerant at the launching spot (until the beginning of the self-propelled movement of the device for inserting into orbit) enhance reliability of the cooling system and save refrigerant which in the end enhances safety of the module flight and its ecologic safety.

The container of the space module according to the invention has, on its side opposite to the shock-absorber device, radiators of a thermocontrol system secured to the cover of the container made of a heat conductive material, the container filled with radioactive wastes accommodating heat exchange members cooperating with the cover.

This facility ensures better conditions for cooling the container and its contents in all phase of the module flight, i. e., during preparation for launching, during the launching, in the path for inserting into orbit, and during further transfer to an area of burial of radioactive wastes in space. This solution to the problem ensures a better sealing of the container, enhances safety of flight and ecologic safety of the Earth.

The provision of the radiators of the thermocontrol system in one embodiment of the invention in the form of zigzag plates results in an increase in the heat exchange surface area of the radiator with a limited size of the interior space of the module in which the container is accommodated. It is preferred that closing means and a docking unit be provided on the protective shield on the side of the insertion stage so as to carry out emergency rescue jobs with the module in a near-Earth orbit for a package-type or cluster-type installation of several space modules on another vehicle for bringing radioactive wastes to a burial area to enhance safety of flight of the module and ecologic safety of the Earth and to expand functional capabilities of the module as regards vehicles for its transfer in space.

Therefore, the space module according to the invention for burying radioactive wastes in space solve this problem with a greater ecologic safety for the Earth, enhanced reliability and greater weight of transferred radioactive wastes with a reduction in the total structural weight of the module.

Description of the Drawings

The invention will now be described in detail with reference to specific embodiments illustrated in the accompanying drawings, in which:

Fig. 1 schematically shows a general view of a space module;

Fig. 2 schematically shows a structural diagram of a space module;

Fig. 3 is a view taken along arrow A in Fig. 2 showing position of structural members on the outer periphery of the module;

Fig. 4 schematically shows a partial view of the module, zone B;

Fig. 5 is ditto of Fig. 4, zone C;

Fig. 6 is ditto of Fig. 4, zone D;

Fig. 7 schematically shows a shock-absorber unit of a bar for the attachment of a container;

Fig. 8 shows position of tanks containing refrigerant with respect to a container the module body;

Fig. 9 schematically shows a structural diagram of a container with radioactive wastes;

Fig. 10 is a schematic partial view of the container, zone E in Fig. 9;

Fig. 11 is a view taken along arrow F in Fig. 9;

Fig. 12 schematically shows a phase during which the module is brought to a position for transfer from a near-Earth orbit into space;

Fig. 13 is a general view of the module during an emergency return from the orbit and landing on the Earth.

Preferred Embodiments of the Invention

A space module for burying radioactive wastes in space according to the invention comprises an insertion stage 1 (Fig. 1), a detachable emergency rescue stage 2, an adapter compartment 3, a conventional docking unit 4 (Fig. 2), a container 5 with radioactive wastes having cooling means 6, and a shock-absorber device 7.

Insertion stage 1 (Fig. 1) has an engine module which comprises a main jet sustainer 8 and auxiliary control engines 9. Insertion stage 1 also has a conventional system 10 for control and communication with the Earth and other on-board support systems for a prolonged self-sustained space flight. Insertion stage 1 may be built around, e. g., as the instrumentation and equipment compartment of "Soyuz-TM" spacecraft. Detachable emergency rescue stage 2 is attached to insertion stage 1 through adapter compartment 3 and has on its body 11 jet engines 12, at least two among which are in the form of solid-propellant rocket engines 13, and auxiliary control engines 14, an automatic control system 15 (Fig. 2), and fuel (fluid) tanks 16 for auxiliary engines 14. The outlets of nozzles 17 of rocket engines 13 face toward insertion stage 1. Angular position of nozzles 17 of engines 13 ensures the maximum possible axial thrust taking into account the admissible thermal and gas dynamic effect of the jet streams of these engines upon the structure of the space module and of the device for inserting it into a near-Earth orbit. Detachable emergency rescue stage 2 is provided with a system 18 for external active cooling of container 5.

Docking unit 4 may be of an androgenic and peripheral type similar to that used for a well-known Soviet-US Apollo-Soyuz Project.

A protective shield 19 is provided between, and connected to insertion stage 1 and emergency rescue stage 2 which is detachable from either of them and which has devices 20 for a rigid attachment of container 5 and for its center of gravity positioning. Body 11 of detachable emergency rescue stage 2 is hollow and open on the side of protective shield 19 and is mounted thereon with its open part to define with protective shield 19 a sealed space 21 for the accommodation of container 5 with radioactive wastes.

Protective shield 19 is attached to body 11 of detachable emergency rescue stage 2 and to insertion stage 1 in its adaptor compartment by means of conventional detachable connectors, e. g., by means of explosive fasteners which are widely used in the space technology and which allow one of the stages (1 or 2) to be detached from protective shield 19 depending on circumstances.

Container 5 has a cooling means in the form of ribs 22 provided on the periphery of its body and a shock-absorber device 7.

Landing supports 23 (Figs. 2, 3) are mounted on body 11 of detachable stage 2 and have telescopic bars 24.

A conventional container 25 with a pilot parachute, a container 26 with main and back-up parachutes, a container 27 with buoyancy support means (inflatable balloons), radio communication equipment 28 of a radio beacon system, a flashing optical beacon , power supplies, and an automatic control system (not shown) are provided in the upper part of detachable emergency rescue stage 2 (Fig. 2). The radio communication equipment may include equipment of the international COSPAS/SARSAT system.

Protective shield 19 has a load-bearing shell 30 (Fig. 4) supported by a load-bearing framing 31 of members in the form of fashioned frame members, and thermal protection layers 32, 33 provided on either side of load-bearing shell 30. A thermal protection layer 32 is provided on the outer surface of the shield facing toward the insertion stage and is made of a carbon/carbon composite which may consist of individual interconnected blocks attached to shell 30. Similar coverings are used at insertion spacecraft such as Shuttle and Buran. Thickness of the covering is determined on the basis of estimated conditions of aerodynamic heating and the necessary reduction of radioactive radiation dose rate of the container with radioactive wastes. It should be noted that the carbon thermal protection coating also has radiation protection properties. Thus graphite blocks are used as reflectors and moderators in nuclear power plants (reactors). Covering 32 may also contain additives of certain elements (e. g. boron) for a more efficient moderation of neutrons and other radiation components.

The inner surface of the shield is covered with a thermal protection layer 33 for heat insulation of load-bearing shell 30 and framing 31. This layer may be made, e. g., of a polymer such as cellular plastic and may also contain necessary additives of elements for improving radiation protection properties of the layer material.

A thermal protection of the upper part and lateral surfaces of detachable emergency rescue stage 2 and of engines 12 is constructed in the same manner. A thermal protection covering of the upper part of the interior space of detachable stage 2 is in the form of an inner thermal protection layer 34 applied to a load-bearing shell 35 (Fig. 5).

A thermal protection covering of the body of engines 12 and of the upper part of detachable stage 2 is in the form of a layer 37 made of carbon/carbon composite blocks applied to a load-bearing shell 36 of the body (Fig. 6).

Each device 20 (Fig. 2) for rigid attachment and center of gravity positioning of container 5 comprises at least two bars 38, 39 of different lengths. Longer bar 38 is pivotally connected to the upper part of container 5 and to protective shield 19. Shorter bar 39 is pivotally connected to the lower part of container 5 and to protective shield 19. Each of the bars 38, 39 has a short-absorbing unit 40 (Fig. 7). Shock-absorbing unit 40 may be in the form of a cylindrical sleeve 41 coaxial with the bar. The blind end of sleeve 41 is connected to a rod 42 of the bar for rotation of the sleeve about its axis. The other end of sleeve 41 has a hole to receive a rod 43 of the bar which has a piston 44 attached to the end thereof. The piston has through axial passages 45 and an outer thread engageable with a thread in the inner surface of sleeve 41. Liquid 46 is in the interior space of cylindrical sleeve 41. Projections 47 are provided on the inner surface of sleeve 41. A set screw 48 holds sleeve 41 against rotation with respect to rod 42.

Protective shield 19 is concave on the side of container 5 (Fig. 2). Shock absorber device 7 of container 5 is located in its bottom part facing toward shield 19 and comprises a shock absorber cushion having a convex outer surface to be a match to the concave surface of shield 19, the convex surface being spaced from shield 19 at a distance of the stroke of shock-absorber unit 40. The shock-absorber cushion may be in the form of a steel honeycomb structure which would collapse when hit by the shield.

External active cooling system 18 may be of a conventional type used in the space technology and may be based, e. g., on supply of refrigerant to the outer surface of the container or to the interior space thereof through special passages.

According to the invention, external active container cooling system 18 consists of two parts. One part of the system comprises tanks 49 containing a refrigerant (e. g., liquefied nitrogen) located in annular space 21 between container 5 (Fig: 2) and body 11 of detachable emergency rescue stage 2 and communicating with one another through pipes 50. The other part of the system comprises fill units 51 and discharge units 52 built in body 11 of detachable emergency rescue stage 2, and at least one of tanks 49 is provided with a discharge valve 53 having a nozzle 54 (Fig. 8).

Refrigerant is supplied from fill unit 51 (Fig. 2) into tank 49 through a pipeline 55 and flows from interior space 21 of detachable emergency rescue stage 2 through an inlet funnel 56 and a pipeline 54 and discharge unit 52 into the environment.

The provision of a gage pressure in space 21 allows resistance of the structure of detachable stage 2 to external dynamic factors to be enhanced, including resistance to the effect of a shock wave in the event of a blow-up of an insertion device in the ascent path to the orbit.

In an embodiment of the space module container 5 (Fig. 9) has radiators 58 of a thermocontrol system attached to a cover 59 of container 5 on the side opposite to shock-absorber-device. Cover 59 is made of a thermally conductive material. Heat exchange members 61 cooperating with cover 59 through a thermally conductive medium (e. g., lead) are installed in container 5 filled with radioactive wastes 60. Heat exchange members 61 may be in the form of conventional heat pipes installed in passages within wastes 60. The upper parts of members 61 are fixed by means of a cage 63 which also separates thermally conductive medium 62 and wastes 60 in the event the thermally conductive medium material is melted because of an emergency heating of the wastes.

It should be noted that the body of container 5 is a multiple-layer structure and consists of a load-bearing shell 64 (Fig. 10) (made, e. g., of steel) which supports on its outer side a cylindrical sleeve 65 having ribs 22 (in certain cases the load-bearing shell may have its own ribs and in this case sleeve 65 is dispensed with). Radiation protection layers adjacent to the inner side of load-bearing shell 64 are as follows: a layer 66 for the protection against gamma-radiation (e. g., lithium hydride), a layer 67 for the protection against neutron flux (e. g., of tungsten). A thermal protection layer 68, e. g., of a carbon/carbon composite is in direct contact with radioactive wastes.

The above-described construction of the module allows best conditions to be provided for cooling the container and its contents during all phases of the flight. Sealing of the container is enhanced, and ecological safety of the Earth is improved.

This is ensured by using heat removal elements which do not have movable parts and which can work in weightlessness and in space vacuum to transfer heat from sealed containers (compartments).

To increase radiating capacity, radiators 58 (Fig. 11) are in the form of zigzag plates. This allows cooling of the container to be improved with a limited interior size of the space in which the container is accommodated.

In an embodiment of the space module, its protective shield 19 (Fig. 2) has closing means 69 and conventional docking unit 4 on the side of insertion stage 1, and namely, in the area of adapter compartment 3.

This allows emergency rescue and assembly and installation jobs to be carried out in orbit so as to enhance safety of flight of the space module and adaptiveness to various vehicles for interorbital (interplanetary) transfer.

The space module for burying radioactive wastes is launched in the following manner.

Container 5 (Fig. 2) containing radioactive wastes 60 is rigidly attached to protective shield 19 by means of bars 38, 39 with the adjustment of position of the center of gravity of the container by turning sleeve 41 (Fig. 7) of the shock-absorber unit after loosening screw 28 which is then tightened after the adjustment to hold sleeve 41 against rotation. Before doing that, docking unit 4 and closing means 69 are installed on shield 19. After the installation of container 5, assembled detachable emergency rescue stage 2 is mated to shield 19 (Fig. 2), and refrigerant supply is immediately connected to fill unit 51 of the detachable emergency rescue stage.

Detachable emergency rescue stage 2 with container 5 is then connected to adaptor compartment 3 which connects to insertion stage 1.

The assembled space module is installed on an insertion device (e. g a launcher rocket) and is inserted into a near-Earth orbit from which the module is boosted by means of a boosting rocket pod 70 (Fig. 12) to a path of flight toward a waste burial area.

It should be noted that after a preset increment of the module velocity is achieved, emergency rescue stage 2 is detached by engines 12 and 14. The booster pod 70 is then detached from insertion stage 1 which, together with container 5 mounted on shield 19, is switched to an independent flight along a transfer path to a burial area with necessary corrections of the trajectory, interorbital dynamic operations, orientation and stabilization, radio communication with the Earth, and command and remote control data exchange.

During the flight, refrigerant is supplied to interior space 21 in which container 5 is accommodated (Fig. 2) to pressurize the interior space of emergency rescue stage 2 to a preset gage pressure. When this pressure is exceeded, refrigerant is discharged through discharge unit 52 with washing of ribs 22 and radiators 58 of container 5 with refrigerant for cooling the container.

In the event of an emergency of an insertion device in the path of its ascent, an urgent detachment of emergency rescue stage 2 from the insertion stage is ensured, and emergency rescue stage 2 with container 5 is removed by solid-propellant rocket engines 13 to a preset area along the insertion path and landed on the Earth or splash-landed with active cooling of container 5 by system 18.

In case of a failure of insertion stage 1 or booster pod 70 (Fig. 12), stage 2 can be descended from orbit, with a braking velocity impulse being imparted by engines 13. The angular position is controlled during the descent by means of control engines 14 (Fig. 13). Detachable emergency rescue stage 2 is detached together with protective shield 19 from adapter compartment 3 of insertion stage 1.

During the landing of stage 2 (carrying container 5) with parachutes that are provided in containers 25, 26 (Fig. 2) and extracted after the opening of the top cover of detachable emergency rescue stage 2, bars 24 of landing supports 23 are extended, and shock-absorber units 40 operate, with subsequent operation of shock-absorber device 7 in the event the shock-absorber units are fully compressed. In the event of a splash landing buoyancy support means 71 (Fig. 13) provided in container 27 are inflated following a command from landing system pick-ups. During the parachuted descent, equipment of radio beacon system 28 comes into play, and flashing beacon 29 is switched on.

Emergency rescue stage 2 may be returned to the Earth for its reuse in case of a normal flight through the insertion path independently by means of engines 12, 13, 14, and stage 2 is stabilized in the path of aerodynamic braking in the atmosphere with its top part forward, with the landing being carried out from the parachuting descent with the use of telescopic supports 23 on the ground or with splash landing with the use of inflatable buoyancy support means 71.

Industrial Applicability

The space module according to the invention may be used with non-reusable or reusable insertion vehicles and is designed for disposing of radioactive wastes of various origin from the Earth and for their burial in space.

Claims

1. A space module for burying radioactive wastes, comprising an insertion stage (1) provided with an engine module, a system (10) for control and communication with the Earth, a detachable emergency rescue stage (2) having jet engines (12) on its body (11) and installed on insertion stage 1, a docking unit (4), and a container (5) with radioactive wastes having cooling means (6) and a shock-absorber device (7), characterized by the fact that a protective shield (19) is provided between, and connected to the insertion stage (1) and the detachable emergency rescue stage (2) and is detachable from either one of them, the shield having devices (20) for rigidly attaching container (5) and for positioning its center of gravity, and by the fact that a body (11) of the detachable emergency rescue stage 2 is hollow and open on the side of the protective shield (19) and is mounted thereon with its open part to define with the shield a sealed space (21) for the accommodation of the container (5) with radioactive wastes, the detachable emergency rescue stage (2) being provided with an external active system for cooling the container (5) and at least two jet engines thereof comprising solid-propellant rocket engines (13) having the outlets of their nozzles (17) facing toward the insertion stage (1).

2. A space module of claim 1, characterized by the fact that the protective shield (19) comprises a load-bearing shell (30) and thermal protection layers (32, 33) provided on either side of the load-bearing shell (30), at least one of the layers being made of a material having radiation protection properies.

3. A space module of claim 1, characterized by the fact that each device (20) for rigidly attaching the container (5) with radioactive wastes and positioning its center of gravity comprises at least two bars (38, 39) of different lengths of which one bar (38), which is longer, is pivotally connected to the upper part of the container (5) and to the protective shield (19) and the other bar (39), which is shorter, is pivotally connected to the lower part of the container (5) and to the protective shield (10), each bar (38, 39) having a shock-absorber unit (40.)

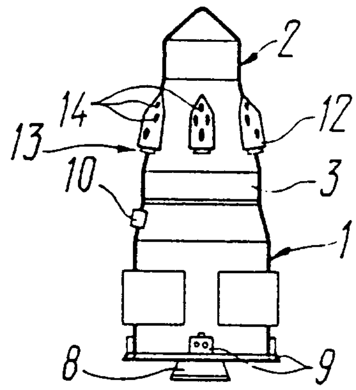
4. A space module of claims 1, 2, characterized by the fact the protective shield (19) is concave on the side of the container (5), the shock-absorber device (7) of the container (5) being provided on its lower part facing toward the protective shield (19) and comprises a shock-absorber cushion having an outer convex surface to be a match to the concave surface of the protective shield (19).

5. A space module of claim 1, characterized by the fact that the system (18) for external active cooling of the container (5) comprises two parts of which one part is in the form of tanks (49) containing refrigerant and accommodated in an annular space between the container (5) and the body (11) of the detachable emergency rescue stage (2), the tanks communicating with one another, and the other part is in the form of fill units (51) and discharge units (52) built in the body (11) of the detachable stage (2), at least one of the tanks (49) having a discharge valve (53) provided with a nozzle (54).

6. A space module of claim 1, characterized by the fact that the container (5) is provided with radiators (58) of a thermocontrol system attached to a cover (59) of the container (5) on the side opposite to the shock-absorber device (7), the container cover being made of a thermally conductive material, and by the fact that heat exchange members (61) cooperating with the cover (59) are provided in the container (5) filled with radioactive wastes.

7. A space module of claim 6, characterized by the fact that the radiators (58) comprise zigzag plates.

8. A space module of claim 1, characterized by the fact that closing means (69) and the docking unit (4) are provided on the protective shield on the side of the insertion stage (1).


2
14
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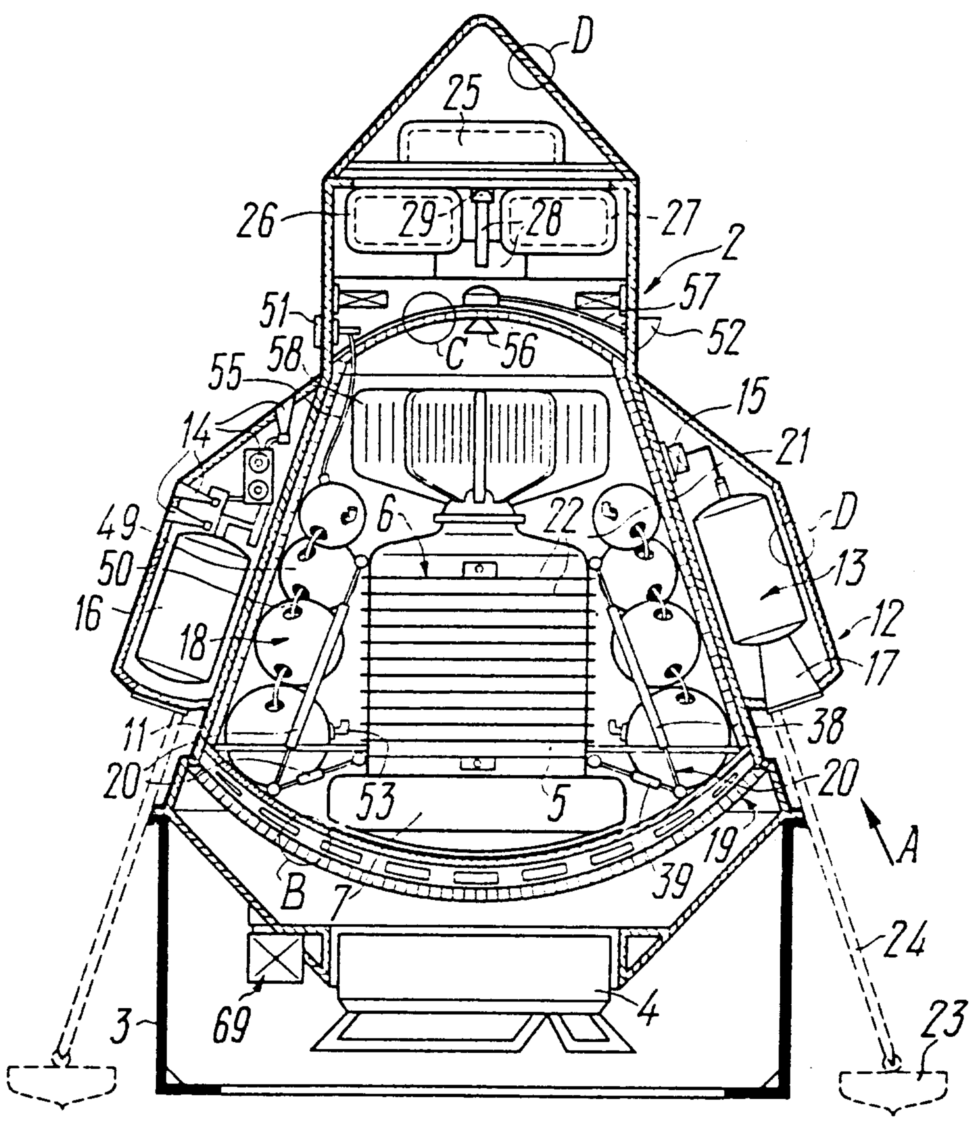
9

FIG. 1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C
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13
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18
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20
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B
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69
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3
23

FIG. 2

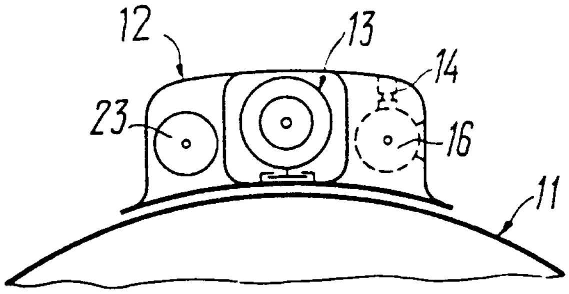

FIG. 3

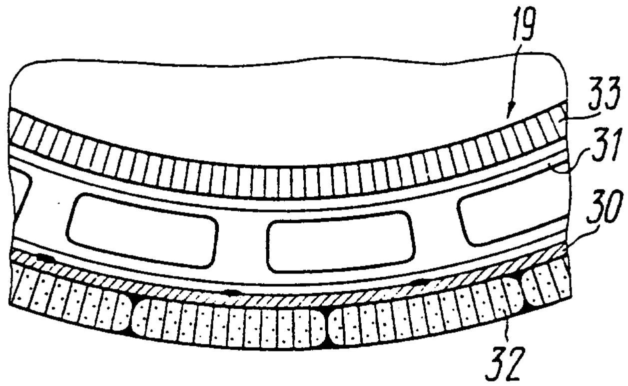

FIG. 4

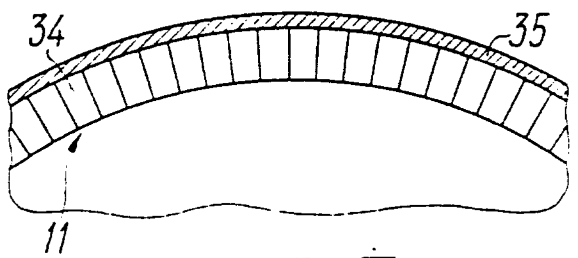

FIG. 5

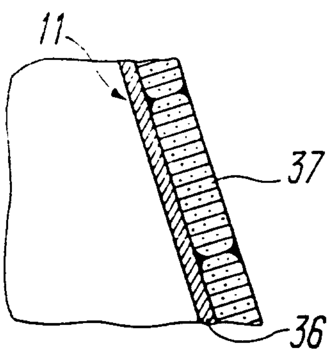

FIG. 6

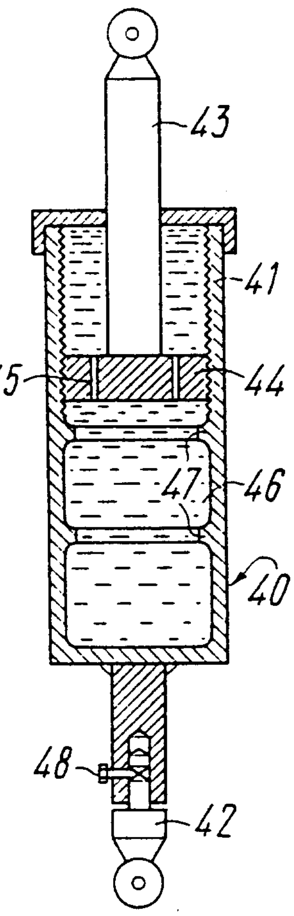

FIG. 7

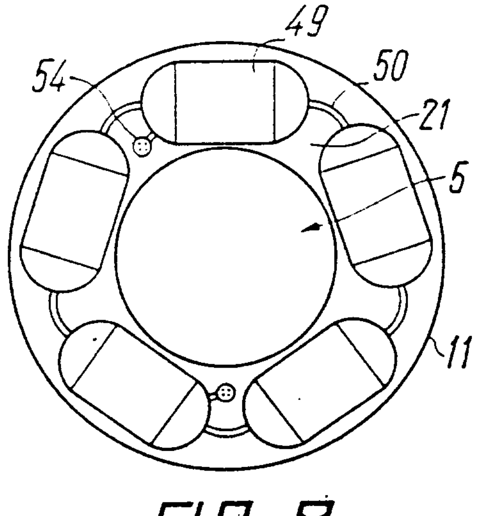

FIG. 8

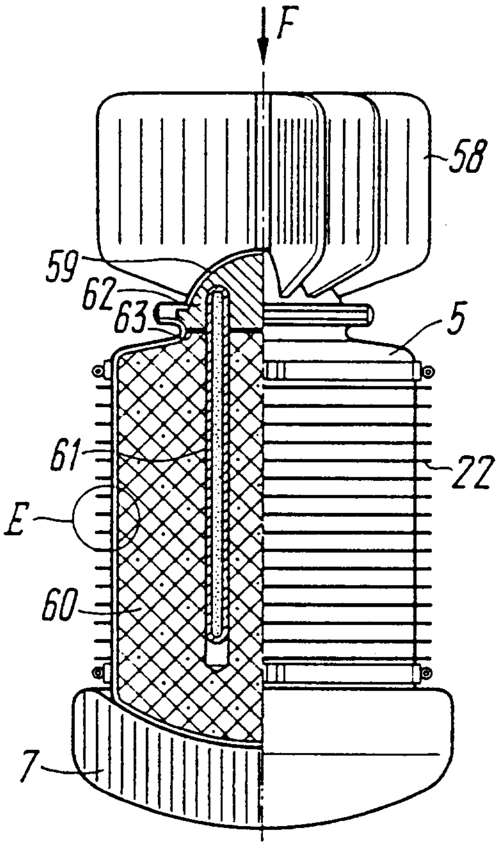

FIG. 9

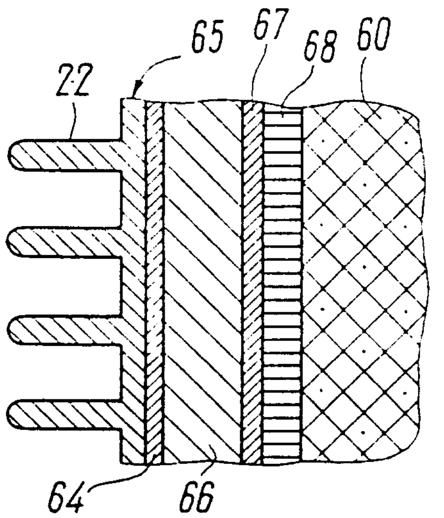

FIG. 10

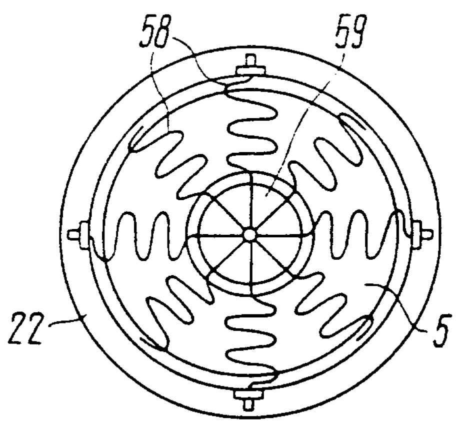

FIG. 11

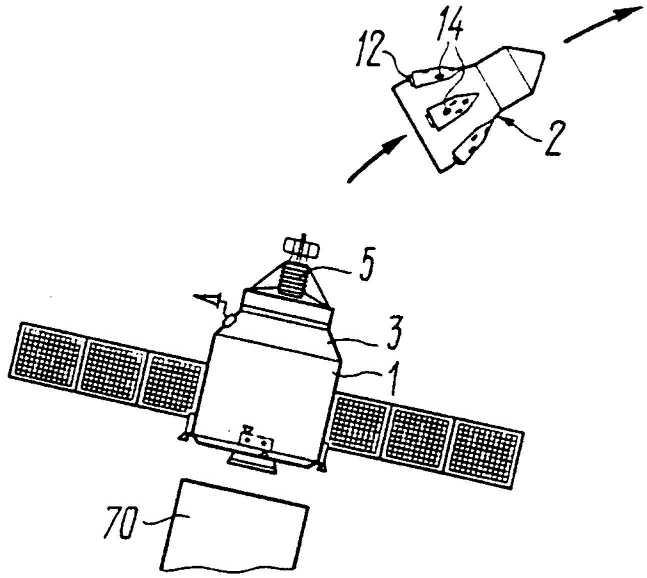

FIG. 12

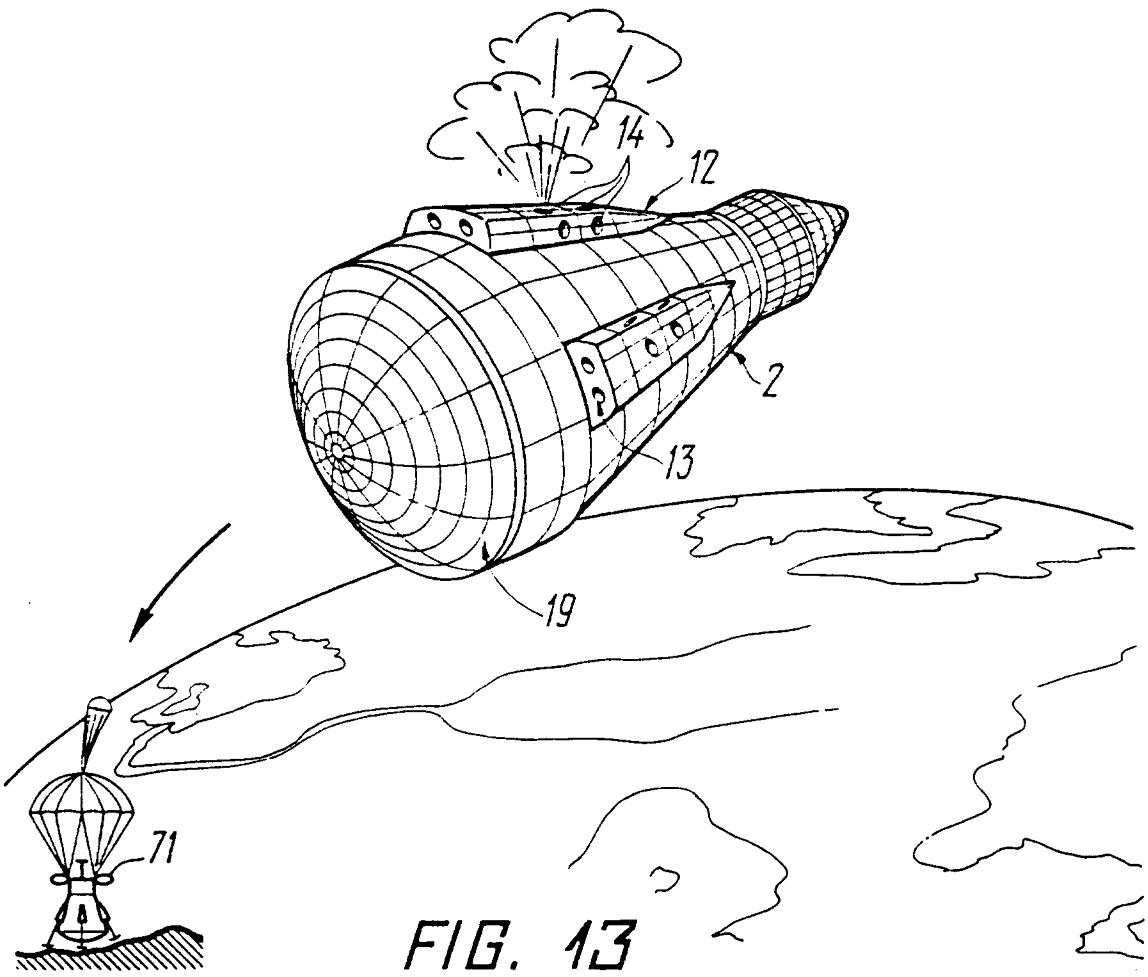

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 91/00246

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl.[5] G21F 9/34

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl.[5] G21F 9/34

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	"Astronautik", issue 2, 1981, entry "H", (Bremen), Prof.Dr. H.O. Ruppe and D.Hayn, "Entsorgung radioaktiven Abfalls durch die Raumfahrt Analyse der Moglichkeiten", pages 42-45	1,2,3,4,5,6, 7,8,9
A	"Gagarinskie nauchnye chtenia po kosmonavtike i aviatsii", 1991, "Nauka", (Moscow). Koval A.D. et al. "O perspektivakh udalenia radioaktivnykh atkhodov v kosmos", pages 184,185	1

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 June 1992 (04.06.92)	28 July 1992 (28.07.92)
Name and mailing address of the ISA/ ISA/RU	Authorized officer
Facsimile No.	Telephone No.