

[54] APPARATUS FOR HANDLING URANIUM HEXAFLUORIDE AT ELEVATED PRESSURE

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[56]

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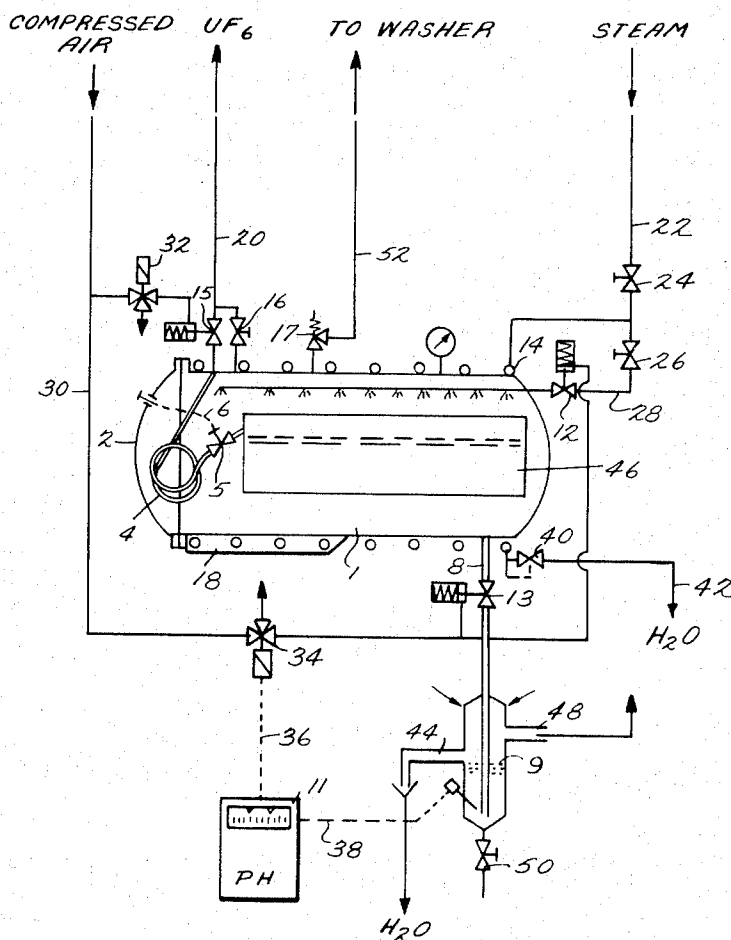
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ABSTRACT

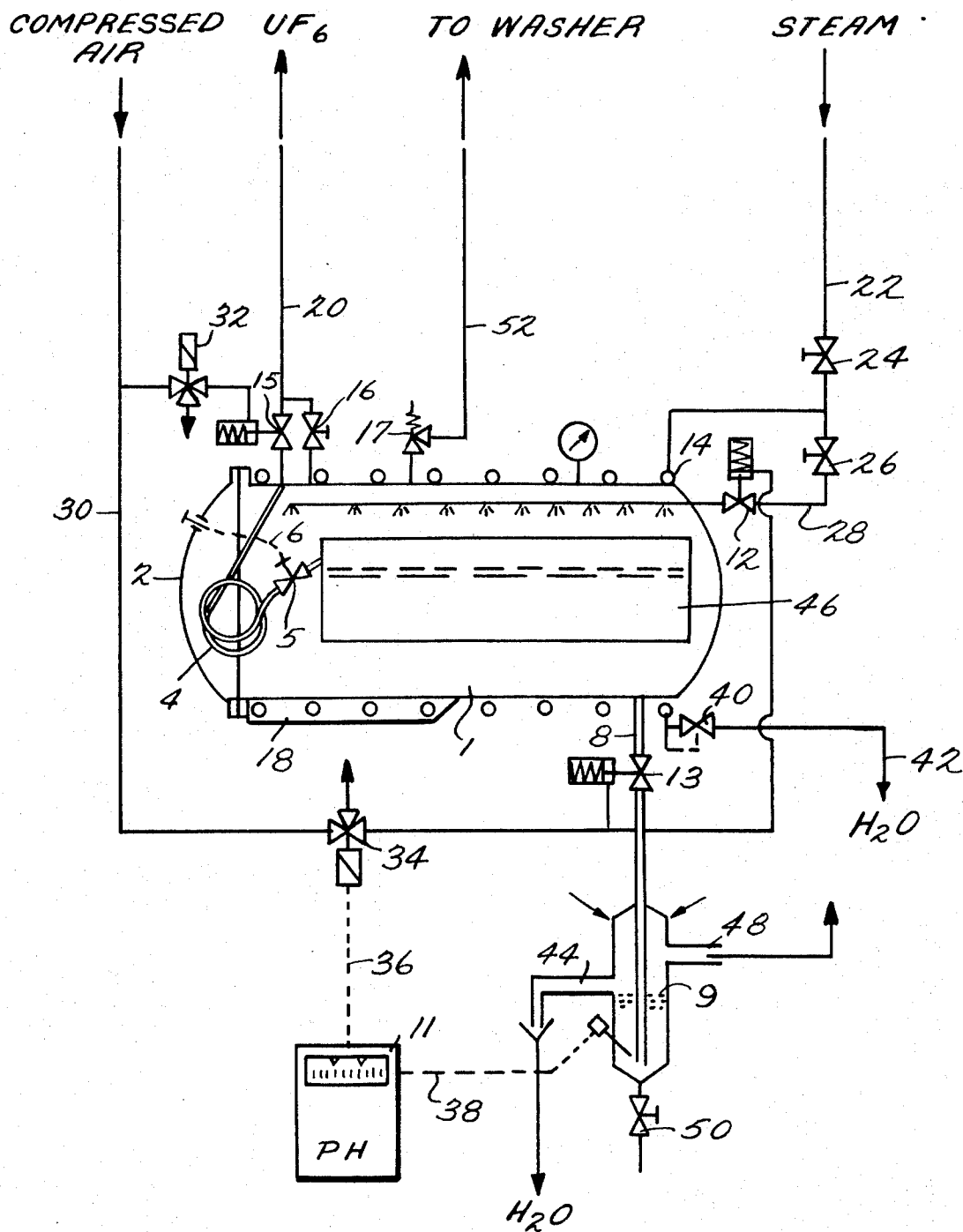
The danger of UF_6 break out is eliminated by placing the container with the UF_6 in an outer container, heating the outer vessel with a condensible gas, catching the condensible gas and any UF_6 leakage, measuring the leakage with an indicating device, e.g. a pH instrument, shutting off the heating and closing the outer vessel when the indicating device exceeds a predetermined value.

4 Claims, 1 Drawing Figure



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APPARATUS FOR HANDLING URANIUM HEXAFLUORIDE AT ELEVATED PRESSURE

Uranium hexafluoride is a colorless salt which is very volatile at room temperature and which changes to the gaseous form without melting. The sublimation point is at 56° C., the triple point at 1.5 atmospheres absolute and 64° C. at a temperature at 100° C. liquid UF₆ already is under a vapor pressure of 4.3 atmospheres absolute. Because of these thermodynamic properties, uranium can be vaporized as the hexafluoride at very low temperatures. UF₆, therefore, has acquired great importance as the starting material in isotope separation and the subsequent production of nuclear fuels with enrichment in U 235.

On account of its high volatility, it is packed in pressure containers of steel, stored, transported and delivered as is done in a manner similar to condensable gases. The filling and emptying of the container can be accomplished in various ways.

In physical chemical processes, as for example, the process of separating or reconversion, the gaseous form of UF₆ is utilized. In this case, UF₆ is taken from the containers as a gas and injected directly into the process by way of hot conduits. In this case, it is liquified under pressure by heat supply through the container wall and withdrawn from the gas cushion above the surface of the liquid continuously by means of reducing valves.

Frequently, however, it is appropriate to handle the liquid UF₆. If, for example, UF₆ from a condenser or a buffer container is packed in another container or different lots should be united in a container for the purpose of homogenization, the handling of the liquid saves time and energy and therefore is preferred to vaporization. In this case, also the UF₆ must be held in pressure containers at a temperature level above the melting point by heat insulation or controlled heat addition or removal so that it can be drawn off as a liquid below the container through openings in the container bottom under the influence of gravity and vapor pressure. After the cooling of the liquid UF₆ down to the melting point, a compact, crystalline material is obtained.

The equipment for handling UF₆ in the above described manner consists of chambers which surrounds the pressure container and are loaded with various liquid or gaseous heating or cooling media, such as, for example, water, air or steam.

The melting of UF₆ is combined with a distinct increase in volume. Therefore, the heat must be steadily distributed over the container surface when heating up the filled containers in order to avoid local buildup of excess pressure (hydraulic bursting apart). The installation of a direct electrical source of heat is not permissible. But even, the use of electrical radiation heating implicates the danger of overheating inspite of possibly more extensive safety precautions whereby the maximum permissible container pressure can be easily exceeded.

Steam in comparison to hot air possesses a higher heat capacity. Moreover, it has the advantage that because of its better heat transfer very short heating up times are required and, using saturated steam, pressure or temperature regulation can be dispensed with. Steam heating also makes it possible to detect reliably and quickly in a simple manner very small UF₆ leakages

by measurement of the change of the conductivity or the pH value in the condensate.

All known equipment for the treatment of UF₆ under pressure does not offer sufficient protection against a spontaneous explosion. Mathematically it can easily be shown that because of the small heat of vaporization, however high the heat capacity of the liquid UF₆, the greater part of the container contents is vaporized during such a failure until the rest effectively is cooled by utilization of the heat of vaporization.

Lately, several accidents have become known in which larger amounts of UF₆ have escaped through defective container valves. Thereby the service personnel were injured dangerously by cauterization of the respiratory ducts. The escaped fluoride could only be made usable again with great losses and after an expensive chemical purification.

The present invention is directed to overcome the depicted dangers and disadvantages which have been unavoidable until now in case of UF₆ escape. Furthermore, the invention also enables an unhindered subsequent treatment in case of failure.

With the apparatus of the invention, a heat container has been developed that takes over the function of a pressure container in the event of a UF₆ escape and which permits escaped UF₆ to be totally caught and to be controllably supplied for further use by a valve on the outer container.

The device will be explained in the following by the example of an evaporating plant with reference to the attached diagram.

The heating vessel consists of a vertically or horizontally arranged cylindrical steel container 1 having a diameter of 1 meter and a length of 2.50 meters in which there is inserted UF₆ container 3 of the type USAEC-30 A by opening locking cover 2. The UF₆ withdrawal takes place over an elastic helical tube and the pneumatic valve 15. The container valve 5 is operated from outside by a flexible spindle 6. The outer pressure container 1 is provided with steam sprinklers 7 on the inside and with a condensate drain 8. Steam enters from line 22 by way of the valves 24, 26, line 28 and valve 12.

The condensate passes through a condensate pot 9 which is provided with a pH measuring electrode 10. This responds to trivial leakages and automatically closes the quick-shut valves 12 and 13 for steam intake or condensate exit by electro-pneumatic control after exceeding an adjustable (predetermined) threshold on the regulator 11.

Criticality calculations have shown that the amounts of condensate and steam found in the container are kept so small by the safety precautions of the apparatus of the invention that a critical accident is out of the question, even by using large UF₆ containers with contents of 2.2 metric tons and enrichment degrees up to 4 percent.

In case of a larger UF₆ leakage, steel container 1 then takes over the function of the UF₆ container until the complete emptying of the UF₆ present.

The withdrawal then takes place additionally or exclusively according to the case of the disturbance through valve 16 and line 20. Thus the steel container 1 is heated with steam by an outer tube register 14. This additional heating apparatus is imbedded in an insulat-

ing layer 18 for the purpose of heat insulation and uniform heat distribution. Steam enters tube register 14 from line 22 by way of valve 24. Compressed air for the pneumatic-electrical control of the valves 32 and 34 enters through line 30. The electrical connection between regulator 11 and valve 34 is indicated by dotted line 36 and the electrical connection between regulator 11 and control 10 is indicated by dotted line 38.

Water condensed from tube register 14 is withdrawn through valve 40 and line 42.

An overflow tube 44 is provided for water to leave condensate pot 9 and vapors in the condensate pot go to a washer (not shown) by way of conduit 48. A drain valve 50 is provided for the condensate pot.

In case of a UF₆ escape, the condensate will react according to the equation:



When in this way the pressure in the outer container 1 rises above the predetermined amount, it opens the safety valve 17 and discharges the excess pressure by way of line 52 to a wash tower.

The heating vessel can also be operated with other gaseous heating media than steam, as, for example, hot air. In order to guarantee a quick shutting down in the case of a UF₆ break out, the exiting air is led over a water bath that is equipped with a pH measuring apparatus and the shutting down accomplished in the above described manner.

In the above example, an evaporation equipment is described. An apparatus for safe handling of liquid UF₆ does not differ in principle from the described apparatus for withdrawal of gaseous UF₆.

Should a container be filled with liquid UF₆, there can be selected an equivalent to the illustrated arrange-

ment, if the container to be filled is first evacuated. In comparison, if liquid UF₆ is then withdrawn the valve of the inner container must be placed at the lowest point of the container bottom. Such an arrangement can be obtained if the apparatus depicted in horizontal position is tilted vertically.

By freezing of liquid UF₆, the container stands under excess pressure until the temperature goes below 56° C. In this case also the use of an additional outer container brings increased safety against UF₆ leakage. In such case, the outer container is impinged upon with a suitable cooling medium, for example, air.

What is claimed is:

1. A method for handling liquid and gaseous UF₆ under elevated pressure and for preventing leakage thereof into the atmosphere comprising: disposing the UF₆ in an inner container; surrounding the inner container with an outer pressure-resistant heat-insulating container; passing a condensible fluid heat exchange medium into the space between the containers; condensing the heat exchange medium on the exterior of the inner container; withdrawing the resulting condensate from the outer container; detecting the presence of UF₆ in the condensate by measuring the pH of the condensate; stopping the flow of heat exchange medium in response to the detection of UF₆ in the condensate; and withdrawing the leaked UF₆ from the outer container.

2. A method as in claim 1 wherein the heat exchange medium is steam.

3. A method as in claim 1 wherein leaked UF₆ is withdrawn from the outer container by withdrawing the condensate.

4. A method as in claim 1 wherein leaked UF₆ is withdrawn from the outer container by heating the outer container and venting the outer container.

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