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Schettler et al.

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[54] **FUEL ELEMENT STORAGE TANK FOR NUCLEAR POWER PLANTS**

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[52] **U.S. Cl.** ..... **220/85 R,** 250/108 R

[51] **Int. Cl.** **B65d 25/00**

[58] **Field of Search** ..... 220/85 R, 85 VR, 85 VS, 220/88 B, 45; 250/108 R, 108 WS, 106 R; 206/1 R

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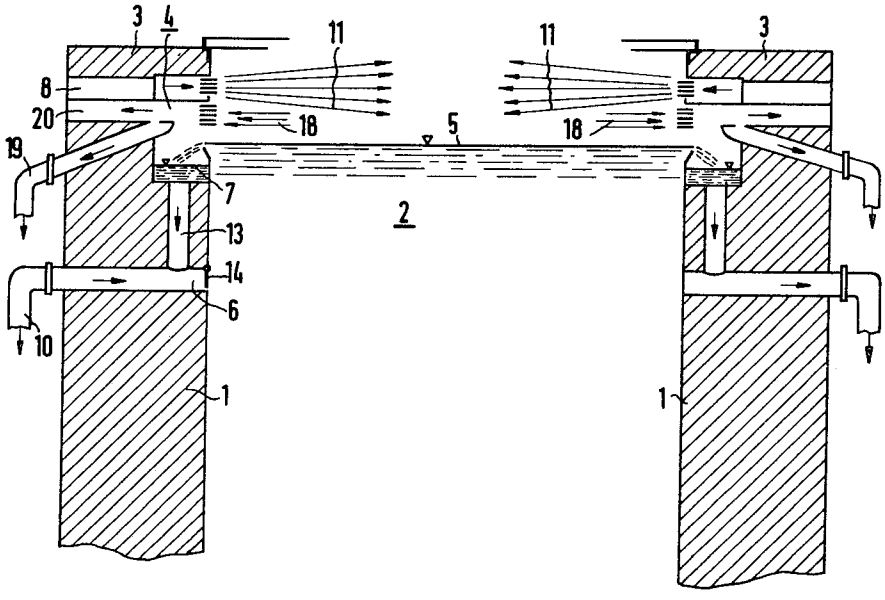
[57] **ABSTRACT**

To avoid the escape of radioactive aerosols from the water surface of a fuel element storage tank, a continuous overflow of the water is maintained together with an air curtain disposed closely above the water surface.

9 Claims, 2 Drawing Figures



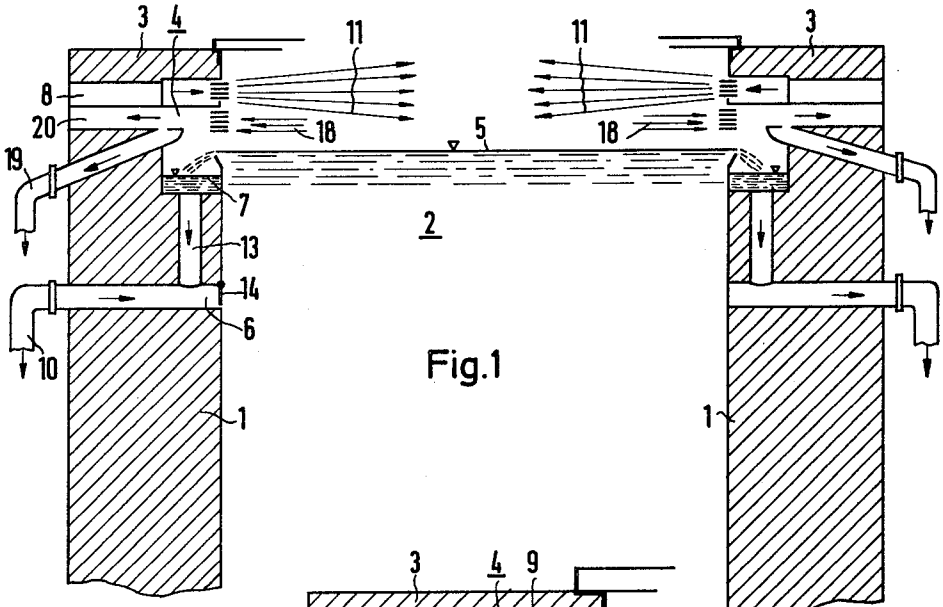

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Fig.1

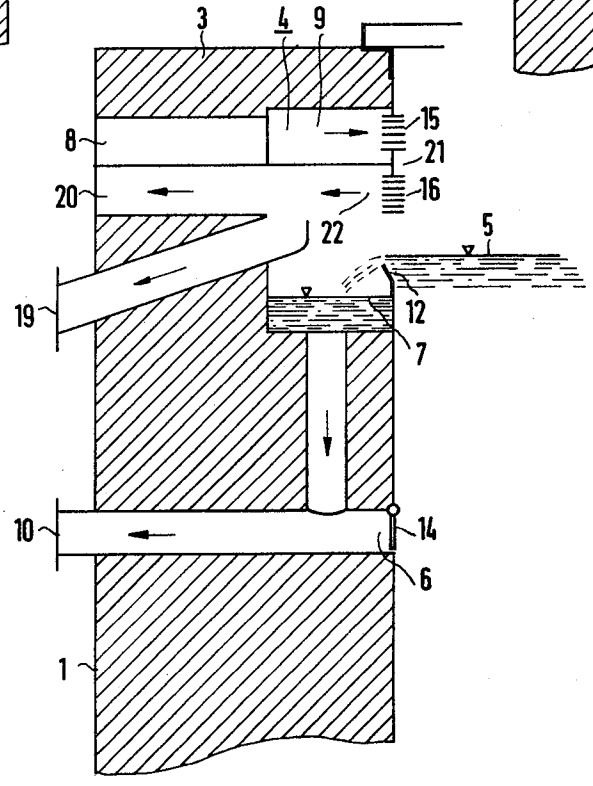
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Fig.2

FUEL ELEMENT STORAGE TANK FOR NUCLEAR POWER PLANTS

The invention relates to a water-filled tank containing fuel elements for nuclear power plants and, more particularly, to fuel element storage tanks or flooded reactor chambers wherein, according to the power of the reactor, the water is more or less intensely heated. With increasing water temperature, the amount of water evaporating from the storage tank increases so that the likelihood of an undesired escape of highly radioactive aerosol must be taken into account.

Attempts have been made to prevent or at least obstruct the escape of radioactive vapors and mists from fuel element storage tanks by placing covers above the water level. In this regard, both solid coverings in the form of foils, jalousies, etc. as well as liquids, which float on the surface of the water due to their relatively low specific weight have been proposed. However, the use of such coverings have the disadvantage that the accessibility of the fuel elements is impeded thereby and that, moreover, when inserting and removing the fuel elements, the respective coverings must be partly or entirely removed.

Consideration has also been given heretofore to providing air suction or similar pneumatic devices to intercept or capture escaping aerosols therewith and render them harmless. If such measures are to have the desired results, attention must be given to the fact that, due to the respectively strong suction, turbulent air currents are produced which cause the formation of waves or ripples on the water surface. This condition is disadvantageous in that the view from above through the water surface to the fuel elements reposing in the water is impeded or prevented. This presents a considerable disadvantage because the fuel element rods cannot therefore be reliably gripped without difficulty in order to remove them from te storage tank. Only when the surface of the water is calm can the location of the individual fuel elements be optically determinable without any trouble.

It is accordingly an object of the invention to provide fuel element storage tank for nuclear power plants which has relatively simple means for reliably preventing escape of radioactive aerosols from the tank.

It is a further object of the invention to provide such fuel element storage tank which avoids the disadvantages of the heretofore known storage tanks of this general type.

With the foregoing and other objects in view, there is provided, in accordance with the invention, fuel element storage tank for nuclear power plants comprising a walled structure enclosing a chamber for receiving water therein up to a given overflow level and having a crown at the top thereof defining an access opening to the chamber, water outlet means in the walled structure below the given water level, the water outlet means being connectible to the suction side of a circulatory pump, water overflow means provided at the water level in vicinity of the crown at least two opposite locations of the chamber, the water overflow means being also connectible to the suction side of the circulating pump and being continously operable for all conditions of the pump, and, also located in vicinity of the crown, first channel means for blowing air in flat sheets above the water level in given direction and second channel means for withdrawing spent air at the water level in direction opposite to the given direction so as to produce and maintain an air curtain over the water level of the water. When the storage tank is of rectangular shape, the water overflow means are located opposite one another along the entire breadth of the storage tank.

In accordance with another feature of the invention, the water outlet means includes suction conduits located far below the water level and having inlet openings communicating with the interior of the chamber means, the water overflow means being connected by connecting lines with the suction conduits.

In accordance with further features of the invention, the suction conduits are provided with means for retarding direct flow of the tank water, the flow retarding means being automatically variable and being in the form, for example, of pivotable flaps.

With respect to the air curtain to be maintained above the water level, in accordance with an additional feature of the invention, slit nozzles are provided for producing laminar currents of air in flat sheets over the water level from opposite sides of the storage tank. In substitution therefor or in addition thereto, there are provided, in accordance with the invention, baffles or guide plates which force the production of a laminar air current. The air currents in the form of flat sheets opposing one another meet substantially in the center of the storage tank above the water level whereat the suction action applied to the air becomes perceptible. Furthermore, in accordance with the invention, openings defined by baffles or guide plates are provided for sucking the air into the second channel means while markedly avoiding the formation of turbulence phenomena, and the air being sucked through the baffles travels substantially parallel to the overlying sheets of air being blown into the tank and in opposite direction thereto.

In an especially economical manner, all of the devices serving to limit or prevent the escape of radioactive aerosol, can be disposed in vicinity of the crown of the storage tank in a chamber or niche provided for the water overflow means or waterfall and simultaneously serving for containing the first channel means or air supply channels and the second channel means or air discharge channels. During all flow operations, the surface of the water remains calm without any wave motion so that a clear optical view of the fuel elements is continously afforded from above the storage tank.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described herein as embodied in fuel element storage tank for nuclear power plants, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages thereof will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing, in which:

FIG. 1 is a vertical sectional view of the fuel element storage tank for nuclear power stations constructed in accordance with the invention; a

FIG. 2 is an enlarged fragmentary view of FIG. 1.

Referring now to the drawing, there is shown in FIGS. 1 and 2, the upper part of a fuel element storage tank having a wall or walls 1 and filled with water 2. A niche or recess 8 is provided in the wall 1 in the vicinity of the tank crown 3 and is of such size as to provide adequate space therein for accommodating accessory equipment which, in accordance with the objective of the invention, prevents the escape of radioactive aerosols from the surface 5 of the water 2.

To cleanse and cool the water 2 contained in the storage tank, a continuous circulation of all the water 2 is conventionally employed for which purpose conduits 10 connected to the aspirating or suction side of a non-illustrated circulating pump are provided. In addition to the suction applied at the inlet openings 6 of the conduits 10, waterfalls 12 of the weir overflow type are provided connecting conduits 13 leading therefrom to the suction conduits 10. Part of the water in the storage tank thus runs as the respective waterfall 12 along a path through the conduit 13 to the suction line 10, while another part of the water is sucked into the respective line 10 through the inlet opening 6.

In order to ensure the maintenance of a waterfall 12 for all operating conditions of the non-illustrated circulating pump, suitable flow retarding devices are provided within the suction line 10 in the vicinity of the inlet opening 6. In the illustrated embodiment, the flow retarding devices are in the form of movable flaps 14 which are of such dimensions with respect to the specific gravity thereof that they thereby exert a controlling function and continually assure an adequate draw of water through the suction conduit 10 to the non-illustrated circulating pump without adversely effecting the waterflow 12 thereby. The water level 7 in the lower region of the niche 4 is always several centimeter lower than the respective level 5 of the water in the storage tank chamber proper.

In order to adjust the partial flow of water automatically, a different controlling flow retarding device other than the flap 14, can be provided. If disturbances occur, such as irregularities at the water level regulating device or, for example, when a pump is turned on and off due to unstable operation, assurance of a reliable water supply to the circulating pump at the suction side thereof is alway provided thereby.

It is also of importance in accordance with the invention that the suction and the water overflow take place at opposite sides of the storage tank, i.e., at both longitudinal sides, in the case of a rectangular storage tank, and if possible along the entire length thereof. If desired, a waterfall can be produced additionally at both narrow sides of the rectangular storage tank. When the storage tank is round, i.e., cylindrical, or oval, the waterfall can be provided around the entire inner periphery thereof. The discharge of surface water on at least opposite sides of the storage tank is advantageous inasmuch as a rising or buoyant flow of the water in the central region thereof within the storage tank takes place due to the heat development caused by the fuel elements, so that with a circulation of the water within the storage tank, one must expect that a rise or upward flow will occur in the center of the water and a downwardly directed flow at the outer wall or walls 1 of the storage tank. The water thereby flows, at the surface 5 thereof, from the center outwardly to the edge or edges of the storage tank chamber so that the suction through the overflow of the water surface 5 proceeds in the same flow direction. The water surface 5 thereby is maintained without any wave motion for all flow processes so that a clear optical view from above of the fuel elements in the storage tank is continually provided.

Furthermore, due to the withdrawal of the water at the surface 5 from at least two opposite sides of the storage tank, all floating substances present therein are removed in a very short time and filtered eventually through a non-illustrated water purifying system.

Simultaneously with the self-cleaning of the water surface 5 by overflow thereof on at least two opposite sides of the storage tank, means are also provided for producing a curtain of air above the water surface 5 by blowing air in laminar flow flatly over the water surface from at least two opposing sides of the storage tank. The air is supplied through conduits 8 into an upper region of the niche 4 where a respective air chamber 9 with suitable outlet nozzles or baffles (guide plates) 15 are provided in order to ensure a laminar flow of air therefrom. The initially tightly bunched together air current traveling in direction of the arrows 11 fans out only above the center of the storage tank in the region 17.

Simultaneously with the introduction of the air above the water level 5 through the nozzles or baffles 15, several centimeters therebeneath, the air is withdrawn from above the water level 5 through baffles 16, located laterally along the same length as the nozzles or baffles 15, and is exhausted through the air discharge channel 22 and the air discharge conduits 20. Due to the blocking or retarding action of the nozzles or baffles 15 in the vicinity of the air supply chamber 9, as well as guides or other devices 21 at the spent air discharge chamber 22, the discharging spent air is mainly withdrawn only from the center region 17 in direction of the arrows 18. As a result of the considerably greater range or radius of action of the blown out jet of air as compared to an air displacement produced only through suction action, it is possible to manage with exceptionally small quantities of air and low air pressures. Aerosol discharge into the room atmosphere is thereby virtually eliminated. By locating the air supply and discharge channels 9 and 22 together with the device of the tank overflow or waterwalls 12 as well as an emergency discharge line 19 in a common niche 4 formed in the crown 3 of the storage tank, a relatively simple embodiment of a storage tank can be produced which is economical both as to cost and as to the space occupied thereby.

We claim:

1. Fuel element storage tank for nuclear power plants comprising a walled structure enclosing a tank chamber for receiving water therein up to a given overlfow level and having a crown at the top thereof defining an access opening to said tank chamber, water outlet means in said walled structure below said given water level, said water outlet means being connectible to the suction side of a circulating pump, water overflow means provided at said water level in vicinity of said crown at at least two opposite locations of said tank chamber, said water overflow means being also connectible to the suction side of the circulating pump and being continuously operable for all conditions of the

pump, and, also located in vicinity of said crown, first channel means for blowing air in flat sheets above the water level in given direction and second channel means for withdrawing spent air at the water level in direction opposite to said given direction so as to produce and maintain an air curtain over the level of the water.

2. Fuel element storage tank according to claim 1 wherein said water outlet means includes suction conduits spaced downwardly from the water level and having inlet openings communicating with the interior of said tank chamber, said water overflow means being connected by connecting conduits to said suction conduits.

3. Fuel element storage tank according to claim 2, wherein said suction conduits are provided with means for retarding direct flow of the water in said tank chamber.

4. Fuel element storage tank according to claim 3 wherein said flow retarding means are automatically variable.

5. Fuel element storage tank according to claim 4 wherein said flow retarding means are in the form of pivotable flaps.

6. Fuel element storage tank according to claim 1 wherein niches are formed in said walled structure in vicinity of said crown thereof, said niches having means for receiving water therein from said water overflow means and including, respectively, a fresh air chamber for receiving therein the air being blown into said tank chamber and a spent air chamber for receiving therein the spent air being withdrawn from said tank chamber.

7. Fuel element storage tank according to claim 6 wherein said fresh air chamber is provided with outlet nozzles for producing an air flow directed in flat sheets above the level of the water in said tank chamber.

8. Fuel element storage tank according to claim 6 wherein said fresh air chamber is provided with baffled openings for producing an air flow directed in flat sheets above the level of the water in said tank chamber.

9. Fuel element storage tank according to claim 6 wherein said spent air chamber is provided with spent air inlet openings, and guide means for guiding the spent air through said spent air inlet openings while preventing the fresh air being blow into said tank chamber from being directly withdrawn through said spent air inlet openings.

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