Feb. 22, 1966 G. H. BILLUE 3,236,053

UNDERGROUND STORAGE AND DISPOSAL OF RADIOACTIVE PRODUCTS

Filed Oct. 9, 1959 2 Sheets-Sheet 1

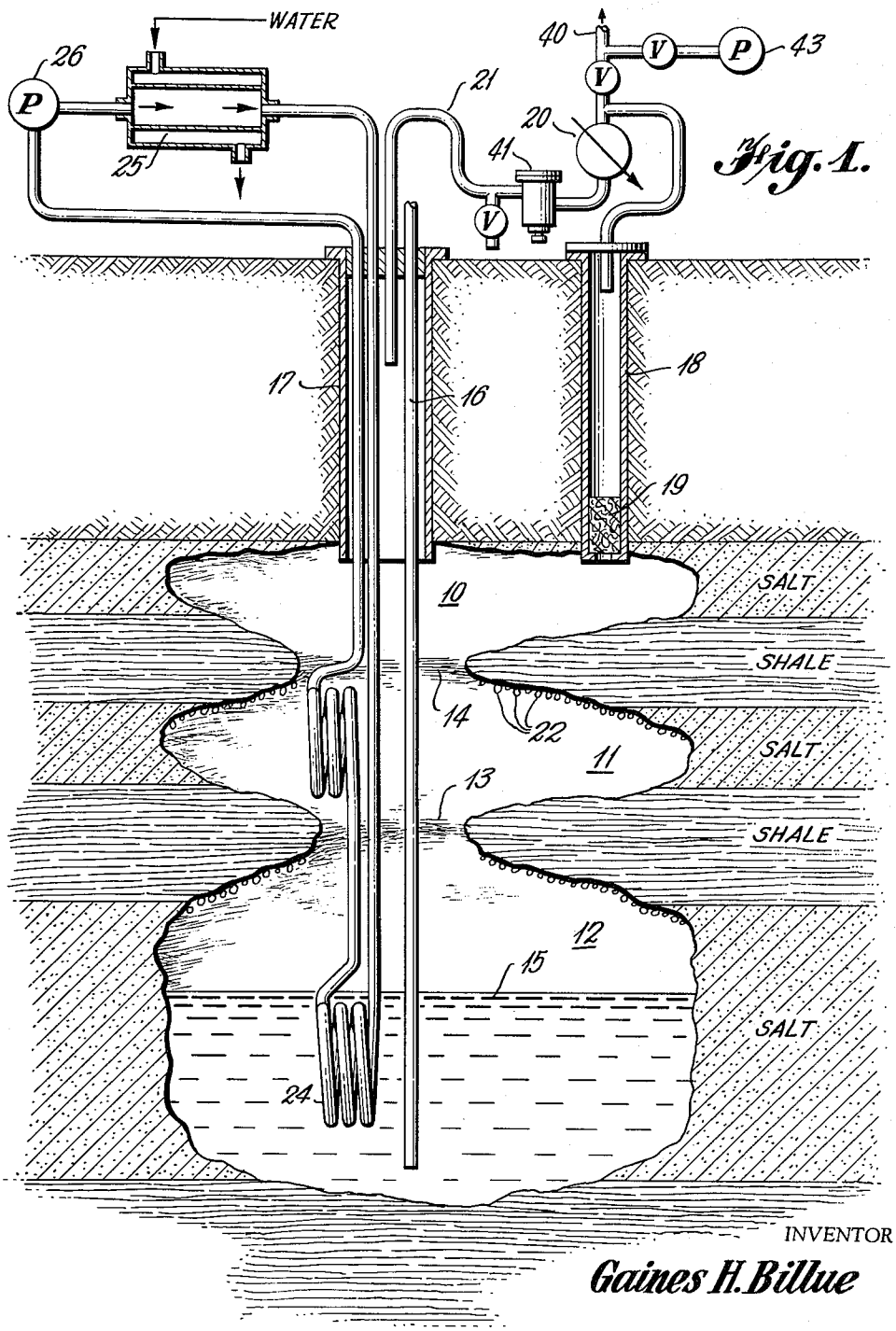

Fig. 1.

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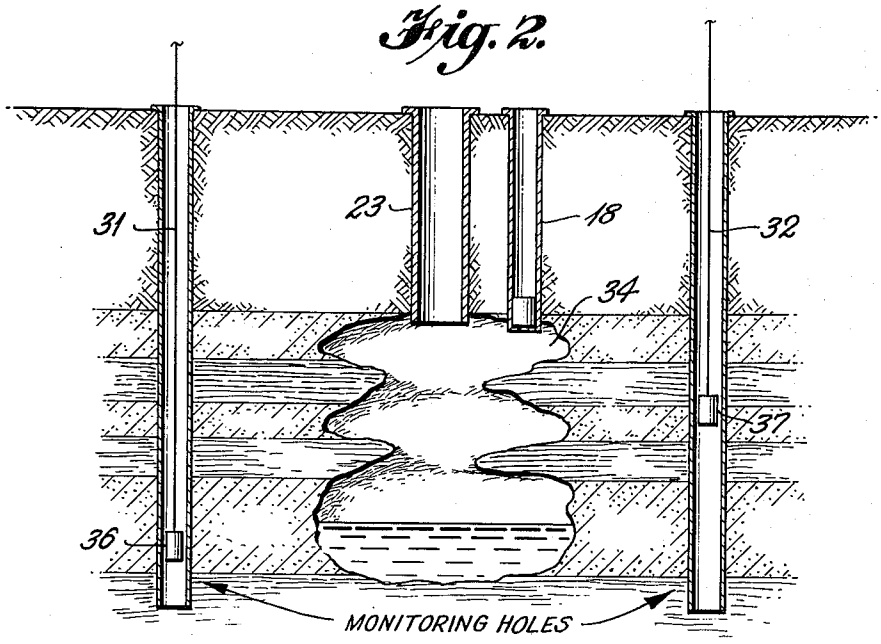
Fig. 2.



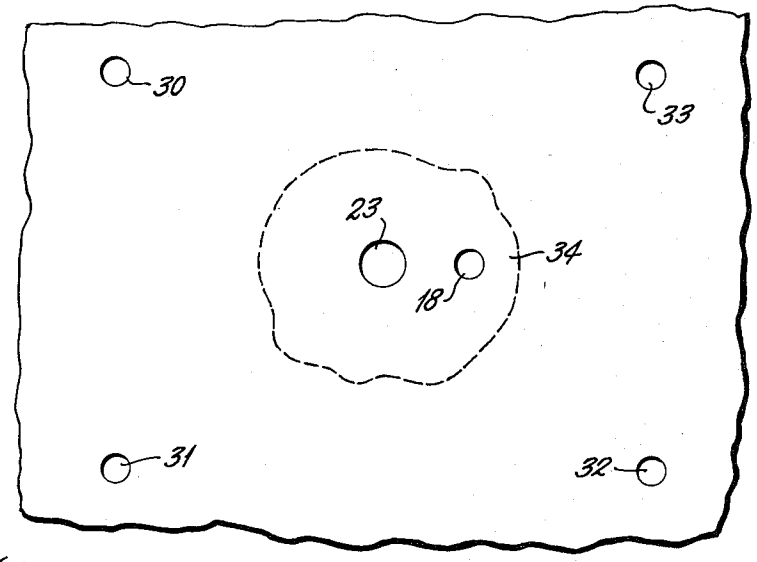


Fig. 3.

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UNDERGROUND STORAGE AND DISPOSAL OF RADIOACTIVE PRODUCTS

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17 Claims. (Cl. 61—.5)

This invention relates to the storage of radioactive materials, and more particularly relates to the storage of surplus products from chain reaction piles in spaces formed by leaching underground strata in which there are alternately present salt beds and layers of shale. The invention also pertains generally to all similar and related methods of underground storage of any type in which the storage space is produced in salt.

After the first operation of radioactive chain reactions under controlled conditions, there began a period of vastly increased interest and activity in the field of nuclear physics. This new era is characterized by a general ability on the part of industry to produce enormous amounts of various kinds of radioactive elements resulting either from fission or from the absorption of neutrons by otherwise inert substances. Accompanying this increased use of nuclear reactions is a corresponding increase in the surplus or waste radioactive products which are created and which must be either stored or disposed of. Unlike ordinary surplus products which can be stored in outdoor dumps, the surplus products from the operation of a nuclear pile are of an extremely dangerous nature and have several peculiar characteristics which make their permanent storage an industrial problem as well as a problem of public health and safety. In fact, the danger to the public would be greatly enhanced in the event the chain reaction products were scattered about indiscriminately, a phenomonon which may well occur if present storage facilities for radioactive waste materials were exposed to forces resulting from atomic bomb explosions, earthquakes or the like.

Existing methods for storing radioactive products involve the use of large thick-walled tanks lined with appropriate corrosion-resistant inner surfaces and provided with cooling means and with suitable radioactivity shielding. Such storage facilities are inadequate for the storage of radioactive wastes for at least two reasons. First, radioactive products emit a considerable amount of heat for a period of years (the longest lived waste product occurring in a high radioactive intensity has a half-life of 33 years), making stored radioactive materials a source of thermal power for an appreciable time. Second, the chemical nature of the stored material is such that the material will tend to break out of containers of ordinary construction. This is due to the fact that these radioactive solutions are relatively rich in nitric acid, and concrete (the most commonly used substance for the construction of the storage tank walls) is readily and rapidly attacked by nitric acid. Thus, in the event of a drastic shock, whether due to atomic bombs, earthquakes, or other natural or man-made occurrences, fractures in the inner walls of present storage tanks could easily develop, permitting the nitric acid to escape and come into contact with the concrete. Destruction of the concrete would remove the last portion of the artificially provided tank lining, permitting the dangerous solution to flow out to the surface of the earth, if the tank is above ground, or into contact with the rock structure or soil, if the tank is below the surface of the earth. The occurrence of such a breakdown of radioactive storage facilities would place in jeopardy the safety, health and welfare of the surrounding community.

It is, therefore, a principal object of the present invention to provide means for storing the presently unsought products of nuclear chain reaction piles in such manner

that the radiation which these products emit is not a source of danger to the public.

It is a further object of the present invention to provide a novel, simple, and efficient method for storing surplus radioactive products in which exhaustive provisions are made to insure the public health and safety and in which the probability of a public disaster occurring is materially reduced.

It is a still further object of the invention to provide means for safely and readily handling the vastly increased amount of radioactive products which are likely to be formed through the increased use of nuclear reactions in industry and elsewhere, and to store nuclear chain reaction products so that they cannot be disseminated by atomic bombs and cannot enter public water supplies or otherwise jeopardize the public health, welfare and safety.

It is a still further object of the invention to provide a technique for determining when a given storage location for radioactive materials has become defective, for removing the stored material from the defective storage location and transporting it to a new storage location with absolute safety, and for ensuring that the defective storage location will not become a source of public danger.

In accordance with the objects outlined above, a bore hole is drilled through alternate layers of salt and shale beneath the surface of the earth, portions of the salt layers or beds are leached away to form a plurality of chambers surrounding the bore hole, salt water is removed from the chambers, a neutralized radioactive solution is deposited in the bore hole in an amount such that the lowest chamber is only partially filled, the bore hole is sealed to prevent the escape of radioactive material therefrom, and any upwardly moving vapors are refluxed back to the bottom of the bore hole to prevent the escape of radioactive material from the bore hole.

Other objects, advantages, and characteristic features of the present invention will become readily apparent from the following detailed description of preferred embodiments of the invention when taken in conjunction with the appended drawings in which:

FIGURE 1 is a vertical section of the formations below the surface of the earth which shows the underground storage reservoir for radioactive products provided by the present invention;

FIG. 2 is a vertical section of the earth formations in the vicinity of the underground storage reservoir which illustrates the use of monitoring holes in the surrounding formations in order to test for radioactive leakage from the storage reservoir; and

FIGURE 3 is a plan view of the underground reservoir and the surrounding monitoring holes provided in accordance with the principles of the present invention.

Referring now to the drawings, and more particularly to FIGURE 1, there is shown a typical underground storage reservoir for radioactive products as contemplated by the present invention. The reservoir is produced by first drilling a bore hole through earth in which there are present alternate layers of soluble salt and unsoluble shale strata. A casing **17** is set in the upper portion of the bore hole and is cemented to the surface of the earth. Water is then introduced into the bore hole to remove portions of the salt layers and to thus form reservoir chambers **10**, **11** and **12**. The chambers **10**, **11** and **12** correspond with the regions that were initially occupied by the salt, and are vertically connected by undisturbed portions **13** and **14** of the original bore. The undisturbed portions correspond to layers of shale rock which of course are not attacked by the water used to dissolve the salt. It should be pointed out that although three chambers are illustrated in FIGURE 1, any other number may be used, the specific designation of three cham-

bers being merely for purposes of illustration and not limitation.

It may readily be seen from FIGURE 1 that the earth formations themselves serve as the walls of the underground storage reservoir. This affords greater security than would be possible if tanks having artificial walls were used because the relatively unlimited expanse of the natural earth walls possesses much greater thickness than artificial walls. Artificial tanks are susceptible of being broken because any feasible wall thickness is not immune from destruction throughout the course of time.

The present invention not only provides facilities for the underground storage of radioactive materials, but provides several additional features in order to afford absolute and complete security and safety. First, only enough radioactive solution is deposited in an underground storage reservoir to partly fill the lowest chamber that has been formed. As is shown in FIGURE 1, the radioactive solution is deposited in the bottom storage chamber **12** until it reaches the level **15**, which is well below the top of the chamber **12**. In addition to only partly filling the storage reservoir with the radioactive solution, another security feature of the invention involves mixing sodium hydroxide or other alkaline material with the radioactive solution before its introduction into the storage hole. The sodium hydroxide or other alkaline solution neutralizes any nitric acid contained in the radioactive solution, thereby preventing attack of the solution on metal fittings.

The radioactive material may be transported to the underground storage reservoirs by means of tank cars or other transportation media. If tank cars are used, the cars are only partially filled with the radioactive solution, with enough space remaining to contain that amount of sodium hydroxide or other alkaline solution required for neutralization purposes. The solution used to neutralize the nitric acid is commonly employed in petroleum refining and contains approximately 50 percent sodium hydroxide and 50 percent water by weight. Preferably, the neutralization is accomplished by introducing the proper amount of sodium hydroxide solution into the tank cars that have been partly filled with the radioactive solution. Since it may be necessary for the tank cars to travel for at least a while only partly filled, baffles may be provided in the tank cars to prevent excessive motion of the radioactive fluid therein.

The neutralized solution consisting of the reaction product of the radioactive solution and the sodium hydroxide or other alkaline reagent is transferred from the tank cars into the underground reservoir by means of a tube **16** which projects through the chambers into the bottom cavity **12**. In the event the tube **16** becomes contaminated, a wash-down with water is employed to remove the contamination. Successive wash-downs with small quantities of water may be employed, with draining intervals between the wash-downs being provided in order to allow any material adhering to the tube to reach the bottom of the reservoir. Acids and ethylene diamine tetraacetic acid sodium salt or other suitable substances may be used in the final cleaning of the pipes used in conveying the solution in accordance with established decontamination practices. This ensures that the pipes are safe for personnel above the ground. After all piping has been installed, all other outlets from the storage reservoir are properly plugged.

Another feature of the invention involves a refluxing principle which affords even greater security against the upward loss of any radioactive material. The radioactive solution present in the bottom of the reservoir will, at least initially, evolve steam due to the thermal effects resulting from the radioactive decay that inevitably takes place. The radioactive substances themselves, however, are not volatile but small amounts may be picked up and become entrained with the steam. The steam or water vapor that is constantly distilling upwardly is contacted by condensing vapor from the cooler upper portions of the reservoir, and this brings about a constant refluxing action which tends to prevent any radioactive substance that may be picked up or entrained with the distilling vapors from ever reaching the surface of the bore hole. These are shown as droplets **22** which form on the underneath sides of the shale ledges and then drop back into the radioactive mass.

In FIGURE 1 there is shown an auxiliary bore hole **18** which extends from the surface of the earth to the upper surface of the uppermost chamber **10**. A filter **19** of positive filter material is placed in the bottom of the bore hole **18** just above the chamber **10**, and a condenser **20** is located at the upper end of the bore **18**. A vent **40** is provided at the condenser inlet, and a trap **41** and drain **42** are located at the outlet of the condenser **20**. A tube **21** extends from the outlet of the condenser **20** into the reservoir so as to complete a closed loop refluxing system. The evolved steam flows from the upper chamber **10** through the filter **19**, where it is purified, up through the auxiliary bore hole **18**, and through the condenser **20** where it is condensed into liquid. Purified condensate may be dropped back into the remaining mass via the tube **21** for cooling. The inlet to the condenser **20** is also connected to a vacuum pump **43**, to allow the cavity to be operated at sub-atmospheric pressures, if desirable, to control the condensate temperatures within the cavity.

The underground storage reservoirs of the present invention may also be provided with cooling means, preferably in the form of a heat transfer system such as is commonly used in shipboard nuclear reactors. The cooling system comprises cooling coils **24**, preferably of stainless steel piping, located inside the reservoir and connected to a cooler **25** and a coolant circulating pump **26** located above the surface of the earth to form a closed coolant circulation loop. Liquid sodium may be employed as the coolant because it does not attack stainless steel or carbon steel and also because it remains in a liquid state over a wide temperature range (i.e., from about 200° to 1600° F.). In the event it is desired to lower the freezing temperature of the coolant to extend its useful range, an alloy of liquid sodium and potassium in the ratio of about 25% of sodium and 75% potassium, which flows freely at room temperature, may be employed.

In the event of a coolant pipe failure, sodium or other alkali material may escape into the stored radioactive solution at the bottom of the reservoir. This may result in the production of a large amount of heat and a very substantial hydrogen pressure due to the reaction

$$2M+2H_2O \rightarrow 2MOH+H_2+\Delta$$

resulting in a problem, the solution for which is discussed immediately below. The possibility of harm is prevented by properly choosing the total volume of the unfilled storage reservoir space so that it is well in excess of the maximum volume of hydrogen that could possibly be generated by all the sodium or other alkali metal that is contained in the entire closed coolant circulation loop. In addition, a well torpedo may be strategically positioned where in the event of emergency it would separate the portion of the coolant pipes below the failure point from that portion above the failure point. The portion of the coolant piping above the break is removed, and new coolant coils are established in the chamber immediately above the one in which the break occurred, since this chamber remains uncontaminated due to the refluxing action described above. The cooling thus provided in the chamber immediately above the break is sufficient to prevent the temperature of this chamber from becoming too great, and by condensing the steam in this chamber the passing of the steam further upward is prevented. Since the portion of coolant piping above the point of separation will not

be contaminated with radioactive material, it may be readily removed by conventional methods.

It should be pointed out that although sodium cooling means have been specifically mentioned, additional techniques may also be employed to maintain safe conditions in the underground storage reservoir. One saisfactory technique it to use a sufficiently large number of underground storage reservoirs so that by reason of its normal heat capacity the earth is able to absorb all the heat that is developed during the entire period in which the radioactive materials are present. The decision as to whether a larger number of storage holes with less individual loading with radioactive materials should be used or whether to place more radioactive material in the holes and provide cooling means for each storage reservoir is influenced by economic factors such as the cost of additional underground spaces on the one hand as opposed to the cost of the cooling system on the other.

The present invention also provides means for detecting when a given storage reservoir becomes defective. As is shown in FIGURES 2 and 3, a plurality of monioring holes **30**, **31**, **32** and **33** (four holes are shown merely for illustrative purposes) are provided in the vicinity of and surrounding a storage reservoir **34** of the type illustrated in more detail in FIGURE 1. These monitoring holes extend to a greater depth than do the storage reservoirs, and they are constantly monitored for radioactivity by means of Geiger counters or other suitable radioactivity detecting instruments **36** and **37** located in the borings **31** and **32** respectively (FIGURE 2). The vertical positions of the instruments in the monitoring holes may be varied so as to provide adequate monitoring through the entire depth of the storage reservoirs. Also, monitoring for radioactivity escape may be accomplished by circulating a gas or liquid through the monitoring holes **30**, **31**, **32** and **33**, and then testing the gas or liquid for radioactivity. The latter method is quite sensitive and provides good early warning means for radioactivity escape. Should any escape of radioactivity from the reservoir **34** be detected, cement or other highly viscous material may be immediately forced ino any escape channel which might be discovered. In the event of a gradual onset of low level radioactivity leakages, additional holes may be drilled, and the cement or other viscous material would be driven into such additional holes in order to plug up the channels of escape. Thus by detecting radioactivity leakage and by stopping any escape channels, an additional safeguard for the public health and safety is provided by the present invention. In addition, the monitoring holes may be used for circulating cooling water to transfer away heat developed in the storage well.

In the event any storage reservoir becomes unsuitable for any reason, such as the development of leakage, repeated accidents to fittings, etc., the present invention also provides a method for disposing of the material then being stored in the unsuitable reservoir and for ensuring that the unsuitable hole does not become a source of danger to the public. More specifically, the method includes removing the contents of the unsuitable storage hole and delivering them into more suitable underground storage caverns. For the purpose of this discussion it will be assumed that the storage hole which has become unsuitable is disqualified for a peculiar reason which is not expected for other similar storage reservoirs, and that there are suitable underground storage caverns within a reasonable distance of the one found to be unsuitable.

When the given storage reservoir becomes unsuitable, its contents are removed by means of a stainless steel pipeline. Before being put to use, the steel pipeline is thoroughly tested for leakage by running a pressure stream of a substance such as a dilution of tritium oxide of krypton 85 gas through the line, and using tracer techniques on portions of the soil in the vicinity of the pipeline to make sure that absolutely no material has escaped from the pipe.

Before the contents of the unsuitable storage cavern are removed, it may be necessary to introduce water into the unsuitable reservoir to dilute the contents or to dissolve any salt crust, in the event the contents of the reservoir become too dry. This dilution is preferably accomplished as follows: First, a small amount of water is introduced into the hole, after which any available fluid is pumped out of the hole. Then, an additional quantity of water is added, and the reservoir is pumped to the depletion of its available fluid. This procedure is repeated, successively continuing the cycles, until the radioactivity level has been lowered by a factor of at least a thousand from its original value.

A gas lift type pump, which employed compressed air as its working substance, is preferably employed to lift the radioactive solution from the unsuitable storage hole up to the ground level. Such pumps are especially suitable for transferring radioactive material because they may be operated with very low chances of failure. One reason for this is that these pumps do not have any valves or accurately machined moving parts. In addition, provisions are readily made for washing down or for otherwise removing any minor cloggings that may occur in the pump line. The compressed air which is employed as the working medium in the gas lift pumps is decontaminated by removing all mist from it. This is accomplished by using electrostatic precipitation, filtering, and if necessary, back wash with water. For added security, the decontaminated air is allowed to escape into the atmosphere only through a suitable sheet metal or other stack extending to an appropriate height above the landscape. By the above means, radioactive solution may be pumped from the unsuitable underground reservoir with a sufficiently high degree of safety as to be compatible with reasonable public policy in the handling of dangerous radioactive material. This procedure is made possible by the fact that radioactive substances in fuel rod products do not emit any appreciable radioactive vapors.

Having decreased the level of radioactivity in the unsuitable cavern by a factor of one thousand, the cavern may then be abandoned. Abandonment of faulty storage caverns will not be permitted until the radioactivity has been reduced to at least a fraction of a thousand below its normal storage value for reasons of public health and safety. Upon abandonment, the cavern is then completely filled with a cement which is unaffected by salt in order to prevent any subterranean movements of liquid material. Ordinary procedures for plugging up crevices and the like leading to the surface may then be employed, with no danger of an accident which will endanger public health and safety.

The gas lift pump arrangements used to pump the radioactive solution out of the storage holes are decontaminated by means of a backward circulation of liquids. One procedure which may be employed is to circulate the liquid cement, with which it is intended to fill the unsuitable cavern, through the gas lift pumps. The pumps, filled and surrounded by cement, may be left in the vertical reservoir borings in which they were originally placed.

Delivery to the new storage locations may be done by means of stainless steel pipes, which have been thoroughly tested as described above. After use for carrying radioactive material, the stainless steel piping is decontaminated, first with acid solutions and then with solutions containing sodium or other alkali metal salts of ethylene diamine tetraacetic acid or with solutions of 2-thenoyl trifluoro acetone or other appropriate decontaminating agents. The solutions of decontaminating agents are delivered through the pipes in small quantities, the pumping occurring from the original ingoing end through the pipe to the storage reservoirs to which delivery is being

made. A plurality of washings are used, with air or steam being blown through the line between successive washings in order to drain the pipes as completely as possible. After decontaminating the line to the greatest possible extent, it is stored in a warehouse properly marked for the keeping of low level radioactive material.

It should be pointed out that the transporting of material from an unsuitable cavern may also be carried out by means of tank cars as was described with reference to the transporting of the material to the underground reservoirs. The choice as to the means of transportation will, of course, depend upon the distance the material is to be moved.

If the reason for abandonment of an unsuitable storage reservoir was too high a concentration of radioactive material, resulting in an excessive heating which caused too much thermal expansion of the earth structure in the vicinity of the original cavity, the radioactive material is preferably first diluted before being delivered into a plurality of new storage reservoirs. An appropriate dilution factor would be selected in order to correct for the excessive loading which was a determining consideration leading to the abandonment of the first storage reservoir. If, on the other hand, the cause of the unsuitability of the first storage reservoir was a crevice or some peculiar feature in the terrain surrounding the storage cavity, geological controls and tracer techniques may be employed to determine the absence of similar crevices or faults in the new storage cavities before the radioactive material is delivered to the new storage holes. A number of tested and unfilled storage holes should always be maintained on a ready standby basis so that prompt removal of radioactive materials from unsuitable holes may be accomplished with a minimum of delay.

It should be pointed out that the above-described methods for the storage and disposal of radioactive materials have been developed with public health and safety as the prime consideration. This is accomplished by first attempting to ensure that any original cause or failure of storage means, highly improbable as it is, will not occur. Also, the public is further protected by additional safety provisions which supervene after such an improbable failure. The total probability that a given storage system will be secure is the product of the individual probabilities for non-failure of the original storage means and for the emergency provisions. For example, if the initial odds that a given storage reservoir will become unsuitable are one in a thousand, the probability that a succeeding emergency storage means will fail, if resorted to, will be even less because of the experience gained during the failure of the first storage cavern. Assuming, then, that the chance of failure of the auxiliary storage cavern is one in two thousand, the concurrent chance that both the first provision and the second provision will fail is less than one in two million. Even in the event that the extremely rare case (which may occur only one time in two million) should take place, the fact that extra, unfilled, tested holes are kept in reserve on a ready standby basis reduces the odds of danger to the public health and safety even more. This is because if a failure did occur in the second reservoir, that portion of the material which suffered such a failure would be immediately transferred to a further underground storage cavern or to a plurality of such caverns in the same manner as that which has been previously employed to transfer the material from the first to the second underground storage reservoir. Thus, the great advantage and utility to the above described storage techniques reside in the exhaustive provisions which have been made to ensure the public health and safety.

Although the present invention has been shown and described with reference to particular embodiments, nevertheless various changes and modifications obvious to those skilled in the art are deemed to be within the spirit, scope and contemplation of the invention.

What is claimed is:

1. A method for safely storing radioactive material comprising the steps of making a bore hole through alternating beds of salt and shale beneath the surface of the earth, leaching away portions of said salt beds to form a plurality of vertically spaced chambers about said bore hole and in communication therewith, removing salt water from said chambers, mixing a solution of radioactive material to be stored with alkali to neutralize any acid present in said solution, depositing the radioactive-alkali solution in at least one of said chambers, and sealing said bore hole to prevent the escape of radioactive material therefrom.

2. A method for safely storing radioactive material comprising the steps of making a bore hole through alternating strata of salt and shale beneath the surface of the earth, leaching away portions of said salt strata to form a plurality of vertically spaced chambers communicating with said bore hole, removing salt water from said chambers, depositing radioactive material in at least one of said chambers through said bore hole, sealing said bore hole to prevent the escape of radioactive material therefrom, and contacting upwardly moving vapors in said bore hole with refluxing condensate to further prevent the escape of radioactive material.

3. A method for safely storing radioactive material comprising the steps of making a bore hole through a plurality of salt layers separated by insoluble strata of salt and shale beneath the surface of the earth, leaching away portions of said salt layers to form a plurality of chambers communicating with said bore hole, removing salt water from said chambers, depositing radioactive material in at least one of said chambers through said bore hole, sealing said bore hole to prevent the escape of radioactive material therefrom, and carrying away heat evolved by said radioactive material.

4. The method of storing radioactive material as set forth in claim 3 in which said radioactive material is in solution and wherein there is added an alkali to neutralize any acid present in said solution.

5. A method for safely storing radioactive material comprising the steps of making a bore hole through alternate layers of salt and shale beneath the surface of the earth, leaching away portions of said salt layers to form a plurality of chambers communicating with said bore hole, removing salt water from said chambers, depositing radioactive material in at least one of said chambers through said bore hole, sealing said bore hole to prevent the escape of radioactive material therefrom, making a plurality of auxiliary borings in the vicinity of said bore hole, but not in communication therewith, monitoring said auxiliary borings for radioactivity escaping from said bore hole, and filling radioactivity escape channels with viscous material in the event an escape of radioactivity is detected.

6. A method for safely storing radioactive material comprising the steps of making a bore hole through layers of salt and separated by beds of shale beneath the surface of the earth, leaching away portions of said salt layers to form a plurality of chambers communicating with said bore hole, removing salt water from said chambers, depositing radioactive material in at least one of said chambers through said bore hole, sealing said hole to prevent the escape of radioactive material therefrom, detecting any escape of radioactivity, and in the event of an escape of radioactivity which cannot be readily corrected, removing the radioactive material from said bore hole and communicating chambers and depositing the removed radioactive material in another similarly constructed bore hole and communicating chambers.

7. A method according to claim 6 wherein water is added to the bore hole from which an escape of radioactivity was detected to dilute the radioactive material in said bore hole and communicating chambers before said radioactive material is removed.

8. A method according to claim 6 wherein the bore hole from which an escape of radioactive material was detected is filled with cement after enough radioactive material has been removed to reduce the level of radioactivity in said bore hole below a preselected level.

9. An underground reservoir for storing radioactive material comprising a plurality of chambers formed by the leaching away of salt layers in alternating beds of salt and shale, said chambers being vertically disposed with respect to each other and connected by a common bore, means for conveying radioactive material into said reservoir, means for sealing said reservoir to prevent the escape of radioactive material therefrom, and refluxing means for passing upwardly moving vapors in said reservoir in contact with refluxing condensate to further prevent the escape of radioactive material.

10. An underground reservoir for storing radioactive material according to claim 9 wherein said refluxing means includes filtering means and condensing means.

11. An arrangement for storing radioactive material comprising an underground storage reservoir, said reservoir comprising a bore hole, a plurality of chambers communicating with said bore hole and formed by leaching away of salt layers in alternating beds of salt and shale, said chambers being vertically disposed with respect to each other and separated by said beds of shale, means for conveying radio active material into the lowermost of said chambers, and means for sealing said reservoir to prevent the escape of radioactive material therefrom, said arrangement also comprising a plurality of auxiliary borings in the vicinity of said reservoir, and said auxiliary borings adapted to contain radioactivity detection means.

12. A method for safely storing radioactive material comprising the steps of making a bore hole into a layer of salt beneath the surface of the earth, leaching away a portion of said salt layer to form a cavity connected with said bore hole, removing salt water from said cavity, depositing radioactive material in said cavity, removing gases from said cavity to create a sub-atmospheric pressure therein, and sealing said bore hole to prevent the escape of radioactive material therefrom.

13. A method for safely storing radioactive material comprising the steps of making a bore hole through layers of salt and shale beneath the surface of the earth, leaching away portions of said salt layers to form a plurality of chambers adjacent to and communicating with said bore hole, removing salt water from said chambers, depositing radioactive material in at least of of said chambers, removing gases from said chambers to create a sub-atmospheric pressure therein, and sealing said bore hole to prevent the escape of radioactive material therefrom.

14. An underground reservoir for storing radioactive material comprising a plurality of chambers formed by the leaching away of salt layers in beds of salt and shale, said chambers being vertically disposed with respect to each other and connected by a common bore hole, means for maintaining a sub-atmospheric pressure in each of said chambers, means for conveying radioactive material into said reservoir, and means for sealing said reservoir to prevent the escape of radioactive material therefrom.

15. An underground reservoir for storing radioactive material comprising a plurality of chambers formed by the leaching away of salt layers in alternating beds of salt and shale, said chambers being vertically disposed with respect to each other and connected by a common bore, means for conveying radioactive material into said reservoir, means for sealing said reservoir to prevent the escape of radioactive material therefrom, and means for carrying away heat evolved by said radioactive material.

16. An underground reservoir for storing radioactive material comprising a plurality of chambers formed by the leaching away of salt layers in alternating beds of salt and shale, said chambers being vertically disposed with respect to each other and connected by a common bore, means for conveying radioactive material into said reservoir, wherein the lowest of said chambers is only partly filled with radioactive material, and means for sealing said reservoir to prevent the escape of radioactive material therefrom.

17. An underground reservoir in a formation comprising a plurality of salt layers with insoluble shale stratum therebetween for storing radioactive material comprising a bore hole penetrating said formation, a chamber in each salt layer adjacent to and communicating with said bore hole, said chambers being vertically disposed with respect to each other and separated by an intervening insoluble shale stratum, means for conveying radioactive material to the lowermost of said chambers, and means to seal said reservoir to prevent the escape of radioactive material.

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