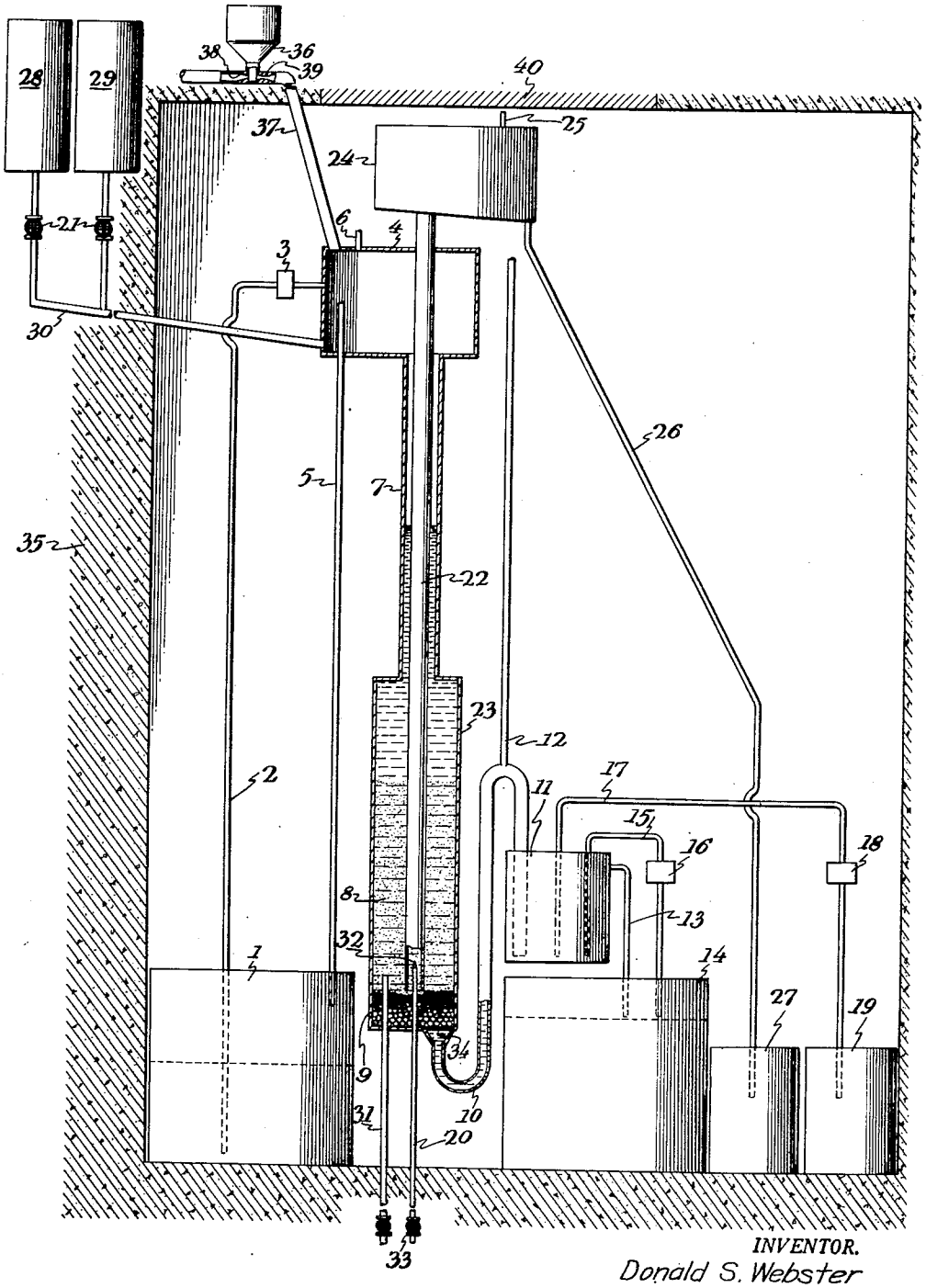
May 28, 1957 D. S. WEBSTER 2,793,753

REMOVAL OF MATERIAL FROM PROCESSING TANKS

Filed April 12, 1945



INVENTOR.
Donald S. Webster
BY
Robert A. Faverdin
ATTORNEY

United States Patent Office 2,793,753
Patented May 28, 1957

2,793,753

REMOVAL OF MATERIAL FROM PROCESSING TANKS

Donald S. Webster, Richland, Wash., assignor to the United States of America as represented by the United States Atomic Energy Commission

Application April 12, 1945, Serial No. 588,058

1 Claim. (Cl. 210—153)

The present invention relates to a procedure for the removal of radioactive materials, and more particularly it concerns the removal of radioactive substances from apparatus by remote control methods wherein such substances have been produced as a result of the fission of a uranium isotope by means of slow or thermal neutrons.

Removal of such radioactive substances involves certain difficulties peculiar thereto in that the entire apparatus is located within very massive shielding barriers and must be accomplished without the operators having close or even visual access to the equipment. Moreover, the nature of the processing equipment is such that heretofore known methods of removing solids from a processing tank are neither practical nor appropriate. This arises from the physical arrangement of the equipment within the shielding barriers; simple methods of slurrying the radioactive solids up out of the processing tank or vessel have not been found practical or possible. The present invention provides a way of removing the radioactive solids from the processing tank which overcomes the objections otherwise faced, which minimizes the need for close operator attention and observation and which obviates the need for a separate opening in the lower part of the processing tank for the removal of these solids. The objectives of the invention are achieved by the adaptation of a gas or vapor lift to the processing tank whereby the radioactive fission products remaining in the tank at the end of a processing run can be slurried and pumped upwardly out of the tank by means of the vapor lift. The vapor lift adapts itself very well to utilization in this combination and minimizes the difficulties attendant to the handling or removing of the radioactive material.

It is an object of the present invention to provide a safe, efficient, and easily operated method and apparatus for the disposal of radioactive fission products subsequent to the separation of plutonium therefrom.

It is a further object of this invention to provide a process wherein such fission products can be readily removed by remote control means through the use of a relatively simple and easily operated apparatus.

Another object of the invention is to provide a system for removing solid material, particularly radioactive fission fragments, from a chemical processing tank comprising means forming a vapor lift extending into the tank and means for admitting liquid and slurrying the material to facilitate its being pumped by the vapor lift.

Other objects of the present invention will be apparent as the description proceeds.

The present invention provides a method and apparatus for disposing of fission products after plutonium has been separated therefrom, which involves first contacting a solution containing said fission products and plutonium with a suitable adsorbent material, such as a base exchange resin, for example, Amberlite IR–1 which is a condensation product of a polyhydric phenol and formaldehyde having methylene sulfonic acid groups incorporated therein to increase the exchange at low pH. Thereafter, the resulting adsorbate is treated with an eluting agent that is substantially specific to plutonium whereby the latter is desorbed leaving the radioactive fission products remaining on the adsorbent. The latter, containing the aforesaid radioactive fission products, can be conveniently removed from the containing vessel by means of an air lift after which a fresh supply of adsorbent is introduced and additional solution containing fission products and plutonium treated as described. In this connection other inert gases, such as for example, nitrogen, carbon dioxide, and the like, may be used in place of air as a means of forcing the radioactive resin out of the containing vessel. The radioactive material thus removed may be conveyed to an underground vault or other suitable storage where it is permitted to remain until the intensity of the radioactivity has diminished to such an extent that those coming into contact therewith are not physically endangered by the handling thereof.

While the present invention is adapted to the removal of substantially any radioactive material carried on a suitable adsorbent therefor, it is particularly applicable to the removal and disposal of the radioactive fission products present in solutions of uranyl nitrate, prepared by dissolving neutron-irradiated uranium in nitric acid.

A preferred embodiment of the present invention, and which will be more completely understood by reference to the accompanying drawing involves first introducing a 10% aqueous solution of uranyl nitrate, containing plutonium and fission products, into head tank **4**, equipped with vent pipe **6** and overflow pipe **5**, from tank **1** through pipe **2** by means of steam jet **3**. From head tank **4** the solution is flowed downwardly through connecting pipe **7** into tower **23** containing base-exchange Amberlite resin IR–1, **8** supported on a filter comprising layer of stainless steel shot **9** having varying diameters of one-sixteenth, one-eighth and one-fourth inch supported on perforated stainless steel disc **34**. From tower **23** the solution of uranyl nitrate, now free from plutonium, flows through pipe **10** into catch tank **11** equipped with overflow pipe **13** and outlet pipe **15** to which is affixed steam jet **16** for transferring the liquid to a suitable container or waste tank **14**. The adsorbent **8**, containing the adsorbed UO_2^{++} ions and plutonium, in order to remove the UO_2^{++} ions, is washed with 0.25 MH_2SO_4 introduced from tank **28** outside of concrete wall **35** by means of valve **21** through pipe **30** into head tank **4** then into pipe **7** and tower **23**. The extract solution is caught in tank **11** and transferred to tank **14** by means shown. The adsorbent is next washed with 1.25 M sodium bisulfate contained in tank **29** and flowed as indicated for the sulfuric acid solution to recover the plutonium. This extract solution containing the plutonium is recovered in tank **11** and transferred by means of pipe **17** equipped with steam jet **18** to tank **19**.

As a result, the adsorbent is substantially free of plutonium and UO_2^{++} ions. However, it is contaminated with highly radioactive fission products which must be removed without endangering operating personnel. This object is accomplished by means of an air lift system which functions as follows, reference being made to the accompanying drawing: Water is introduced into pipe **7** and tower **23** from tank **1** through pipe **2** by means of steam jet **3** to a predetermined level in connecting pipe **7** depending on the height through which the liquid is discharged, this height generally being ⅓ to ½ of the distance of the overall lift. Air, or other suitable inert gas, is next passed upwardly through pipe **22** from pipe **20**, controlled by valve **33**, by means of foot **32**. As a result of the bubbling action, the density of the liquid contained in pipe **22** is reduced and forced in an upwardly direction by the liquid medium of greater density which surrounds and is in communication with the submerged end of pipe **22**. Under such conditions the adsorbent **8** forms a slurry

in vessel **23** and is forced upwardly through pipe **22** into tank **24** equipped with vent **25**, from which it flows downwardly through pipe **26** into container **27**. If desired, water may be admitted into the bottom of vessel **23** at a point just above shot layer **9** through pipe **31** for the purpose of producing a slurry with said adsorbent. Fresh adsorbent resin for a subsequent run is introduced from hopper **36** into pipe **37** where a slurry thereof is formed with the water entering from nozzle **38**. The stream of water coming from nozzle **38** strikes venturi **39** causing a partial vacuum in the line leading to hopper **36** thereby aiding in the feeding of the resin into pipe **37** from which the slurry is conducted into tank **4** and thereafter introduced into tank **23**. If desired, cover **40** may be removed and entry made into the interior of the concrete enclosure in order to repair the apparatus or for other purposes. Prior to entering said enclosure, however, it is necessary to wash out the apparatus, which is preferably constructed of stainless steel, with a solution capable of removing the radioactivity therefrom, such as for example, dilute solutions of nitric or hydrofluoric acids or mixtures thereof.

It will be apparent to those skilled in the art that the process and apparatus generally set forth above are susceptible of numerous modifications without departing from the scope of this invention. It is, therefore, to be strictly understood that any such modifications are regarded as lying within the scope thereof.

I claim:

Apparatus for processing a liquid material containing radioactive fission products, comprising an enclosure of radiation shielding material, an ion exchange reaction tower disposed vertically within said enclosure, filter means comprising metal shot forming a layer at the bottom of said column, a second layer formed of a solid absorbent material disposed directly above and supported by said bottom layer, said absorbent material being capable of absorbing radioactive fission products from a process liquid filtered therethrough, said tower having an opening near the top thereof for the entrance of the liquid material to be processed, and having an outlet at the bottom thereof for the removal of said liquid after processing, a hollow tube extending downwardly into said tower from the top thereof to a point adjacent the top of said filter means, an injector for admitting gas into the lower end of said tube, and a water pipe terminating in said layer of absorbent material at a point adjacent the end of said tube.

References Cited in the file of this patent

UNITED STATES PATENTS

660,946	Butler	Oct. 30, 1900
1,042,189	Beduwe	Oct. 22, 1912
1,316,507	Pollard	Sept. 16, 1919
1,444,921	Hunter	Feb. 13, 1923
1,512,561	Oliphant	Oct. 21, 1924