H. F. SMITH.

TANK.

APPLICATION FILED JAN. 17, 1918.

1,387,080. Patented Aug. 9, 1921.

2 SHEETS—SHEET 1.

Fig. 1.

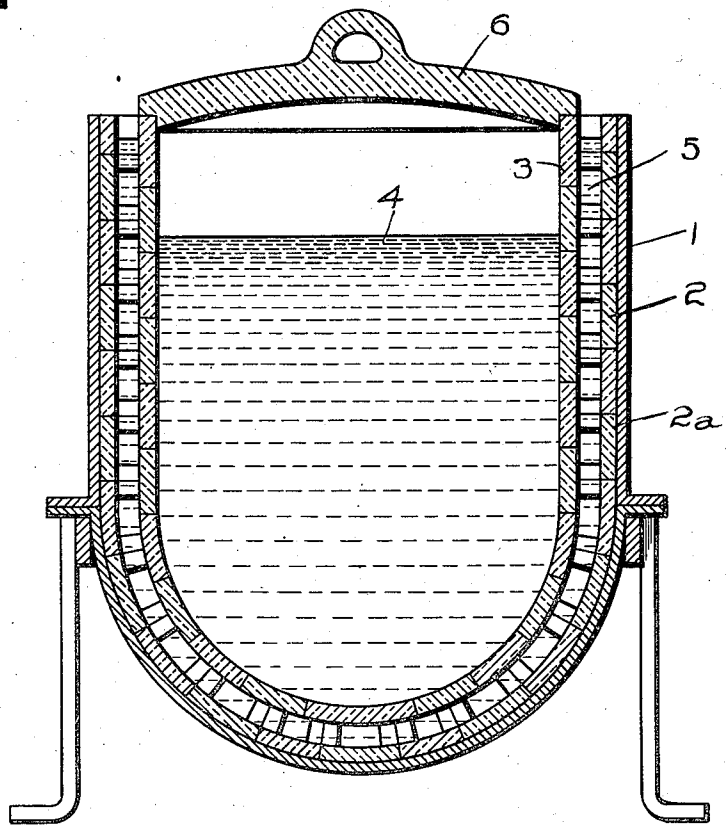
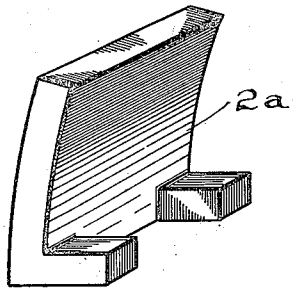


Fig. 2.



Witnesses.
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2 SHEETS—SHEET 2.

Fig. 4.

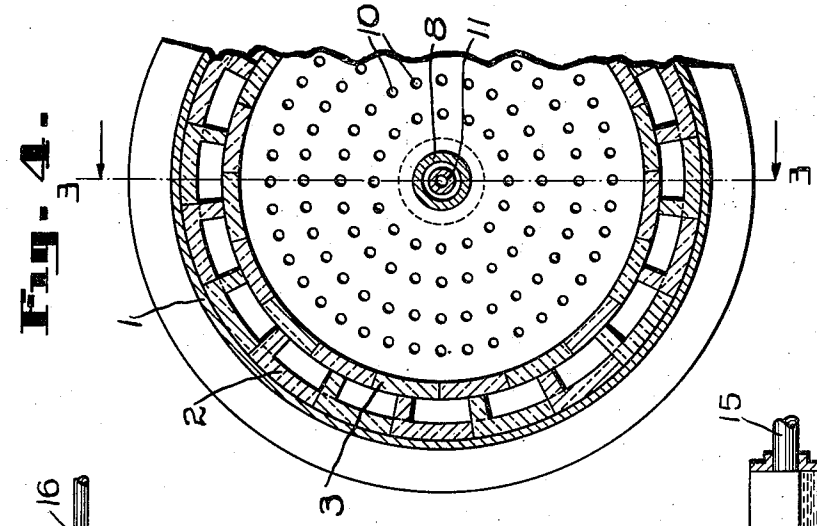
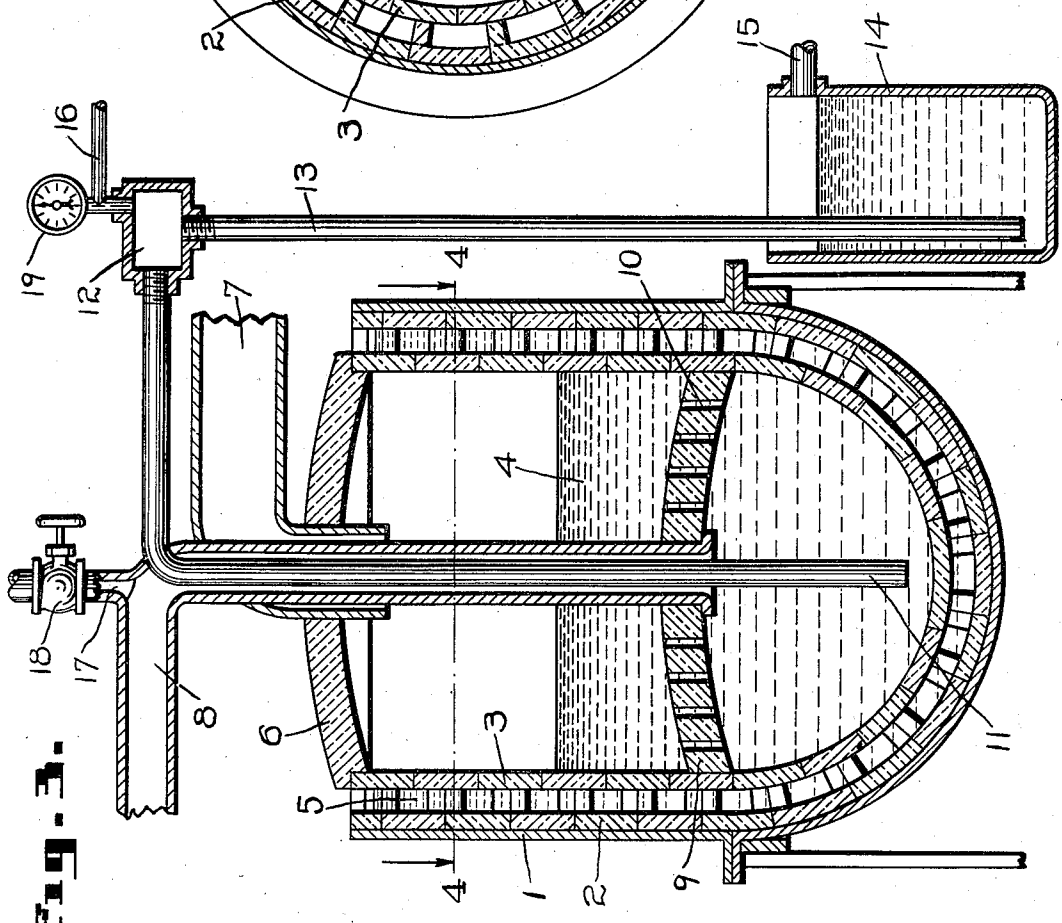


Fig. 3.



Witnesses.

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UNITED STATES PATENT OFFICE.

HARRY F. SMITH, OF LEXINGTON, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE GAS RESEARCH COMPANY, OF DAYTON, OHIO, A CORPORATION OF OHIO.

TANK.

1,387,080. Specification of Letters Patent. Patented Aug. 9, 1921.

Application filed January 17, 1918. Serial No. 212,330.

To all whom it may concern:

Be it known that I, HARRY F. SMITH, a citizen of the United States, residing at Lexington, in the county of Richland and State of Ohio, have invented certain new and useful Improvements in Tanks, of which the following is a full, clear, and exact description.

This invention relates to an improved form of tank and more particularly to a form of tank adapted for use in storing chemically active solutions or liquids.

The greatest difficulty in the storing of many chemically active substances is to secure storage vessels or tanks which are capable of resisting the action of these substances and are not too expensive to be commercially practicable. It is of course possible to find substances inert in the presence of any one solution, but many of these substances are so extremely expensive that it would be beyond the question to attempt to use them in a practical and commercial manner. This problem of finding a satisfactory means of storing chemically active liquids becomes very important in view of the fact that great quantities of the very active acids are used in numerous industries. Especially is this true where there is a desire to store such solutions as dilute sulfuric acid which act very readily upon most metals when in such dilute form.

It has been the general practice heretofore in storing such substances as dilute sulfuric acid to use a tank lined with lead. This is done because of lead being a substance unacted upon by the acids in general use. It is, however, evident that such a tank is defective when considered from a practical point of view. In the first place it is very expensive because of the high price of the lead used therein. In the second place it is objectionable in that, especially in large sized tanks, it is very difficult to absolutely prevent leaks in the lead lining. Obviously any defect in the lining which permits the solution therein to come in contact with the body of the tank will, unless the body of such tank is formed of a substance unacted upon by the solution therein, result in the formation of a salt of the acid to thus affect the condition of the solution while at the same time affecting the condition of the tank. In order to obviate the difficulty attendant upon the storage of chemically active compounds in lead lined tanks, it is a not unusual practice, therefore, to form the body of the tank of a substance which is itself inert in the presence of the solution to be stored therein. For instance in tanks adapted to hold dilute sulfuric acid, it is a quite usual practice to use a copper tank lined with lead. This is done because, among other reasons, the copper is not affected an appreciable amount by the action of any dilute sulfuric acid that may come in contact therewith. It is evident, however, that a tank composed of two metals such as lead and copper is even more expensive than one composed of iron and lead.

One object of the present invention, therefore, is to provide a tank capable of resisting chemical action in which the necessity for using high priced metals such as lead and copper is entirely obviated, but which is thoroughly effective and practicable, and at the same time quite simple and inexpensive of construction and of being maintained in repair.

Other objects and advantages of the invention will be apparent from the description set out below, taken in connection with the appended drawing.

For carrying my invention into effect I make use of apparatus similar to that disclosed in the drawing in which:

Figure 1 is a vertical section of a form of tank adapted for storage purposes;

Fig. 2 is one of the tiles forming the hollow lining 2;

Fig. 3 is a sectional view along the line 3—3 of Fig. 4 showing a form of tank embodying my invention adapted for acid absorption of a gas or liquid, and especially designed for ammonia absorption in sulfuric acid;

Fig. 4 is a sectional view along the line 4—4 of Fig. 3.

In the drawing, in which like characters of reference designate like parts throughout the several views thereof, 1 designates a tank which may be constructed of steel, iron or any other similar material. This part of the tank 1 may be made of any desired material and need not be chemically inactive inasmuch as none of the stored solution will

come in actual contact therewith, and it is merely necessary, therefore, that it have sufficient strength to form the body of the tank.

Extending throughout the inside of tank 1 is a lining 2 of hollow tile. This hollow tile should be of some material which will not readily disintegrate when subjected to the action of acids or of other chemical solutions. It is not intended that this tile should be normally subjected to the action of such a solution, but under extraordinary circumstances it may be. The spaces inside the lining 2 are so arranged as to communicate and together form a space substantially coextensive with the lining. In Fig. 2 is shown a form of tile 2^a that I consider quite satisfactory for forming the lining 2. As shown this tile is L-shaped in cross section, one leg of the L being curved to correspond to the curvature of the tank and the other being radial thereto and adapted to constitute a supporting means for the lining 3, mentioned below, and a spacing means for separating this lining from the curved portion of the tile lining 2. Extending through the spacing and supporting leg of the tile is a passage. When the tile is placed in position these passages connect the spaces inside the various rows of tiles in such manner as to constitute a single space practically co-extensive with the lining. Covering the inner surface of the lining 2 is a second lining 3, the tiles forming this lining being chemically inactive in the presence of the solution to be stored therein and being cemented in place with a cement likewise inactive. This lining 3 is made, so far as possible, impervious to the solution 4 contained in the tank.

The space inside the lining 2 is adapted to contain a liquid 5, the exact character of the liquid used being dependent upon the solution in the tank. The level of the liquid 5 is maintained at such a height with reference to the solution carried inside the tank that the inward pressure of such liquid at any point of the lining 3 is equal to or greater than the outward pressure of the solution in the tank at the same point. This being true it is evident that if for any untoward reason a leak should develop in the lining 3 thereof, a flow of liquid 5 through the leak into the tank rather than a flow of solution 4 from the tank outwardly through the lining 3 into the hollow tile lining 2 will ensue. Consequently if for any reason a leak should occur in the lining of the tank, no part of the solution in the tank will come in contact with the metal shell 1, and there can be, therefore, no contamination of the solution in the tank from the chemical compounds formed by the action of the solution upon the metal shell and no resulting deterioration of the tank because of such chemical action.

The liquid within the hollow lining 2 may be of any desired character and may be varied to suit particular conditions in view of the character of the solution in the tank. If desired ordinary water may be used as the liquid in the lining 2. So long as the height of this liquid is kept sufficiently great to cause a preponderating pressure inwardly of the tank, it is evident that any leaks that may develop will result in nothing further than a transfer of this water to the inside of the tank, with a corresponding dilution of the liquid therein if such liquid enters into solution with water. If for any reason the level of the water in the lining 2 falls so that the pressure from the inside out preponderates, it is evident that there will be a transfer of a part of the solution 4 into the lining 2. Such a condition, however, can be readily detected, inasmuch as this transfer would result in imparting to the water chemical characteristics corresponding to the solution in the tank, and by proper tests such condition could be readily determined. For instance, if the solution stored in the tank is an acid solution of some form, it is evident that leakage into the lining 2 would cause the water therein to become acid in reaction, and a simple litmus test or something analogous thereto would disclose this fact. If desired the lining 2 may be filled with a liquid which is adapted upon chemical contact with the solution in the tank to form an insoluble salt. For instance, if the solution in the tank is sulfuric acid, the liquid 5 might readily be a solution of a soluble calcium compound, which, upon contact with the acid in the tank, would form an insoluble calcium sulfate. The formation of such an insoluble compound, taking place as it would at the point where the leak existed, would tend to calk or clog the crack through which such leak was taking place, and thus automatically maintain the tightness of the lining 3. Obviously any suitable solution may be used in the lining 2, it being merely necessary where it is desired to secure this sealing action, in case of a leak developing, that the solution in the lining 2 be such a one as will cause the formation of a precipitate insoluble in the liquid in the tank, and therefore a precipitate which will effectively stop any leak so long as liquid of the same character remains in the tank. Or, if desired, a substance, such as heavy oil may be used in the lining 2. Where such is used and any leakage occurs permitting the flow of oil into the tank, the oil being lighter than the solution in the tank, will rise to the top thereof, and form a film over the surface of the liquid thus permitting a ready detection of the leakage. If an oil is used in the lining 2, it is evident that it can be used only when the solution in the tank will not react chemi-

cally with such oil, as otherwise there might be a very deleterious effect upon such solution. And it is also evident that where oil is used it must have a less specific gravity than the liquid in the tank.

If desired a top 6 may be used in connection with the tank, which may obviously be of any desired construction. As illustrated, however, this top is composed of material analogous to that constituting the lining 3 in order that it may be entirely inactive in the presence of any gases or fumes that may exist above the level of the liquid in the tank. I have shown this top as covering only the inner lining 3, thus allowing ready access to the liquid 5 in the hollow lining 2 in order that tests as to the character or condition of that liquid may be readily made. Obviously, however, this top may be made to completely cover the tank if this is considered desirable.

The form of tank illustrated in Fig. 1 and described above, is intended primarily for storage purposes. In Figs. 3 and 4 I have illustrated a tank embodying my invention which is especially adapted for an acid absorption process such as is in quite general use for recovering ammonia as a by-product, as from coal gases, or where it is synthetically manufactured. In this form of apparatus the tank itself is similar to that described above and illustrated in Fig. 1, merely having added thereto certain other structure necessary for carying out the absorption process. In such an absorption process the solution 4 ordinarily consists of dilute sulfuric acid. For filling the lining 2 I preferably use a solution containing a compound whose sulfate is insoluble; for example, a concentrated solution of calcium chlorid. Other suitable compounds may be used, the character of these compounds varying to accord with the solution 4 within the tank. It is evident that if any leakage occurs permitting an inflow of the solution within the lining 2 into the tank there will be a consequent precipitation of the corresponding sulfate, which will quickly stop such leak.

Opening through the top 6 is a pipe 7 through which the gases are led off from the tank after having passed through the absorbing medium. Also extending through the top 6 and within the outlet pipe 7 is an inlet pipe 8, the lower end of which extends below the surface of the absorbing liquid in the tank, adapted to lead into the tank the gases to be subjected to the action of the acid solution. Extending across the inside of the tank a substantial distance below the surface of the liquid carried therein, is an arch 9 composed of some acid proof material such, for instance, as the acid proof tile which constitutes the lining 3. The lower end of the pipe 8 extends through this arch and terminates adjacent the lower surface thereof. Extending through the arch are a number of perforations or passages 10. Any gas introduced through the pipe 8 will pass downwardly and issue therefrom at a point below the arch 9 where it will come into intimate contact with the acid solution. As the gas passes upwardly through the acid solution it must pass through the perforations 10 where it will be split up into fine streams and thus be thrown into even more intimate contact with the acid solution.

Extending upwardly from the extreme lower end of the tank is the pipe 11 for withdrawing therefrom suitable quantities of the solution 4. This pipe passes upwardly through the top of the tank, being located inside the pipe 8, and leads into a drum 12. Extending downwardly from the drum 12 is a pipe 13, the lower end of which opens into a vessel 14, having an outlet pipe 15 leading to a settling or evaporating tank, not shown, where the salts contained in the acid solution may be separated therefrom. Leading off from the drum 12 is a pipe 16 connected to an exhaust pump. In order to withdraw acid from the bottom of the tank, a partial vacuum is created in the drum. As a result liquid will be drawn into the pipe 11 from the tank and also into the pipe 13 from the vessel 14, but since the distance from the surface of the liquid in the vessel 14 to the drum 12 is greater than the distance from the surface of the solution in the tank to the drum, the acid solution will flow into the drum before the liquid from the receiving vessel 14. As a consequence a siphonic action will be induced removing the solution from the tank so long as reduced pressure is maintained in the drum. In this manner the neutralized acid in the tank may be readily withdrawn without the necessity for using any valves or of opening the tank to the atmosphere. The liquid thus withdrawn automatically causes a corresponding quantity to escape through the pipe 15 to the evaporating or settling apparatus. Opening through the pipe 8 at the top of the tank is an inlet pipe 17 controlled by means of a valve 18 adapted to supply fresh acid solution to the tank to take the place of that withdrawn. The necessity for interrupting operation of the apparatus when it is desired to remove a part of the saturated solution from the tank is thus obviated. Attached to the pipe connecting the drum 12 to the exhausting mechanism is a gage 19 to show the degree of vacuum in the drum.

In the actual operation of this device a continuous supply of gas will be passed into the tank and a continuous stream of neutralized acid solution withdrawn from the bottom of the recovery tank through the pipe 11. During such action the valve 18 will be

open and a stream of fresh acid introduced through the valve 18 just sufficient in quantity to take the place of the solution withdrawn. Inasmuch as the ammonium sulfate or analogous salt formed in the tank may be readily crystallized out, it can thus be easily separated from the acid withdrawn from the tank after which the remaining acid solution can be returned to the tank through the pipe 17 to be used again. While I have shown the form of tank illustrated in Figs. 3 and 4 as especially adapted for containing an acid solution to be used in the formation of ammonium salts, it is obvious that a tank of this character may be used for many other purposes. It is merely necessary that the lining 3 be composed of some material which is inactive with regard to the solution to be used therein, and that the liquid 5 be such as is not capable of forming a deleterious chemical compound when brought into intimate contact with the solution to be used therein. And the same applies equally well to the form of tank disclosed in Fig. 1 which is obviously capable of a wide range of use.

My invention is by no means limited to the precise structural details disclosed, inasmuch as numerous modifications might well be made therein without in any way departing from the spirit, or exceeding the scope, of my invention. For a true definition of my invention, therefore, reference should be had to the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. In a tank adapted to contain a chemically active material, a shell, a lining therein inert to the material to be used in said tank, and means intermediate the shell and lining for sealing any leaks in said lining.

2. In a tank adapted to contain a chemically active material, a shell, a lining therein inert to the material to be used in said tank, and sealing means intermediate the shell and lining adapted to co-act with the material in the tank to form a compound insoluble in such material.

3. In a tank adapted to contain a chemically active material, a shell, a lining of inert material therein, a hollow lining intermediate the shell and the first named lining, and a material in said hollow lining adapted to co-act with the material in the tank to form a compound insoluble therein.

4. In a tank adapted to contain a chemically active material, a shell, a lining of inert material therein, a hollow lining intermediate the shell and first named lining, and a sealing solution in said hollow lining the inward pressure of which at any point of the lining is greater than the outward pressure of the material in the tank at the same point, said sealing solution being adapted upon the formation of leaks in the first named lining to co-act with the material in the tank to form an insoluble precipitate at the point of such leak.

5. In a tank adapted to contain a chemically active material, a shell, a lining of inert material therein, a hollow lining intermediate the shell and first named lining, and a perforated arch in the tank intermediate the ends thereof.

6. In a tank adapted to contain a chemically active material, a shell, a lining of inert material therein, a hollow lining intermediate the shell and first named lining, a perforated arch in the tank intermediate the ends thereof, and an inlet pipe extending through and terminating below said arch.

7. In a tank adapted to contain a chemically active material, a shell; a lining of inert material therein; a hollow lining intermediate the shell and first-named lining; a perforated arch in the tank intermediate the ends thereof; an inlet pipe extending therethrough and terminating below said arch; and means for withdrawing material from the tank without interrupting the operation thereof.

8. In a tank adapted to contain a chemically active material, a shell; a lining of inert material therein; a hollow lining intermediate the shell and first-named lining; a perforated arch in the tank intermediate the ends thereof; means for introducing fresh material into said tank, comprising an inlet pipe extending through and terminating below said arch; and separate means for withdrawing material from the tank; said introducing means and withdrawing means each being adapted to function without interrupting the operation of the other and without interruping any operation going on within the tank.

9. A tank adapted to contain a chemically active material, comprising a perforated partition intermediate the top and bottom of said tank; an inlet pipe leading into said tank and passing through and terminating below the said partition; and a siphon, for removing material from said tank, the leg of the siphon within the tank terminating below said partition.

10. In a tank for containing chemically active materials, a shell, a lining therein inert to the material, and means intermediate the shell and lining capable of combining with any of the material that may leak through said lining to render such material innocuous with relation to the shell.

11. In a tank for chemically active materials, a shell, a lining therein inert to the material, and fluent means intermediate the shell and lining capable of reacting with the material to form a compound inactive with respect to the shell.

12. A tank adapted to contain a chemically active material, comprising a perforated partition therein dividing the tank into

upper and lower zones, the upper zone being adapted to contain principally fresh liquid introduced into the tank and the lower zone to contain spent liquid to be removed from the tank; and a siphon for removing such spent liquid, the leg of the siphon within the tank extending through and terminating below said partition.

13. A tank adapted to contain a chemically active material, comprising a perforated partition therein intermediate the top and bottom of said tank; an inlet pipe leading into said tank and terminating below the said partition; an outlet pipe leading off from said tank and terminating below said partition, a drum in said outlet pipe having means coöperating therewith for lowering the pressure therein, said drum and outlet pipe upon such lowering of the pressure constituting in effect a siphon for withdrawing liquid from the tank.

14. In a tank adapted to contain a chemically active material, a shell; a lining therein inert to the material to be used in said tank; a hollow lining intermediate the shell and said first-named lining; and a top for said tank; the tank and top being so constructed as to leave the space within said hollow lining at all times open to the outside, whereby ready access may be at all times had to the space within said hollow lining to permit of ready inspection or test of fluid therein.

In testimony whereof I affix my signature.

HARRY F. SMITH.