Aug. 19, 1952 W. G. SEE 2,607,661

APPARATUS FOR CONCENTRATING ACIDS

Filed April 9, 1946

FIG. 1

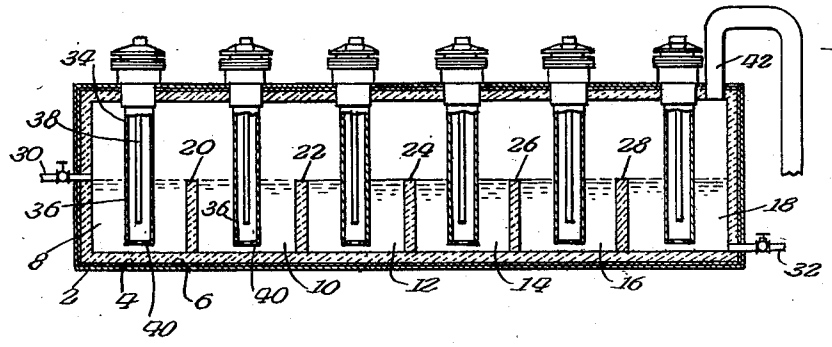


FIG. 2

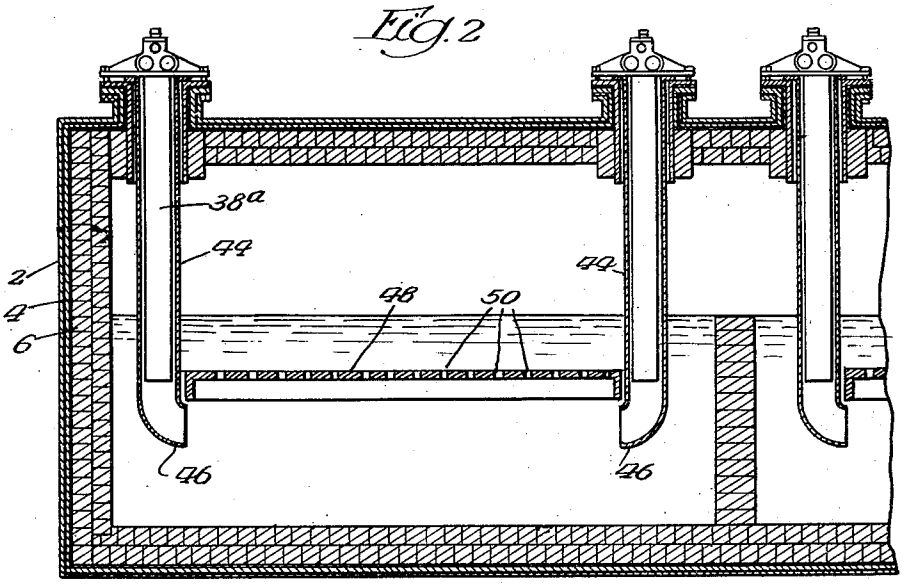


FIG. 3

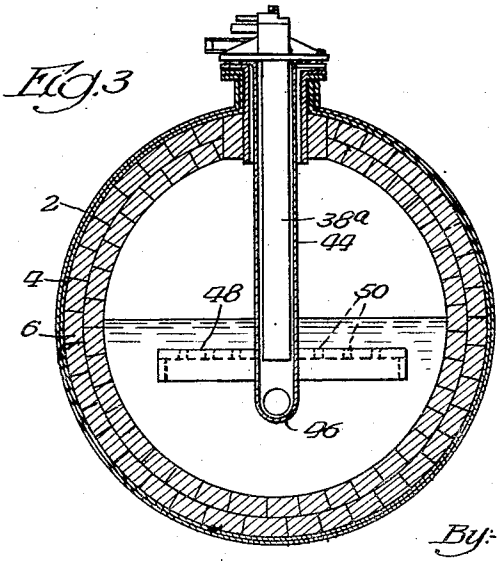
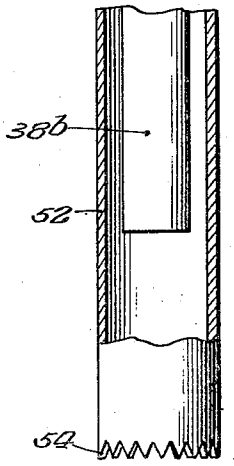


FIG. 4



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APPARATUS FOR CONCENTRATING ACIDS

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2 Claims. (Cl. 23—275)

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This invention relates in general to an improved apparatus and method for concentrating liquids, for example, dilute acids, or for recovering concentrated acids containing contaminants. More specifically, the invention relates to the concentration of dilute acids by means of submerged combustion.

It has been found that the use of submerged combustion burners to heat the dilute acid in a tank is much more efficient than former methods used for accomplishing the same result. Submerged combustion burners have been used primarily for other purposes such as in heating tanks, for example, hot water tanks, or for heating pickling baths. Burners for such uses have been disclosed in Patent Number 2,118,479 to Theodore S. See et al. However, when submerged combustion burners are used for purposes of recovering or concentrating acids it has been determined to be advisable to use modified forms of burners and a plurality of chambers containing progressively concentrated acid, with a burner in each chamber. The operation of such burners as are disclosed herein is conventional.

One of the principal objects of the present invention is to provide an apparatus in which a dilute or less concentrated liquid can be passed into one portion thereof and a more concentrated liquid can be withdrawn at another portion thereof.

Another object of the invention is to provide a tank having a plurality of connecting chambers therein, each of which chamber contains an acid of progressively increasing concentration and in which the dilute acid can be added to the first chamber and the concentrated acid withdrawn from the last chamber.

A further object of the invention is the provision of a tank divided into a plurality of chambers wherein each chamber is provided with a submerged combustion burner for heating the acid contained in each chamber by passing the combustion gases through the acid and vaporizing some of the water or driving off the contaminants contained therein, thus leaving a more concentrated acid.

A still further object of the invention is to provide a new and improved method for concentrating acids.

Still another object is to provide an improved method of concentrating dilute acids by utilizing the combustion gases of a submerged combustion burner.

Other objects and advantages of the invention will be apparent by reference to the following

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description in conjunction with the accompanying drawing in which:

Fig. 1 is a longitudinal section through the concentrator or tank used in concentrating the dilute acid;

Fig. 2 is a somewhat enlarged fragmentary vertical section through a concentrator having a modified form of submerged combustion means;

Fig. 3 is a vertical transverse section through the apparatus of Fig. 2, and

Fig. 4 is a further modification of the submerged combustion burner.

In all forms of the invention I provide a tank which is divided into a plurality of connecting chambers to enable the acid to pass progressively from one chamber to the next. In each chamber I provide a submerged combustion burner adapted to be ignited whereby the combustion gases will pass through the acid to provide an efficient heat exchange, thus heating the acid and vaporizing some of the water or volatilizing the contaminants herein to produce a more concentrated acid.

In one form of burner I provide an inturned flange at the lower end thereof which has certain advantages which will be more fully described hereinafter. Another form of the invention utilizes two such burners so arranged as to distribute the combustion gases below a perforated plate, and a still further form contemplates the usage of a serrated lower edge on the outer casing of the burner.

While the invention described herein has particular reference to merely concentrating a dilute acid, it will be understood that the apparatus and process are equally applicable for use in recovering concentrated acids containing contaminants.

Referring now more particularly to the drawing, it will be seen that in Fig. 1 an elongated tank is provided having an outer steel covering 2 within which a lining 4 is located which may preferably be formed of lead. As an additional protection, a lining of acid resistant brick 6 may also be provided within the lead lining.

The tank, as shown, is divided into chambers 8, 10, 12, 14, 16, and 18, by means of the partitions 20, 22, 24, 26 and 28. An inlet conduit 30 extends through one end of the tank into the first chamber 8 and permits dilute acid or other liquid to pass therein. At the opposite end of the tank a conduit 32 is provided for drawing off the concentrated liquid. When the apparatus is in use each of the chambers 8 through 18 has a body of acid located therein, each body being of a progressively higher concentration so that when

the apparatus is in continuous operation, the dilute acid passes into chamber 8 and the concentrated acid is drawn off from the last chamber 18.

In each chamber a submerged combustion burner 34 is located which comprises an outer casing 36 and an inner tubular member 38. The The combustible mixture of gas and air may be either pre-mixed and passed downwardly through the inner member 38 or only the gas may be passed therethrough, with additional means therein for supplying air. This type of submerged combustion burner is conventional, as disclosed in the above referred to See patent, and, for the purposes of this invention, it makes no difference whether or not the gas and air are pre-mixed. In either event, combustion takes place at the lower end of the inner tubular member 38, where a suitable burner plate is located.

In the form of the invention shown in Fig. 1 it will be noted that the lower end of each of the outer casings 36 has an inturned flange 40. The purpose of this is to build up a certain amount of back pressure which will aid the combustion and insure the continuity thereof. Each of the partitions 20 through 28 extend upwardly and terminate at substantially the level of the acid so that there will be a continuous flow of acid from one chamber to the next.

During operation of the apparatus as shown in Fig. 1 the combustion gases from each of the submerged combustion burners will pass outwardly through the acid thus agitating the acid and raising the temperature thereof to a point which will either vaporize any water in the acid or volatilize the contaminants therein or both. Thus, as the dilute acid passes into the first chamber 8 it will be subjected to the action of a stream of combustion gases produced by the action of the submerged combustion burner therein. After a certain amount of vaporization and volatilization has taken place, the resulting acid will have a higher concentration as it passes into the next succeeding chamber 10. The same action takes place simultaneously in each of the chambers so that each succeeding chamber will contain acid of progressively increasing concentration. The last chamber 18 is provided with an upwardly extending flue 42 through the roof of the tank, which carries the vapors away from the tank to be disposed of in any desired manner.

In the modification shown in Fig. 2 the same form of tank is used and is similarly divided into a plurality of chambers, each containing acid of progressively increasing concentration. The main difference is in the construction of the submerged combustion means.

Again, the function and operation of the submerged combustion burner is conventional, as explained above, except that a perforated plate is used in conjunction with one or more burners. In the form shown, two of such burners are located in each chamber and the outer casing 44 of each burner extending beyond the inner casing 38*a* is turned inwardly toward the other at the lower end thereof as at 46. The inner tubular member 38*a* is similar to the member 38. Substantially centrally located in each chamber is a horizontally extending plate 48, made of acid resistant material, such as graphite, and has a plurality of openings 50 therein. As the combustion gases leave the outer casing they will be directed inwardly and beneath the plate 48 immediately thereabove, and will pass upwardly through the openings 50. This form of the invention is designed to increase agitation of the acid and provides excellent heat exchange qualities. If desired, however, only one such burner need be used in the center of the plate to direct the gases outwardly therebelow. The function of the burners, however, is the same as explained above with respect to the form of the invention shown in Fig. 1, and provides an improved apparatus and method for concentrating dilute acids.

Fig. 4 shows a still further modified form of the submerged combustion burner wherein the inner member 38*b* is also similar to the member 38, but the lower end of the outer tubular member 52 is serrated as at 54. This serrated lower edge is so designed as to break up and permit even distribution of the combustion gases as they leave the lower end of the outer casing to be passed through and agitate the acid within the chamber.

If desired, the space within the burner and between the inner tubular member 38, and the outer casing 36 can be utilized for the addition of chemicals for specific purposes.

While I have described my invention herein, for the most part, as relating to the concentrating of acids, it is to be understood that the apparatus and method can be used for the concentration of any suitable liquid.

From the foregoing it will be evident that I have provided new and novel apparatus and method for the use of submerged combustion burners in the concentration of dilute acids. It will also be clear that certain changes may be made in the form and construction of the apparatus disclosed herein by those skilled in the art without in any way departing from the spirit of the invention or sacrificing any of the attendant advantages thereof.

Having thus described my invention what I claim as new and desire to secure by Letters Patent of the United States is:

1. An apparatus for concentrating dilute acids comprising a plurality of intercommunicating chambers connected in series and adapted to contain acid to be concentrated, means for continuously passing dilute acid into the first of said chambers, means for continuously withdrawing concentrated acid from the last of said chambers, a plurality of tubular submerged combustion burners spaced in each of said chambers, the discharge ends of said burners being directed inwardly of their respective chamber and toward each other, and a submerged perforated plate extending horizontally above the bottom of each chamber and immediately above and overlying the discharge ends of the burners therein, whereby to distribute the combustion gases through said acid and vaporize a portion of the water therefrom.

2. An apparatus for concentrating dilute acids comprising a plurality of intercommunicating chambers connected in series and adapted to contain acid to be concentrated, means for continuously passing dilute acid into the first of said chambers, means for continuously withdrawing concentrated acid from the last of said chambers, a plurality of tubular submerged combustion burners depending in spaced relation in each chamber, each of said burners including spaced inner and outer tubular members adapted to mix and pass a combustible mixture therethrough and having the outer tubular member extending beyond the inner member and turned inwardly of the respective chamber, and a sub-

merged perforated plate extending centrally and horizontally of each chamber above the bottom thereof, the inturned ends of said burners being located immediately below and adjacent the marginal portion of said submerged plate, whereby to distribute the combustion gases through said acid and vaporize a portion of the water therefrom.

WALTER G. SEE.

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