Sept. 4, 1945. C. TIETIG 2,383,946

METHOD AND APPARATUS FOR FLUID CONTACT

Filed Oct. 9, 1941 2 Sheets-Sheet 1

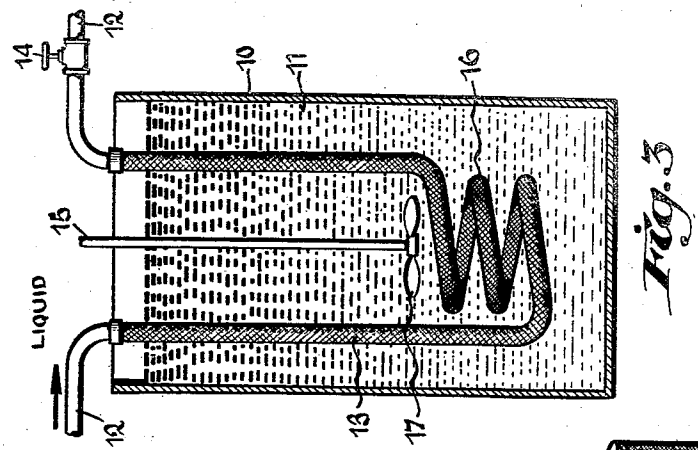


Fig. 3

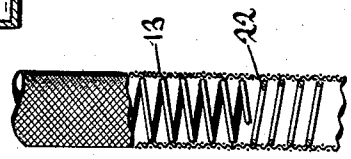


Fig. 5

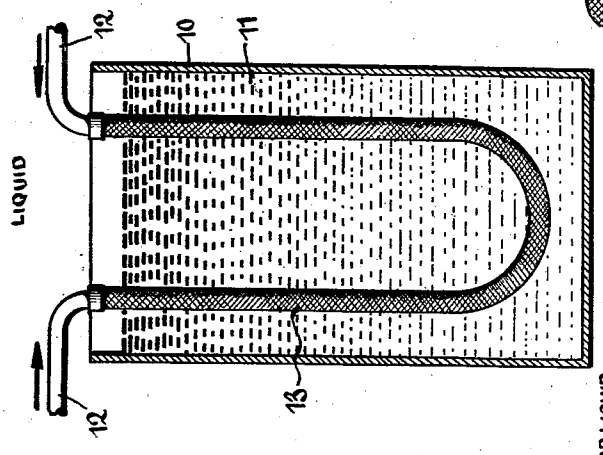


Fig. 2

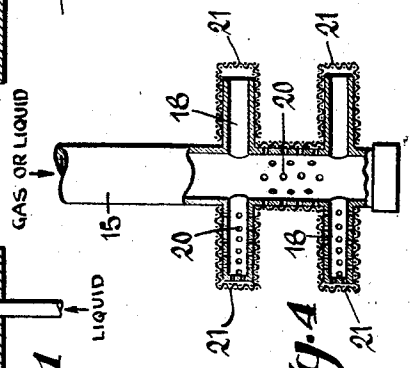


Fig. 4

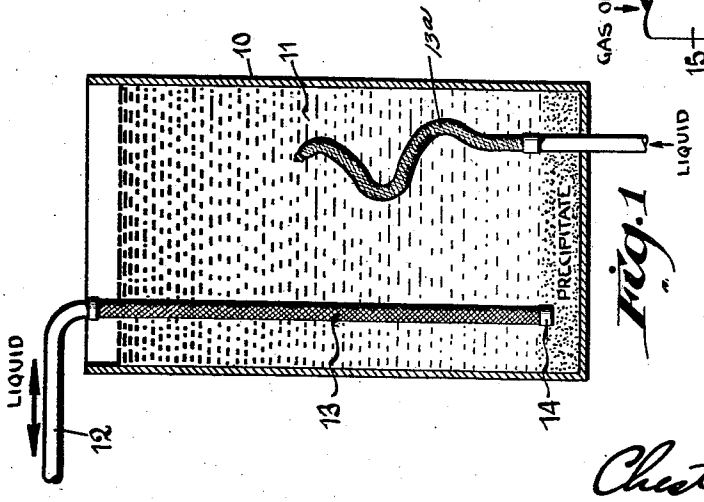


Fig. 1

INVENTOR.

Chester Tietig

Sept. 4, 1945. C. TIETIG 2,383,946

METHOD AND APPARATUS FOR FLUID CONTACT

Filed Oct. 9, 1941 2 Sheets-Sheet 2

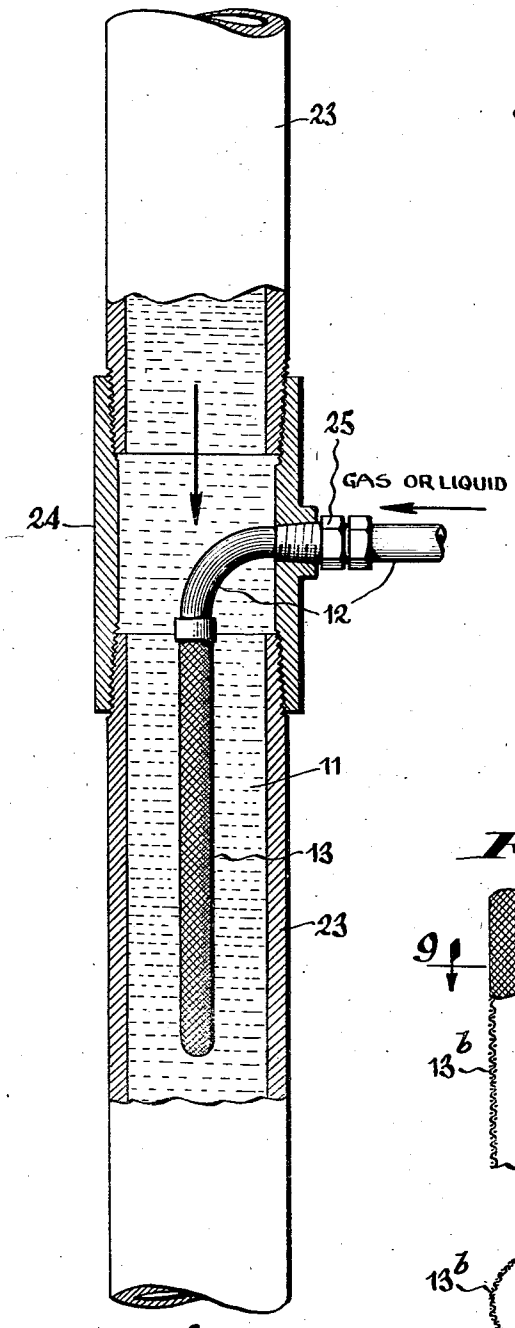


Fig. 6

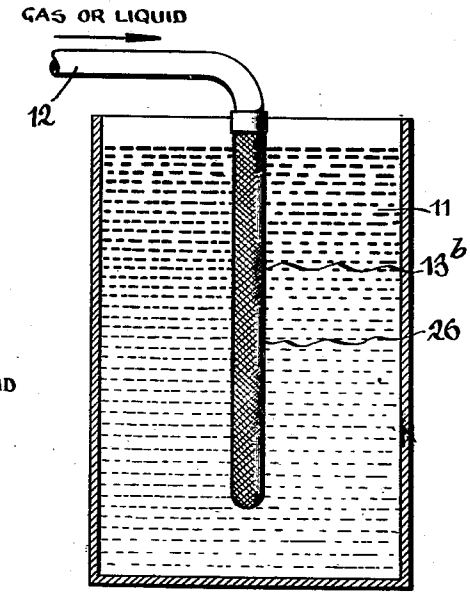
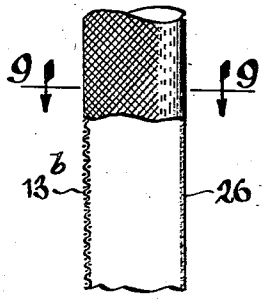


Fig. 7

Fig. 8



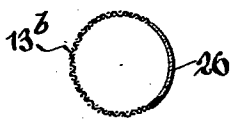


Fig. 9

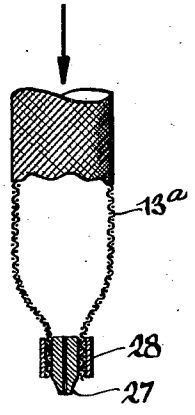


Fig. 10

INVENTOR.

Chester Tietig

Patented Sept. 4, 1945

2,383,946

UNITED STATES PATENT OFFICE

2,383,946

METHOD AND APPARATUS FOR FLUID CONTACT

Chester Tietig, Covington, Ky.

Application October 9, 1941, Serial No. 414,291

3 Claims. (Cl. 23—1)

This invention relates to a method and apparatus for contacting fluids so that very intimate contact is achieved. By my method and with the use of my apparatus, the utmost economy of reagents is possible, coupled with thoroughness of reaction and in certain cases, elimination of other agitating gear.

Briefly stated, my method comprises forcing through woven or braided fibrous tubing made of chemically-resistant material, the gas or liquid with which it is desired to treat another liquid. The second liquid covers the exterior of the tubing. The invention is not limited to the use of braided or woven tubing since minutely porous flexible chemically-resistant material such as "Thiokol," "Neoprene" and "Buna" may also be used. Equivalents of woven or braided fibrous glass tubing are tubings made of synthetic fibers such as vinyl chloride, cellulose acetate and "Nylon." The term "chemically-resistant" is a relative one. As here used, it means that the tubing is more resistant to chemical reagents than ordinary cotton or wool, but it does not mean that it is resistant to all reagents. This is necessarily so since no substance will withstand all chemicals.

Among the chemical processes to which my method and apparatus are particularly adapted are nitrations, chlorinations, sulfonations, air agitation, treatments with gaseous hydrochloric acid and extraction of lubricating oil stocks by such liquids as acetone and furfural. It is to be noted that such extractions and air agitations are not chemical reactions, so that the process is really broader than merely a chemical one.

Referring now to the drawings:

Fig. 1 is a vertical section of a tank of liquid having suspended therein a single porous tube according to my invention and a second porous tube extending upwardly from the bottom of the tank.

Fig. 2 is a similar section of a tank of liquid having suspended therein a U-bend of my tubing.

Fig. 3 is a similar view in which use is made of my tubing arranged in a coil about a zone of agitation.

Fig. 4 is a view partly in longitudinal section of a hollow perforated agitator covered with my tubing.

Fig. 5 is a view, partly in longitudinal section showing my tubing provided with a chemically-resistant distender.

Fig. 6 is a vertical section of piping into which there is fitted a porous tube according to my invention so that gas or liquid may be injected through the tube to contact the flowing stream of liquid inside the pipe.

Fig. 7 is a vertical section of a tank in which is suspended a porous tube according to my invention, said tube having a non-porous area on one side thereof to cause the tube to thrash about when gas or liquid is injected into the contents of the tank through the tube.

Fig. 8 shows a length of porous tubing, partly in section with a non-porous area upon one side.

Fig. 9 is a cross section of Fig. 8 taken along the line 9—9 showing the porous and non-porous areas.

Fig. 10 is an end of a porous tube provided with a jet through which gas or a liquid may flow at a high velocity and small volume to cause the tube to thrash about.

In the drawings, 10 is a tank which may be open or closed and which contains a liquid 11. Above the tank a rigid pipe 12 extends over the liquid. Attached to the pipe 12, there is a porous chemically-resistant pipe 13 which is preferably made of woven fibrous glass so that it is minutely porous. Its dimensions will be governed by the amount of gas or liquid that it is desired to deliver to the liquid 11. Naturally if a larger delivery is desired, the tube 13 must be larger. 14 is a closure at the end of the tube 13 and is intended to build up a pressure inside that tube.

In operation gas or liquid is fed by a pump or blower as the case may be through pipe 12. Since the gas or liquid cannot make its exit through closure 14, it leaves the tube 13 through the pores thereof, so that very fine bubbles or jets or both extend through the tube 13 into the liquid. This leads to very intimate contact and consequent rapid absorption coupled with a thorough reaction. The porous tube 13 should be entirely submerged in the liquid 11 if best results are to be obtained, however in order to render the drawings clearer, the top part has been shown above the liquid surface. Extending upwardly from the bottom of the tank at its right-hand side is shown a tube 13a similar to the tube just described but adapted to partake of a thrashing action as hereinafter more particularly described in connection with the form of the invention illustrated in Fig. 10.

In Fig. 2, the tube 13 is in the shape of a U-bend, the ends being attached to two rigid pipes 12 above the liquid level. In this case, gas

or liquid is fed into these pipes and into the tube 13 simultaneously from opposite directions, thereby forcing the gas or liquid through the pores of the tube 13 into the liquid 11. If necessary or desirable, gas can be fed through one pipe 12 while the liquid is fed through the other pipe 12. In this way both gas and liquid will be forced out of the tube 13 to exert their simultaneous effects upon the liquid 11.

In Fig. 3, there are also two pipes 12, the right hand one being provided with an exit pressure regulating valve 14 which is desirable for purposes of accurate control of pressure within the tube 13. The latter tube is wound in coil form under the surface of the liquid 11 and an agitator 15 is placed so that gas or liquid making its exit from the tube 13 in the neighborhood of the interior of the coil 16 will be caught by the agitator blade 17 and given additional swirling contact with the liquid 11 so as to promote very intimate mixing.

In Fig. 4, the agitator shaft 15 is hollow and a number of hollow agitator arms 18 are provided. These may be perforated as shown to the left of Fig. 4 or may have open ends as shown on the right. The agitator shaft 15 may itself have perforations 20. The agitator arms 18 as well as the agitator shaft are covered with boots 21 of porous chemically-resistant fabric or tubing and a gas or liquid is fed under pressure through the hollow agitator shaft 15 and thence through the perforations and then through the fine pores of the boots 18, whereby extremely fine subdivision is accomplished simultaneously with excellent dispersion.

In Fig. 5 is shown a form of porous chemically-resistant tubing 13 which is protected against collapse by an internal coil or spring 22 preferably made of high grade chemically-resistant stainelss steel. This form of tubing is especially adapted for uses such as shown in Fig. 3 where bends must be made in the tubing 13 and collapse guarded against, like vacuum filtration, decantation, etc.

In Fig. 6, 23 is a pipe of larger diameter, 24 is a coupling joining two lengths of such pipe, 12 is a pipe adapted to feed gas or liquid under pressure, 25 is a coupling leading the pipe 12 through the coupling 24 and into the center of the pipe 23. The pipe 12 is turned in the direction of flow of the liquid 11 within pipe 23. Attached to pipe 12 is a porous chemically-resistant flexible tube 13. It is therefore evident that if there is a large flow of a liquid 11 through pipe 23 and if as is the case an immense number of very small bubbles or jets come out of the pores of tube 13, it will be unnecessary to use large tanks for the treatment of the liquid 11. For instance, the tube 12 may feed gaseous or liquid chlorine and the liquid 11 may be water. By the apparatus and method disclosed, immense volumes of water may be chlorinated with the comparatively small apparatus shown.

Referring now to Fig. 7, this figure illustrates a modification of the invention by means of which the tube 13^b not only disperses the liquid or gas which is fed through it but also provides its own agitation. To this end one or more areas 26 on one side of tube 13^b are rendered non-porous. This may be done by heating the area to incipient fusion by means of a blow torch or the pores may also be sealed with a cement such as sodium silicate. Not more than 180° of the tubing should be sealed, and the sealed area should in general not be longer than about one foot. It is sufficient to create unbalanced pressure on one side of the tube, i. e., the free side so that the tube is caused to thrash about in the liquid 11 while gas or a liquid under pressure is flowing through it into liquid 11. Another way of accomplishing the same result is to provide a small jet 27 at the bottom of the tube 13^a, as shown in Fig. 10. The jet may be held on by a collar 28. It is sufficient that the jet will constrain the gas or liquid to move through it at a very high speed coupled with a very small volume. This will produce the thrashing effect and provide good mixing throughout the whole liquid 11 as well as excellent dispersion coupled with greater economy of the reactant supply.

When such substances are used as the artificial rubbers, I prefer them to be nearly microscopically porous although larger pores or even small holes are permissible. The essential conditions to be met are that the tubing have an extremely large number of perforations of relatively small size, that the tubing be of chemically-resistant material and that the tubing be flexible. It is also contemplated that more of the tubing or fabric be used than what would constitute a mere strainer and that competent judgment be exercised by skilled chemical engineers in selecting the length, porosity and material with which to work. Such matters are within the province of a skilled chemical engineer. Pore size in elastic materials such as synthetic rubber tubing can be controlled, i. e., made larger by putting the tubing under tension.

I claim as my invention:

1. The process of reacting potentially reactive fluids which comprises immersing a relatively light flexible porous tube in a body of one of the fluids to be reacted with one of its ends free for thrashing movement therein, passing another fluid under pressure through the tube and controlling the escape from the tube of a portion of said latter fluid relatively to the normal escape of the remainder of the fluid through the pores of the tube while maintaining the pressure of the fluid in the tube sufficiently high for imparting a thrashing movement to the free end of the tube to effect intimate contact of said other fluid passing through the pores of said tube with the surrounding fluid.

2. The process of reacting potentially reactive fluids which comprises immersing a relatively light, flexible porous tube in a body of liquid constituting one of the fluids with one of its ends free for thrashing movement therein, passing a gas under pressure through the tube and controlling the escape from the tube of a portion of said gas relatively to the normal escape of the remainder of the gas through the pores of the tube while maintaining the pressure of the gas in the tube sufficiently high for imparting a thrashing movement to the free end of the tube to effect intimate contact of the gas passing through the pores of said tube with the surrounding liquid.

3. A tube for contacting potentially reactive fluids, said tube being composed of a relatively light, woven fabric, porous over most of its area and flexible substantially throughout its length, and means for coupling one end of said tube to a fluid-supply pipe, said tube having a non-porous area of appreciable extent along one of its sides.

CHESTER TIETIG.