March 23, 1965 W. G. SEE ETAL 3,174,820

METHOD FOR UTILIZING SUBMERGED COMBUSTION

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FIG. 2

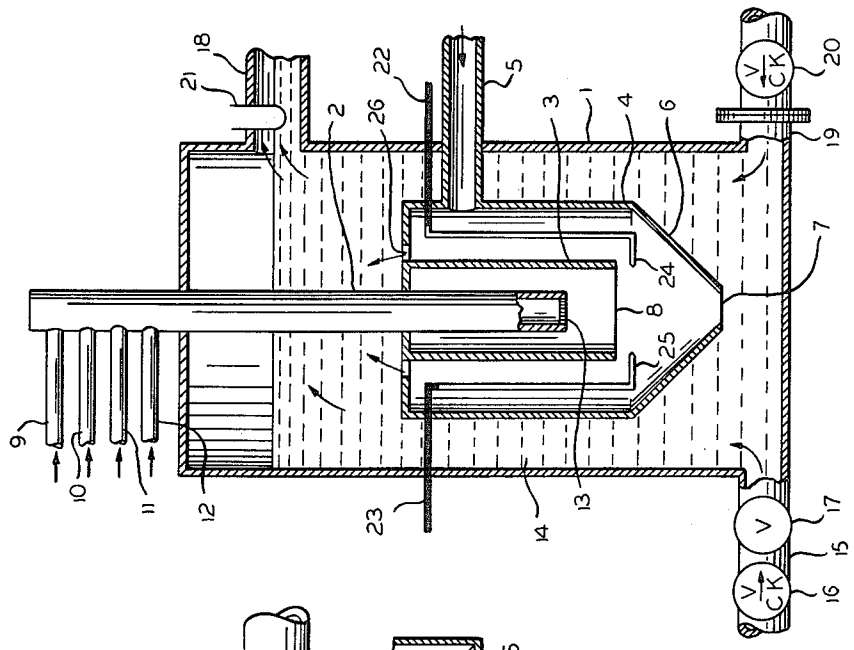
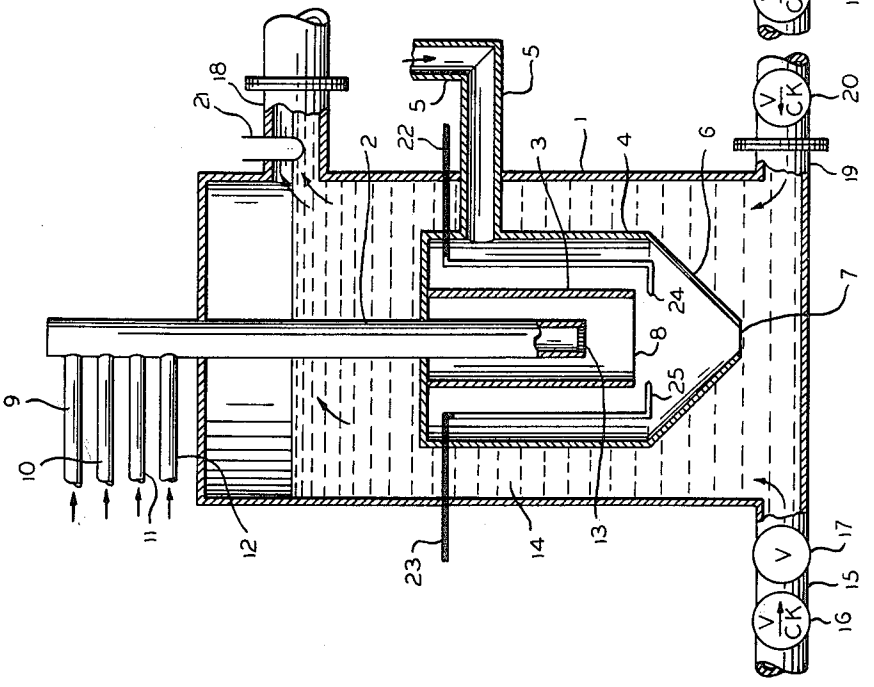


FIG. 1



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METHOD FOR UTILIZING SUBMERGED COMBUSTION

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This invention relates to new and improved process for utilizing submerged combustion.

This application is a continuation-in-part of our copending application Ser. No. 340,176, filed March 4, 1953, now abandoned.

Submerged combustion burners are known in the art and have been used very satisfactorily in heating liquids, as for example, in heating pickling baths containing sulfuric acid. One of the difficulties heretofore encountered in the use of submerged combustion burners which has made them inapplicable for many purposes is the very high flame temperature which may be from around 2500° F. to 8000° F., depending upon the combustible gas used in the burner. For example, where natural gas is used as the fuel, the flame temperature is around 2900° F. This temperature is too high to permit the burner to be used directly in heating some types of solutions where the high temperature would produce charring or otherwise have a harmful effect upon the solution being heated.

One of the objects of the present invention is to provide a new and improved method and apparatus for utilizing submerged combustion wherein the flame temperature of the submerged combustion burner is controlled, altered and/or governed by the introduction of coolants and/or reagents, chemical or otherwise.

Another object of the invention is to provide a new and improved submerged combustion apparatus which is applicable for use in carrying out chemical reactions.

Other objects and advantages of the invention will be apparent by reference to the following description in conjunction with the accompanying drawings in which:

FIG. 1 represents an elevated view partly in section and with parts broken away of one form of apparatus suitable for the practice of the invention;

FIG. 2 represents a modified form of the apparatus illustrated in FIG. 1.

The apparatus illustrated in FIG. 1 comprises a cylindrical closed heat exchange chamber 1 containing a submerged combustion burner 2. A cylindrical combustion chamber 3 is provided around the lower end of the submerged combustion burner 2 and is surrounded by a shell 4 which is provided with an inlet 5 near the upper end thereof and walls 6 which taper to form an opening 7 in the lower end thereof. The combustion chamber 3 is provided with an opening 8.

The submerged burner 2 is preferably of the type described in See et al., U.S. Patent 2,118,479. In the type of burner shown, a fuel gas such as natural gas or other suitable type of fuel gas, is introduced through a main gas conduit 9 and a pilot gas conduit 10. Support for combustion is provided through a main air conduit 11 and a pilot air conduit 12. The combustion occurs at the burner plate 13 which is located within the combustion chamber 3. The operation of the submerged combustion burner can be controlled automatically in a number of different ways but since such controls do not form a part of the invention they will not be discussed in detail.

The liquid 14 which is to be heated is introduced into the heat exchange chamber 1 through conduit 15 controlled by valves 16 and 17. The heated liquid can, if desired, be circulated to a tank or other vessel through the outlet 18 and can be recirculated through the conduit 19,

provided with check valve 20. A thermometer well 21 is provided in order to make it possible to determine the temperature of the heated liquid. For specific purposes additional liquids can be added through the conduit 19.

The burner assembly has a shell or manifold 4 to which a suitable gas or vapor is added in order to dilute and reduce the temperature of the hot products of combustion issuing from the opening 8 in the chamber 3. Since the manifold 4 is substantially concentric with respect to the chamber 3, the stream of hot gases issuing from the chamber 3 is virtually surrounded by a stream of cooler gases or vapors introduced through conduit 5 and passing between the inner walls of manifold 4 and the outer walls of chamber 3. In this way the high temperature of the hot gases of combustion is reduced in a uniform manner and local overheating as these gases strike the liquid 14 is substantially avoided. The submerged combustion apparatus is provided with additional conduits 22 and 23 (or multiples thereof) which are adapted to conduct chemical reagents into the shell or manifold 4 in such a manner that they can be sprayed or caused to be brought into contact with each other through nozzles 24 and 25 (or multiples thereof) located most favorably between the port of flame 8 and the port of emergence 7.

The apparatus illustrated in FIG. 2 is generally similar to that illustrated in FIG. 1 and like numerals indicate like parts. One difference between the apparatus illustrated in FIG. 1 and that illustrated in FIG. 2 is the provision of the opening 26 around the combustion chamber 3 which permits the liquid to recirculate upwardly through the burner assembly and around the outside of the shell 4. Opening 26 may be reduced to a nozzle and may permit release of recirculating liquid and gases above or below the material level as operation may demand.

In operation heat is supplied by the submerged burner 2 which delivers high temperature flames at point 13 located within the combustion chamber 3 and which in turn empties out into the shell 4. Chemicals which it is desired to react are introduced through the conduits 22 and 23 or multiples thereof. The intensity of the heat causes these chemical reagents to be heated to the desired temperatures before emerging through the opening 7 where the resultant gases, vapors, liquids and/or fluids are doused into a body of other chemicals, gases, vapors, liquids and/or fluids contained in and/or being conducted through the heat exchange chamber 1 for positive control of reaction factors. Where it is desired to control, govern and/or ameliorate the flame temperature a diluting gas or vapor is introduced through the conduit 5. When conduit 5 is not used for this purpose it can in some instances be used to remove reaction products by flow in the reverse direction from that shown by the arrow in the drawing.

The apparatus described can be employed to oxidize sulfur and sulfur-bearing reagents to sulfur trioxide and sulfuric acid. It can also be used to oxidize and to cause the nitration of organic chemicals for the production of derivatives of these chemicals. In particular, it can be used for the processing of lignite, coal, oil shales, carboxylic acids, petroleum, cyclic compounds derived from petroleum in present day refining apparatus and like substances.

Another use for the apparatus is to employ sulfur-bearing gases and vapors such as those derived from petroleum as fuel by introducing them through the gas conduits 9 and 10 and then absorbing the resultant sulfur dioxide and/or sulfur trioxide in water or other liquids (e.g., liquids which are to be sulfated or sulfonated), to bring about the formation of sulfuric acid or sulfated or sulfonated organic compounds. In this way it is possible to utilize objectionable sulfur-containing by-products from petroleum refineries for the purpose of making sulfuric acid and other desirable products. It is also possible

to supplement and/or replace present day apparatus for separating sulfuric acid from acid sludges produced in oil refineries.

It will be recognized that the manifold or shell 4 can have a variety of shapes with numerous inlets and outlets for accomplishing and controlling chemical reactions and changes. Its possibilities are exceedingly flexible.

In a typical installation burning natural gas supplying a B.t.u. value of 250,000 B.t.u. per hour, 41 cubic feet per minute of air is added through the pilot air and main air inlets of the burner and 180 cubic feet per minute of auxiliary air is added through conduit 5. Throttling valves can be used on the various conduits supplying air and gas to the burner and the conduits supplying auxiliary air in order to control the fuel and air supply as well as temperature within the desired limits. Either the air or the fuel gas, or both, can be throttled within certain limits. The pressure of the air and gases must be sufficient to overcome the head of solution. Thus, for 60 feet of water approximately 31 pounds of air and 31 pounds of gas pressure are required to overcome the head of solution and greater pressures are required for solutions having a higher specific gravity.

It will be understood that suitable control valves and check valves can be added to the apparatus and that other variations and modifications can be made without departing from the invention. Instead of air relatively pure oxygen, such as tonnage oxygen, can be used to support the combustion of the gas in the burner.

The apparatus described can be operated at atmospheric, subatmospheric or superatmospheric pressures. If subatmospheric or superatmospheric pressures are used the heat exchange chamber 1 must be pressure-tight and must be provided with suitable pressure release devices.

The invention provides an apparatus comprising a burner having a burner plate adjacent one end thereof, a combustion chamber around said burner with the inside walls of said chamber spaced from the outside walls of said burner and projecting beyond said burner plate in the direction of flame propagation, the projecting end of said combustion chamber having an opening therein, a shell spaced from the outside walls of said combustion chamber forming a passageway around said combustion chamber and projecting beyond said combustion chamber in the direction of flame propagation, the portion of said shell projecting beyond said burner plate having an opening therein, and a conduit in said shell communicating with said passageway. By introducing air or other suitable gas, coolants, and/or reagents into said last named conduit, the flame temperature can be controlled, altered and/or ameliorated for the intended purpose.

By providing a conduit or multiple conduits communicating with the space between the opening in the combustion chamber and the opening in said shell or manifold, it is possible to introduce into the zone between the opening in the combustion chamber and the opening in the shell one or more chemicals capable of reacting with

components of the combustion gases or with each other in order to produce chemical compounds which can then be conducted to a suitably prepared solvent, diluent or reagent in the heat exchange chamber 1 for removal from the reaction zone. Thus, the invention provides a new method of carrying on chemical reactions.

The invention is hereby claimed as follows:

1. A process of conducting a chemical reaction at a controlled temperature in a zone heated by hot combustion gases which comprises propagating from a burner a flame, forming a substantially enclosed, reaction zone beneath the surface of a body of liquid into which the hot combustion gases flow, introducing into said reaction zone a coolant gas in a quantity sufficient to cool the hot combustion gases in said zone to a desired reaction temperature, simultaneously introducing into said reaction zone at least one chemical reactant which reacts in said zone at the aforesaid reaction temperature, and discharging from said zone through a restricted opening therein into said body of liquid said combustion gases, coolant gas, and products of reaction in said reaction zone, thereby dousing the discharged mixture in said body of liquid.

2. A process for conducting a chemical reaction at a controlled temperature in a zone heated by hot combustion gases which comprises propagating from a burner a flame, forming a substantially enclosed, reaction zone beneath the surface of a body of liquid, flowing hot combustion gases from said flame through said zone, introducing into said reaction zone a fluid to regulate the temperature in said reaction zone at the desired reaction temperature, simultaneously introducing into said reaction zone at least one chemical reactant which reacts in said zone at the aforesaid reaction temperature, and discharging from said reaction zone through a restricted opening therein, along with said combustion gases, the products of reaction into said body of liquid, thereby dousing the discharged mixture in said body of liquid.

3. A process as claimed in claim 2 wherein said flame is propagated from said burner within an enclosed combustion zone located within said reaction zone and opening in the direction of flame propagation into said reaction zone.

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