

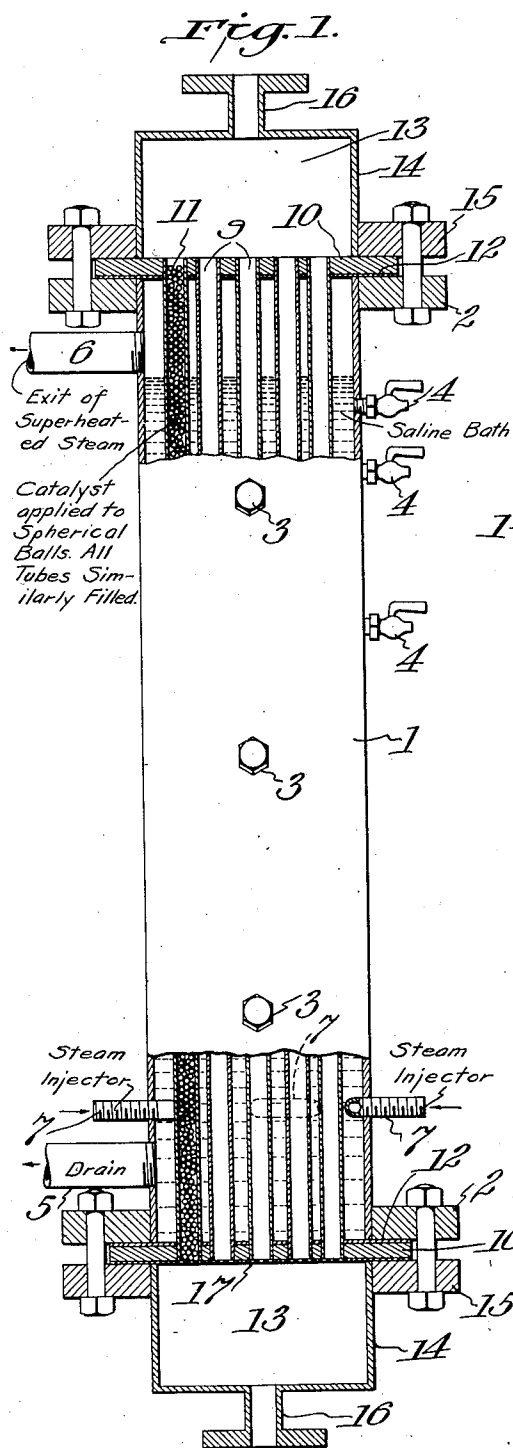
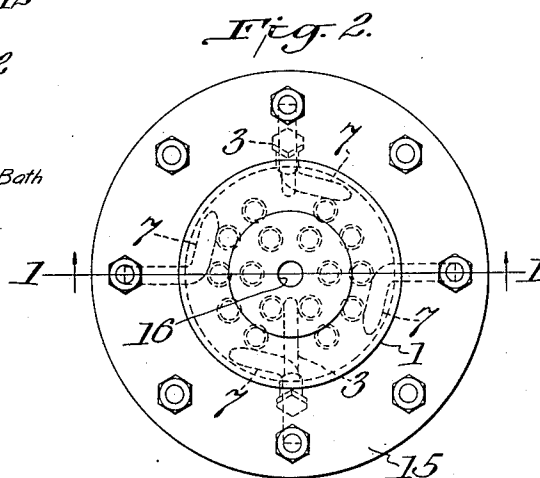
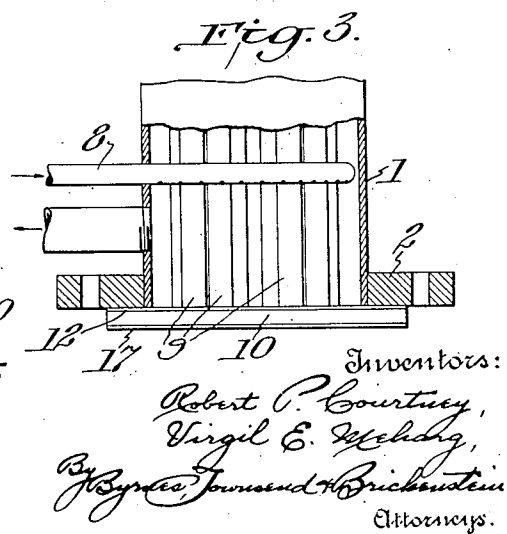
Jan. 5, 1932.

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1,840,186

METHOD OF CONTROLLING REACTIONS

Filed May 12, 1928



UNITED STATES PATENT OFFICE

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METHOD OF CONTROLLING REACTIONS

Application filed May 12, 1928. Serial No. 277,383.

This invention relates to methods of controlling exothermic reactions of the type requiring a comparatively close heat regulation at temperatures decidedly above that of boiling water. Without thereby limiting our invention we will describe the same by reference, as a specific illustrative example, to the manufacture of formaldehyde by the catalytic oxidation of methanol at a temperature approximating 350° C.

In accordance with our invention the reaction vessel, in tubular or other form, is surrounded by a bath of a molten salt or salts at the appropriate temperature. For effective temperature control it is essential that a certain increment of heat should be removed from the molten saline bath in unit time; and also that the bath should be thoroughly agitated in order to remove the highly heated portions from immediate proximity to the walls of the reactor and to maintain these walls substantially at the temperature of the molten bath. We accomplish both of these objects by injecting directly into the molten bath a spray of a liquid which is readily volatilizable at the reacting temperature.

An apparatus embodying the above-mentioned features and suitable for carrying out the method of our invention is illustrated in the accompanying drawings in which

Fig. 1 is a front elevation with the end portions in section on the line 1—1 of Fig. 2, revealing the internal construction and arrangement of the apparatus;

Fig. 2 is an end view of the apparatus shown in Fig. 1; and

Fig. 3 is a front elevation of the lower end of the saline bath receptacle of Fig. 1 with the front wall of said receptacle broken away.

Referring to the drawings, 1 is the saline bath receptacle, being a cylindrical tube about 6.5 inches internal diameter and 30 inches long. The receptacle 1 carries end flanges 2, 2 and is provided with suitable thermometer wells 3, 3, 3, pet cocks 4, 4, 4 for adjusting the height of the saline bath, a valved saline bath drain 5, and a superheated steam or vapor exit pipe 6. The four spray jets 7, 7, 7, 7 marked "Steam injector" on Fig. 1 project through the wall of receptacle 1

near the lower end thereof, bend toward the inner wall of the receptacle and terminate in nozzles, see Fig. 2. Any desired number of jets may, of course, be used and instead of the jets 7 a ring-shaped, perforated spray pipe 8, see Fig. 3, may be used.

The reaction tubes 9 in the apparatus illustrated are about 0.5 inch in diameter and about 30 inches long and are secured in headers 10, 10. The tubes are filled with the catalyst 11, preferably in the form of spherical balls which assume an orderly arrangement. The group of reaction tubes 9 is positioned within the receptacle 1 with the headers 10, 10 resting against the end flanges 2, 2, preferably with suitable copper-asbestos gaskets 12, 12 therebetween. The ends of the tubes 9 open into chambers 13, 13, formed by the tubular shells 14, 14, having flanges 15, 15 for attachment to flanges 2, 2, that is, as illustrated flanges 14, 14 are bolted to flanges 2, 2 with the outer edges of headers 10, 10 clamped between them. A perforated plate 17 serves to support the catalyst 11 in the tubes 9. Chambers 13, 13 are provided with projecting conduits 16, 16 for connection to a source of fluids, such as a mixture of methanol and air or oxygen, to be treated and to apparatus, such as a condenser (not shown) for suitably treating the resulting gases.

It is to be understood that the invention is not limited to the specific apparatus illustrated and described, it being obvious that the size, shape and construction constitute no part of and may be modified without departure from the invention.

We prefer to use water as the vaporizable liquid, and to atomize it into the molten bath by means of a jet of steam at appropriate pressure. Fine atomization of the water is desirable, since otherwise the vaporization may take place with considerable violence. We have found it satisfactory to employ a molten bath consisting of a mixture of sodium and potassium nitrates, or nitrites, cooled by water sprayed with about 50% by weight of steam.

The operation as described presents several important advantages, among which the following may be mentioned:

1. The apparatus may be quite compact and relatively inexpensive, since no mechanical agitators are required.

2. Advantage is taken of the heat of vaporization of the water or other liquid introduced as such, thereby effecting a marked economy in the use of steam.

3. The direct contact of the steam and water with the molten bath accomplishes the desired heat transfer at high efficiency.

4. The superheated steam arising from the bath may be utilized as desired, but preferably for preheating the incoming gases, thereby conserving the heat of reaction.

It is within the scope of our invention to remove the heat from the molten bath by a spray of water or other volatile liquid on the one hand, or by a jet of steam on the other; but neither of these methods is as advantageous as that described above in which a commingled spray of water and steam is employed. The expression "finely divided cooling agent" is used herein to include liquids, gases, and mixtures thereof.

The reaction velocity, and hence the heat evolution, varies considerably throughout the process being comparatively rapid at first and slowing down as the concentration of methanol in the reaction mixture diminishes. Hence we find it desirable in certain cases to carry out the operation in two or more stages, each in an independently heat-controlled reaction vessel and such modification is within the scope of our invention.

We claim:

1. Method of controlling exothermic reactions, comprising contacting the walls of the reactor with a molten bath, and agitating said bath and removing excess heat therefrom by means of a finely divided cooling agent, including water and steam, contacting directly therewith.

2. Method of controlling exothermic reactions, comprising contacting the walls of the reactor with a molten saline bath, and agitating said bath and removing excess heat therefrom by means of a finely divided cooling agent, including water and steam, contacting directly therewith.

3. Method of controlling exothermic reactions, comprising contacting the walls of the reactor with a molten bath, and agitating said bath and removing excess heat therefrom by contacting directly therewith a finely divided cooling agent including a gaseous component and a liquid which is vaporizable at the temperature of the bath.

4. Method of controlling exothermic reactions, comprising contacting the walls of the reactor with a molten bath, and agitating said bath and removing excess heat therefrom by contacting directly therewith a finely divided liquid cooling agent which is vaporizable at the temperature of the bath.

5. Method of controlling exothermic re-

actions, comprising contacting the walls of the reactor with a molten saline bath, and agitating said bath and removing excess heat therefrom by contacting directly therewith a finely divided liquid cooling agent which is vaporizable at the temperature of the bath.

In testimony whereof, we affix our signatures.

ROBERT P. COURTNEY.
VIRGIL E. MEHARG.

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