Canadian Patents Database

01/09/2002 - 12:28:27

(12) **Patent:**

(11) **CA 380219**

(54) REACTION CHAMBER TEMPERATURE CONTROLLING APPARATUS

(54) APPAREIL DE CONTROLE DE LA TEMPERATURE DE CHAMBRE DE REACTIONS

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(45) Issued on:	**Mar. 21, 1939**
(22) Filed on:	
(42) Laid open on:	
(52) Canadian Class (CPC):	**23/425**
(51) International Class (IPC):	**N/A**
Patent Cooperation Treaty (PCT):	**No**
(30) Application priority data:	**None**
Availability of licence:	**N/A**
Language of filing:	**Unknown**

ABSTRACT:

CLAIMS: Show all claims

*** Note: Data on abstracts and claims is shown in the official language in which it was submitted.

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This invention relates to a method and apparatus for controlling the temperature of chambers in which an exothermic reaction is taking place.

According to the present invention the temperature of the reaction chamber is maintained at the desired point by cooling it by the evaporation of a liquid and adjusting the temperature at which the liquid boils. The liquid used for cooling is naturally so chosen that its boiling point corresponds approximately to the temperature at which the reaction chamber is to be maintained; by varying the pressure under which the liquid boils, the temperature can be adjusted within fine limits.

Apparatus in accordance with the invention for carrying out this method of temperature control comprises a reaction chamber, a boiling chamber in thermal contact with the reaction chamber, means for heating a liquid to its boiling point and introducing it into the boiling chamber and adjustable means for controlling the pressure in the boiling chamber. Preferably means are provided for condensing the vapour produced in the boiling chamber and leading it back into the boiling chamber, so that a closed circuit is formed. Other features of the invention will appear from the following description.

Apparatus for carrying out the invention is shown in the accompanying drawing, which is of a somewhat diagrammatic character. In the apparatus shown, the reaction chamber and the boiling chamber are formed by three coaxial tubes 1, 2 and 3, the space between tubes

1 and 2 forming the reaction chamber and the space between tubes 2 and 3 forming the boiling chamber. At their lower ends tubes 2 and 3 are connected together and provided with an inlet for the liquid. The upper end of tube 2 is closed, while the upper end of tube 3 is open. The liquid in the boiling chamber boils off, the latent heat of vapourisation being taken from the reaction chamber. The vapour thus produced passes down through tube 3 to an outlet, from which it passes through a pipe 4 to a condenser 5. The liquid from the condenser is raised by a pump 6 through a pipe 7 to a receiver 8, from which it flows by gravity through a pipe 9 to a heater 10, which raises its temperature to boiling point, and thence through a pipe 11 back into the boiling chamber. The level of liquid in the boiling chamber depends on the level in the receiver 8 and this latter level is maintained by an overflow pipe 12 which leads from the receiver to a liquid trap 13. The liquid trap also acts as a pressure chamber by means of which the pressure in the cooling system (and thus the boiling point of the cooling liquid) can be controlled. To this end, the pressure chamber 13 is connected through a pipe 15 provided with a regulator valve 16 with a source of compressed gas 14 and is provided with a pressure gauge 17 and with a safety valve 18. Alternatively, or in addition, the pressure chamber can be connected to a vacuum pump, so that the pressure in the cooling system (and thus the boiling point of the liquid) can be reduced.

Owing to the fact that the co-efficient of transmission of heat to a liquid from a surrounding wall is much greater when the liquid is boiling than when it is not, the temperature difference between the reaction chamber and the cooling liquid is reduced to a minimum when the system of the present invention is employed. The system thus presents considerable advantages over systems which depend simply upon a circulating liquid.

When the liquid in the annular space between tubes 2 and 3 is actually boiling, its apparent density will be less than the actual density of the liquid, owing to the presence of vapour bubbles in the liquid and its surface 22 will accordingly lie above the level of the liquid in the receiver 8. If now the pressure within the cooling system is increased in order to raise the boiling point of the liquid, and thus the temperature at which the reaction chamber is maintained, the liquid will temporarily cease to boil. Owing to the disappearance of the vapour bubbles, the apparent density of the liquid in the annular space will increase and consequently the surface of the liquid column will fall to the position indicated in dotted lines at 23. The upper part of the tube 2 is thus no longer in contact with the cooling liquid and can effect no appreciable cooling of the reaction chamber. The apparatus described is particularly intended for controlling the temperature of catalytic reactions. In such cases it is important that the catalyst itself should not be overheated and it is therefore arranged in a cylind-

rical bed immediately surrounding the cooling tube 2. It will be clear, however, from the foregoing explanation that in certain circumstances the upper part of the cooling tube may cease to have any appreciable cooling effect. Accordingly the catalyst should, as is indicated in the drawing, be arranged around the lower part only of the tube 2, which is allowed to project above the top of the catalytic bed. This ensures that the catalyst is always adequately cooled and overheating is prevented. This arrangement has also a further advantage. The fluid which is to take part in the reaction should when it reaches the catalytic bed be at a temperature as near as possible to that of the catalyst itself. A preheater can, of course, be used to raise the temperature of the gas or other fluid to the required level, but it is always possible that the temperature may vary between the preheater and the catalytic bed. With the arrangement above described, however, the protruding portions of the tube 2 (which are normally at substantially the same temperature as the catalyst) adjust the temperature of the incoming gas (which preferably enters at the upper end of the reaction chamber through a tube 24 and leaves at the lower end through a tube 25) in a most efficient manner, before it reaches the catalytic bed.

The condenser 5 and pump 6 of the apparatus above described may be omitted and the vapour from the boiling chamber led through a pipe 19 to a condenser 20 situated above the receiver 8, any small quantity of

liquid which condenses in the rising pipe being re-vapourised by means of a heater 21, all as indicated in broken lines on the drawing. In this way the pump may be eliminated and the cooling system is rendered independent of any moving parts.

The condenser 5 or 20 of the apparatus above described may take the form of a heat exchanger in which the heat of the vapour is given up and utilised for heating purposes of any kind, or it may be replaced by a vapour engine of any suitable construction.

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1. Apparatus for controlling by cooling the temperature at which an exothermic reaction takes place, comprising a reaction chamber, containing a catalytic bed a boiling chamber defined between a wall of the reaction chamber and a second wall closely adjacent thereto, means for heating a liquid to its boiling point, means for introducing such heated liquid into the lower part of said boiling chamber, means for maintaining the level of the liquid surface in said boiling chamber above the level of the top of said catalytic bed, means for withdrawing vapour from the upper part of said boiling chamber, means for condensing said vapour and returning it to said heating means, and means for varying the pressure in said boiling chamber.

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2. Apparatus for controlling by cooling the temperature at which an exothermic reaction takes place, comprising a reaction chamber, a catalyst situated in the lower part of said reaction chamber, a boiling chamber defined between a wall of the reaction chamber and a second wall closely adjacent thereto, means for heating a liquid to its boiling point, means for continuously introducing such heated liquid into the lower part of said boiling chamber, means for maintaining the surface level of said liquid above the top level of said catalyst, means for with-

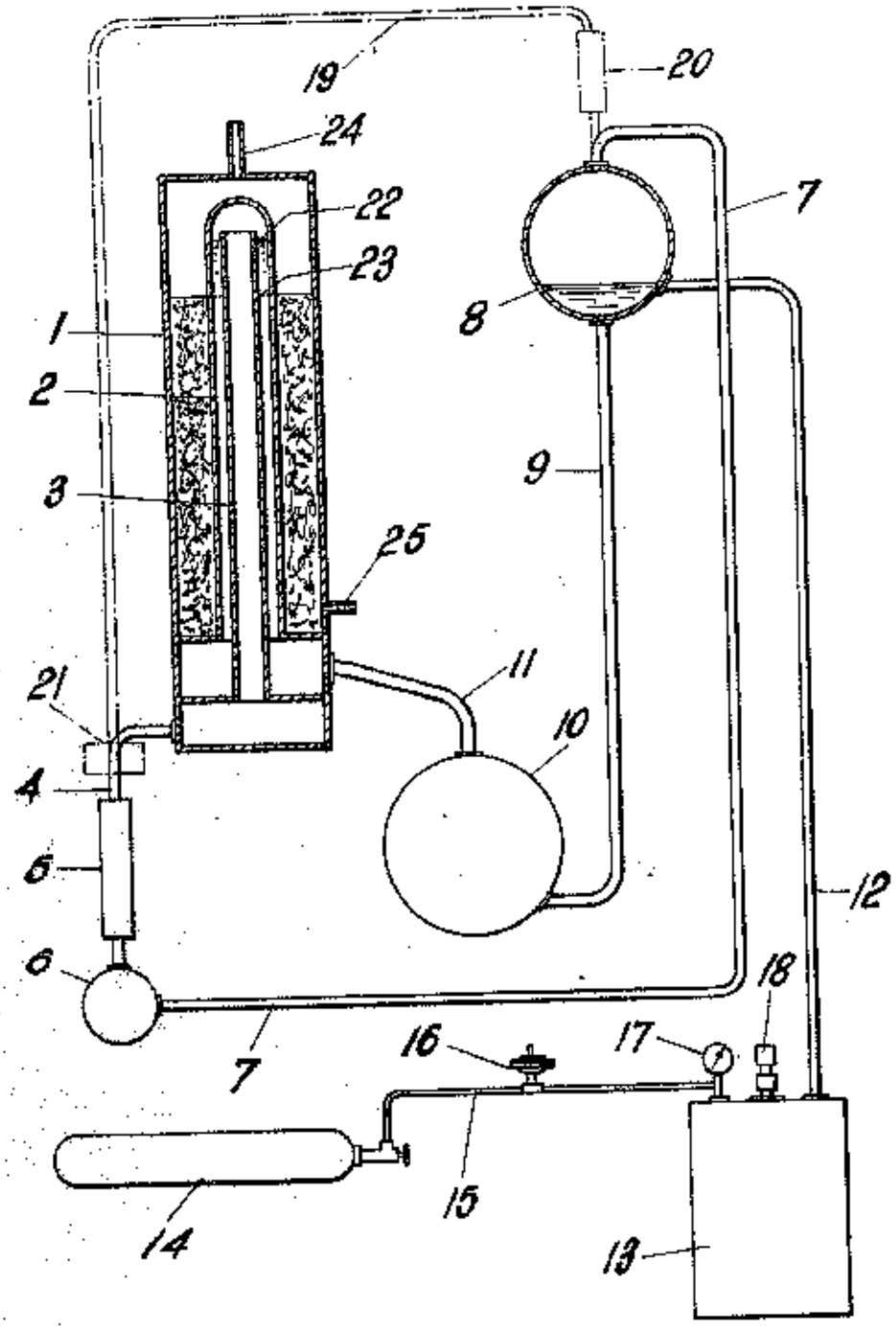
drawing vapour from the upper part of said boiling chamber and means for varying the pressure in said boiling chamber.

3. Apparatus for controlling by cooling the temperature at which an exothermic reaction takes place, comprising a tube closed at its upper end, a second tube open at its upper end disposed coaxially within said first tube, means for continuously introducing a liquid heated to its boiling point into the lower part of the annular boiling chamber defined between said coaxial tubes, a reaction chamber in thermal contact with the liquid in said boiling chamber, a catalyst in the lower part of said reaction chamber, means for maintaining the surface level of the liquid in said boiling chamber at least as high as the top level of said catalyst, means for withdrawing vapour downwardly through said second tube and adjustable means for controlling the pressure in said boiling chamber.

4. Apparatus for controlling by cooling the temperature at which an exothermic reaction takes place, comprising a tube closed at its upper end, a second tube open at its upper end disposed coaxially within said first tube, means for continuously introducing a liquid heated to its boiling point into the lower part of the annular boiling chamber defined between said first and second tubes, a third tube disposed coaxially about said first tube, a catalyst disposed in the reaction chamber defined between said first and third tubes, means for maintaining the surface level of the liquid in said boiling chamber at least as high as the top level

of said catalyst, means for withdrawing vapour downwardly through said second tube and adjustable means for controlling the pressure in said boiling chamber.

5. Apparatus for controlling by cooling the temperature at which an exothermic reaction takes place, comprising a tube closed at its upper end, a second tube open at its upper end disposed coaxially within said first tube, means for continuously introducing a liquid heated to its boiling point into the lower part of the annular boiling chamber defined between said first and second tubes, a third tube disposed coaxially about said first tube, a catalyst disposed in the reaction chamber defined between said first and third tubes, means for maintaining the level of the liquid surface in said boiling chamber above the level of the top of said catalytic bed, an inlet for reaction gases at the upper end of said reaction chamber, and outlet for the products of reaction at the lower end of said reaction chamber, means for withdrawing vapour downwardly through said second tube and adjustable means for controlling the pressure in said boiling chamber.



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Certified to be the drawings referred to in the specification hereunto annexed.
Ottawa, Ont., Canada, November 16, 1936