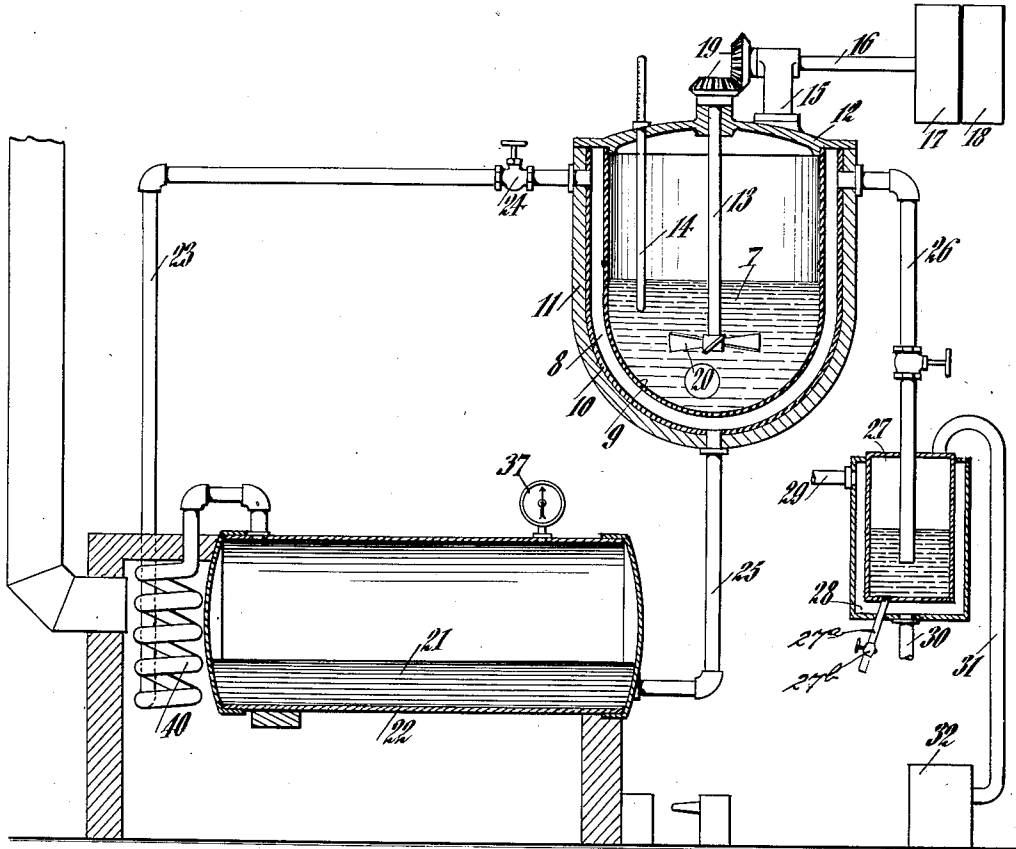


C. FIELD.
METHOD OF HEATING AT HIGH TEMPERATURES.
APPLICATION FILED JAN. 12, 1917.

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METHOD OF HEATING AT HIGH TEMPERATURES.

1,403,471.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, CROSBY FIELD, a citizen of the United States, and a resident of Wappingers Falls, in the county of Dutchess, and State of New York, have invented certain new and useful Improvements in Methods of Heating at High Temperatures, of which the following is a specification.

This invention relates, in general, to a method for providing heat at temperatures higher than that ordinarily obtainable with steam, and particularly to a method of indirect heating of this character, which shall be adapted to technical processes, involving high temperature operations or pyro-chemical reactions.

Methods of heating applicable to processes of the character described, have hitherto been used, but these have always entailed difficulties of application, operation and cost, which make them disadvantageous as to effectiveness and efficiency for the purposes described herein. Chief of these are oil baths, which have had quite a wide application in this connection, but these are limited in practical scope by the difficulty of not always finding a suitable oil, having a high enough boiling point, so that it may not volatilize before the desired temperature is reached. The oils that have been thus far used, for this purpose are usually complex organic compounds, which "crack" or break up at high temperatures and, therefore, become inapplicable for the desired purpose at such temperatures. Furthermore, these oils usually contain glycerides, which when given off in the form of vapor under the influence of heat, result in noxious fumes, which not only may be dangerous, but which may also interfere with the proper carrying out of the technical processes. As has been already stated, these oils are organic compounds and almost invariably carbonize under the influence of high temperature heating. As a result, the oil is gradually burnt up and a layer of carbon forms on the inner walls of the bath, which, as is well known, offers very high resistance to the passage of heat, thus reducing considerably the efficiency of the heating bath from the standpoint of the energy required therefor, and from the standpoint of the time consumed in the transmission of the heat from the primary source to the oil and thence to the substance being heated.

Easily fusible metal alloy baths usually containing bismuth have been used, but these solidify very readily and are very cumbersome and not at all adapted to processes in which heat must be circulated over very large surfaces. Steam circulated through heating coils has been widely used, but that method of heating would, of course, be inapplicable to technical endothermic processes, requiring a temperature from about 400° to 500° C. for their successful operation. As is well known, the highest temperature obtainable with superheated steam is far below that range and can only be obtained under comparatively enormous pressures, it being remembered that the boiling point of water at atmospheric pressure is only 100° C. Furthermore, apart from this limitation to its practical application in this connection, various disadvantages appear in the use of steam in processes of the character referred to; even where the required temperature is not a bar to the use thereof. These disadvantages relate specially to economy and efficiency and will be clear from the following considerations:

The number of calories necessary to turn one gram of water into steam at a temperature equivalent to 199° C. at 15 atmospheres, is given as 667 calories. This is, of course, a measure of the energy required to obtain substantially 200° C. temperature, and will be referred to hereinafter in connection with the much lesser expenditure of energy required by the use of the method I have invented.

Furthermore, it is well known that when heat passes from metal plate to fluid, as is the case in the steam boiler, it encounters a film of fluid (water) adhering to the plate and the resistance to the passage of the heat is greatly increased, due to the low heat conductivity of water as compared with that of iron. This increased heat resistance has caused great trouble, due to the failure of the heat to be conducted away from the boiler plate to the water rapidly enough, and the consequent excessive heating of the boiler plate, and its accompanying fire hazard. In technical processes this excessive heating of the boiler is accentuated greatly because of the precipitation or throwing down of scaly and tarry compounds during the reactions that take place. There is also occasioned by this retarda-

tion of the heat conduction, a loss of efficiency from the standpoint not only of the excessive heat and higher temperatures that need be supplied, but from the standpoint of time that it takes to bring the fluid up to its boiling temperature.

One object, therefore, of this invention is to provide a method of indirect heating, which shall provide heat at temperatures higher than those ordinarily obtainable with steam.

Another object of this invention is to provide a method of indirect heating, which shall provide such temperatures under low pressures.

A further object of this invention is to provide a method of heating at high temperatures, which shall be free from the defects of carbonization and also avoid the difficulties incident to low heat conductivity of the fluids used heretofore.

A still further object of this invention is to provide a method of indirect heating, which shall be free from the disadvantages incident to oil baths and fusible metal alloy baths as hereinbefore described, and circulating oil baths in which the oil is heated in a separate coil or boiler, and this hot oil is pumped to the oil bath.

A still further object of this invention is to provide an inexpensive and efficient method of heating of the character described, which shall be free from the necessity of such cumbersome apparatus, as is required in heating systems, employing steam at high pressures, and which shall require the installation of very simple apparatus.

Further objects and advantages of this invention will appear from the detailed description, and the features of novelty will be particularly pointed out in the claims.

I have discovered that the difficulties incident to the various methods of heating hereinbefore described, are due chiefly to the nature of the heating substance used. It has, therefore, occurred to me to provide an indirect system of heating in which the substance used as a vehicle for the heat, has such physical and chemical properties, as to make it free from the defects of the substances hitherto used. Therefore, to accomplish these various objects, I provide a method of indirect heating, in which the heat vehicle is a metallic liquid, which has a high boiling point, considerably higher than that of water, which is capable of being vaporized at low pressures, preferably lower than atmospheric pressure, and which has a very high heat conductivity and low heat of vaporization, relative to water.

A study of the physical properties of mercury has shown me that this element is the most suitable for the purposes described herein, in that it is free from carbon and

hence, no carbonization is possible, and in that it possesses all the characteristics set forth above, besides being very clean and easy to handle. This will appear from the following considerations:

The consideration that mercury hardly wets the metals in contact therewith, with few exceptions, shows how greatly superior it is to water from the standpoint of heat conductivity and consequent decrease of fire hazard and economy of time as hereinbefore explained.

Experiment further has shown that mercury vapor may be obtained at 430° Fahrenheit under a pressure of only nine-tenths pounds to the square inch. Higher degrees of heat may be obtained with corresponding increase in pressure. This does away with the necessity of designing cumbersome apparatus to withstand high pressures, as is the case with steam and also makes possible the maintaining of a vacuum in the boiler, in which the mercury is vaporized, so as to reduce its boiling point. This is also true where a circulating system is employed. In fact under a 28 inch vacuum, the boiling point of mercury is reduced from 357° C. to 236°. Hence, considerably less energy is required under suitable vacuum to vaporize a gram of mercury.

Furthermore, the mercury being vaporized at pressures below that of the atmosphere, leakage of the vapor from the apparatus into the air is impossible and the danger of any of the vapors reaching the attendants as is the case with hot oil baths is entirely eliminated.

My new method of heating therefore, consists in using as a carrier for the heat, the hot vapor of mercury, which is circulated around the substance to be heated, as herein-after described. The carrying out of my invention will now be clear and may be best understood in connection with the accompanying drawings, forming a part of this specification, and in which—

The figure is a layout of a heating plant embodying a primary direct heater, a secondary indirect heater, a retort, and a safety device therefor;

The drawings are used to illustrate one of the usual forms of utilization of indirect radiation or heating systems. The form shown is best suited to the utilization of a retort for volatilizing a liquid body, such as indicated by the numeral 7. Preferably, the retort comprises a hollow jacket 8 having thin metal walls 9 and 10, and a vitreous coating or lagging 11. Preferably the inner chamber of the retort is closed by a cover 12, which also forms a central supporting bearing for an agitator shaft 13. Supports also are provided in the cover 12 for a thermometer 14 of suitable structure furnishing a sight gauge exterior to the cover 12.

The cover 12 also supports a standard 15 for a driving shaft 16. The shaft 16 is furnished with the conventional pulleys 17 and 18, one of which is driven and the other
 5 free to run idle on the said shaft. The shaft 16 is operatively connected by means of a mated pair of bevel wheels 19 with the shaft 13 to drive an agitating blade 20.

The heating medium employed for volatilizing the liquid body or charge 7, is the vapor of mercury 21. The mercury 21 is held in a boiler 22 over a furnace of suitable form. The vapors are carried from the boiler 22 by way of the pipes 23, the superheating coil 40 and valve 24, to the jacket 8. The superheating coil for superheating the mercury vapor similarly as is done in steam systems, may be used when desired, or may be dispensed with. Mercury condensed in the jacket 8 is returned to the boiler 22 by way of the pipe 25 to maintain the level of the charge in the boiler 22. A body of condensed mercury is maintained at all times in the lower portion of the pipe 25 and serves as a barrier between the main body of mercury 21 and the vapor receiving space 8 to prevent the return of uncondensed vapors to the boiler 22, thus insuring the extraction of all heat and its transfer through
 30 the wall 9 and the return to the boiler 22 of only the condensation of the mercury vapor. It will, therefore, be apparent that the mercury vapor is admitted to the comparatively restricted expansion space 8 of the jacket at substantially the vaporization temperature of the mercury and is passed through this space at relatively high and uniform velocity in enveloping relation to the inner wall 9 of the jacket and at substantially the initial vaporization pressure.

A difficulty however, arises from the use of mercury in producing what may be termed fugitive or uncalculated fumes or gases incident to sublimation. Certain of the gases do not readily condense. These, in the present invention, are passed by a pipe 26 to a condensing chamber 27. The chamber 27 is surrounded by a water-cooling jacket 28. A continuous stream of water is supplied to the jacket 28 by means of an inlet pipe 30, and is carried from the jacket 28 by means of an outlet pipe 29. A drip pipe 27^a and a valve 27^b for the periodic cleaning of the chamber 27, is provided.

The reduced temperature produced in the chamber 27 congeals the major portion of the gases referred to. Any gases not congealed will be forced out of the chamber 27 by the elevation of the liquid contents thereof into a communicating pipe 31 for delivery to a trap or vacuum pump 32 where the gases are consumed or otherwise accounted for.

Means for maintaining a variable vacuum in the boiler is the pump 32, which is
 85 operated and controlled in the usual man-

ner, and a usual pressure gauge 37 is employed in connection therewith. By means of the pump 32 any desired degree of vacuum may be maintained in the restricted expansion space 8 to thereby variably regulate
 70 the velocity flow of the mercury vapor through this space and thus control the rate of transfer of the heat of the vapor by the wall 9 to the liquid under treatment.

My invention finds application in connection with chemical and pyro-chemical reactions, where high temperatures are necessary, and in its use has given excellent results.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is—

1. The process of indirect heating which consists in imparting heat to mercury to boil it at one region in a circulating system, absorbing heat from the mercury vapor at another region in the system, and returning the condensed vapor to the region at which the mercury is boiled, while applying suction to the system at a point near the region of condensation, whereby the boiling point is reduced, and the lighter uncondensable gases, if any are present, are removed.

2. The process of indirect heating which consists in imparting heat to mercury to boil it at one region in a circulating system, absorbing heat from the mercury vapor at another region in the system, and returning the condensed vapor to the region at which the mercury is boiled, and withdrawing impurities from the system during operation at a point where non-condensing gases tend to collect.

3. The process of indirect heating through a closed circulating system which consists in imparting heat to the mercury to form mercury vapor while subjecting the entire system to a pressure materially less than atmospheric, admitting said mercury vapor within a space around the heat transferring wall to condense at a predetermined temperature and returning the condensate to the body of mercury subjected to heat.

4. The method of performing endo-thermic operations requiring the application of heat within a narrow range of critical high temperature, which consists in providing in contact with the heat absorbing wall a rapid flow of the vapor of a medium having low specific heat, high vaporization temperature and normal atmospheric boiling point higher than said range, and rapidly removing the condensate from contact with said wall, while regulating the condensation temperature of said medium within said critical range of constant temperature by maintaining a corresponding vacuum.

5. The process of indirect heating through a closed circulating system which consists in imparting heat to the mercury to form mer- 130

- cury vapor while subjecting the entire system to a pressure materially less than atmospheric, admitting said mercury vapor within a space around the heat transferring wall to condense at a predetermined temperature and returning the condensate to the body of mercury subjected to heat, and preventing reverse flow of mercury vapor through the return path for the condensate.
6. The method of indirect heating which method consists in generating and applying heat to boil mercury; causing circulation of the mercury through an external closed circuit including separate lead and return conduits and an interposed condensing space of relatively small volume; maintaining in said space a predetermined approximately constant vacuum, sufficient to cause high velocity flow of the mercury vapor into said space and also sufficient to maintain the entire circulating system under a pressure less than atmospheric throughout all variations

in quantity and velocity of the mercury vapor; and maintaining a body of condensate in the return conduit of the circuit to prevent reverse flow of mercury vapor from the boiling space to the condensing space through the return conduit, whereby the expansion energy of the mercury vapor is utilized in producing high velocity circulation in said expansion space, and whereby said condensing wall is maintained at an approximately uniform temperature and variations of quantity of heat absorbed thereby are compensated for by variation of the high velocity flow of the mercury vapor into contact with said wall.

In testimony that I claim the foregoing as my invention, I have signed my name in presence of two subscribing witnesses.

CROSBY FIELD.

Witnesses:

HENRY BAUM,
A. R. TANNER.