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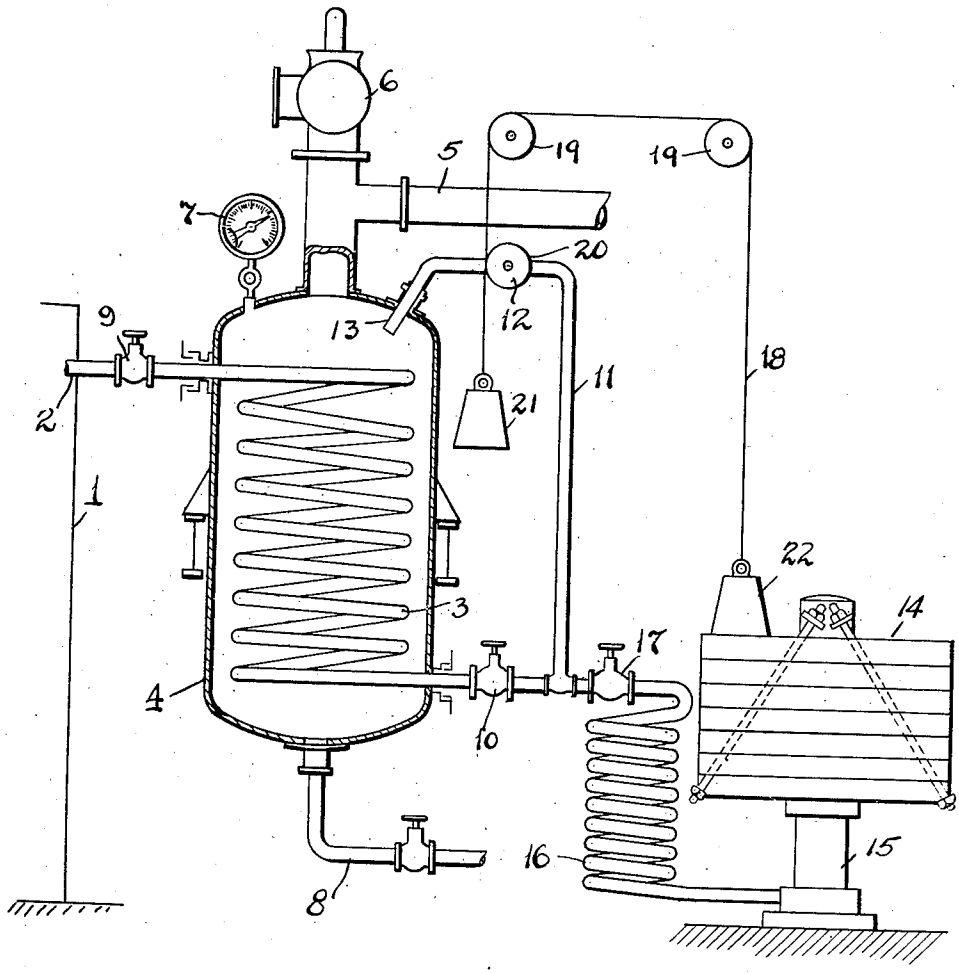

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LIQUID HEATING AND VAPORIZING

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This invention relates to liquid heating and vaporizing, and more particularly the management of fluids under high pressures. In the processing of liquids at high pressure and elevated temperature, and in other arts involving the handling of liquids at high pressure and elevated temperature, it is usually necessary to reduce such pressure to atmospheric and it is well known that considerable difficulty is encountered in so doing. One object of the present invention is to mitigate the duty or lessen the wear on the reducing valve or equivalent pressure reducing device that is necessarily employed for the purpose of discharging such high pressure, high temperature liquid, such valve or device, as is well known, being subject to scour, pitting or corrosion by the hot liquid, resulting in short life and high upkeep charges. It is, of course, much simpler to design and build a satisfactory pressure reducing valve for operation at a lower temperature than at such higher temperature, and at the same time the risk of accident to attendant or operator is also markedly less. A further object of the invention is to transfer the heat from the high pressure, high temperature liquid to a low pressure, lower temperature liquid or specifically to the same liquid at such low pressure and lower temperature so that the sensible heat available for self evaporation of the liquid at such lower pressure may be usefully employed for this purpose. In other words, the same results are attained as would have been were the high pressure, high temperature liquid to be directly discharged and expanded.

While the improved process constituting the invention is not limited to use with any particular liquid having the characteristics just described, a particular application of the invention is found in the reduction in pressure of the treated liquor in a process wherein a chemical reaction is continuously carried on in an autoclave or equivalent apparatus. In such case, it is desirable or necessary to maintain a specified pressure and temperature in a continuously flowing body of liquid and this in turn requires the continuously throttling of such flow from the high pressure to such lower pressure as may be convenient for the next step.

A still more specific application is to the processing of a mixture of chlorobenzene and water solution of caustic soda for the production of phenol. Here both pressure and temperature are abnormally high and it has been found extremely difficult to construct and maintain valves capable of withstanding the service for any length of time. In this last mentioned process, one of the steps following the reaction in the autoclave is the vaporization of the resulting liquor for the elimination of sodium chloride and production of a concentrated solution of sodium phenate. For example when operating at in excess of 3,000 pounds pressure per square inch and a temperature of approximately 350° C., there is enough sensible heat stored in the liquor after treatment to evaporate a large fraction of such liquor when the pressure is reduced. This evaporation, which may be termed "self-evaporation", results from the conversion of stored sensible heat into latent heat through reduction in pressure and, if obtained, obviously saves steam or other form of heat in subsequent concentration of the liquor and also has other advantages connected with separation of various products and their impurities. Because of the difficulty involved in throttling the hot liquor through a reducing valve, the practice heretofore has been first to cool the liquid before reducing its pressure and thereby waste the stored heat, which might otherwise be employed for such self evaporation.

To the accomplishment of the foregoing and related ends, the invention, then, consists of the features hereinafter fully described, and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail but one of the various ways in which the principle of the invention may be employed.

In said annexed drawing:—

The sole figure is a side elevation, partly in section, showing one form of apparatus contemplated in the invention.

Referring more particularly to the draw-

ing, the furnace 1 in which the pipe 2 is heated, is merely diagrammatically indicated, and the detail construction of such pipe heaters being well known, any further illustration of the structure either of it or such furnace is here unnecessary. From the heating furnace, the pipe 2 extends as a container for the hot fluid under high pressure, such container preferably taking the form of a coil 3. About the container or coil is a casing 4 that forms an enclosure chamber therefor, such chamber having a vapor offtake 5 leading to a condenser system of any desired form, the detail of which it is unnecessary to show. A safety valve 6 is provided for said chamber, also a pressure gauge 7, and from the bottom of the chamber leads a valve-controlled drain line 8.

A valve 9 is desirably interposed in the line 2, and at the outlet from the coil 3 is another valve 10, beyond which the line is divided to form two branches. One such branch 11 is controlled by a valve 12 beyond which it communicates with the casing 4, for instance by a nozzle 13 that is directed upon the coil 3.

The valve 12 may be operated or controlled by hand if desired, or in any other suitable manner, but preferably I provide an automatic control in the form of a pressure-responsive device in mechanical connection with the valve. A convenient arrangement for this device is a so-called accumulator, as illustrated, consisting of a pressure chamber 15 with a plunger carrying a heavy weight 14, such chamber being connected with the other branch 16 of line 2. This branch desirably takes the form of a cooling coil, so that the hot liquid in the line will not come in direct contact with the accumulator device and a valve 17, as shown, is preferably interposed in the branch in advance of the coiled portion thereof, between the cooling coil and the connection line. For the purpose of operatively connecting said accumulator with valve 12, a flexible cable or the like 18 extends over sheaves 19 and to a hitch about the sheave 20 fixed to the valve stem, thence extending to a weight 21 while the lead-end of the cable is conveniently secured to the weight 14 by means of a second weight 22 which rests upon the first.

The portion of pipe 2 that lies within the furnace being suitably heated, and the fluid therein raised to high temperature and under high pressure, the fluid proceeds on through the coil 3 and into the branch 11 and the cooling coil 16. From the latter, the cooled fluid impresses its pressure upon the accumulator device and correspondingly brings about, through the cable 18 and valve 12, an opening of the valve so that the fluid from the connection 11 jets out upon the coil 3. The fluid as discharged from the nozzle 13 into the larger passageway represented by the casing 4, is lowered in pressure, and coming in contact with the coil 3, a heat transfer from the container of the highly heated presure fluid therein occurs with the resultant vaporization of the fluid thus applied to the outer surface of the coil.

The vapor produced in this manner passes off by the offtake 5 to the condenser system and its heat may be usefully employed for other purpose or wasted; while the residual liquid will be drained either continuously or intermittently through pipe 8. If desired, the valve in the latter may be so adjusted as to maintain a body of the liquid in the lower portion of chamber 4, in which body the lower portion of coil 3 will be immersed.

It will thus be seen that with hand control or automatic control, as the case may be, for the valve 12, the highly heated high-pressure fluid in the coil container 3 is externally subjected to or brought into contact with the same fluid as passed on out from the coil into the casing. A corresponding vaporization of the fluid occurs in the casing and at the same time heat is taken up from the coil by the fluid thus applied to the exterior of the coil, as jetted thereon. In this manner all the sensible heat available for self-evaporation is effective through absorption after pressure reduction and step-down from very high pressures and temperatures is made practicable with a valve which would not function as well or as safely on the original high temperature liquid. The invention accordingly makes practicable the discharge of the high pressure, high temperature liquid through a valve of usual type not ordinarily adapted for use at such high temperatures by partially cooling the liquid before release of pressure thereon and accomplishing such cooling by the evaporation of the liquid after discharge thereof, at the same time conserving a portion of the sensible heat of the reaction mixture which would otherwise be lost.

Should a rupture of coil 3, i. e. of that portion of pipe 2 lying within chamber 4 occur, with attendant release of high-pressure liquid within chamber 4, the safety valve 6 will function to vent the same, and such safety valve may be connected to any receiver or other device suited to conserve the vented liquor and vapor, if desired.

Other modes of applying the principle of the invention may be employed, change being made as regards the details disclosed, provided the steps stated in any of the following claims, or the equivalent of such, be employed.

I therefore particularly point out and distinctly claim as my invention:—

1. The method of simultaneously discharging and concentrating a high pressure, high temperature fluid reaction mixture, such mixture including a vaporizable constituent

and a dissolved solid constituent, which comprises cooling such high pressure mixture by passing same in heat exchange relation with said mixture following discharge thereof, which heat exchange is accomplished by venting such cooled mixture with release of pressure and bringing said vented mixture into indirect heat exchange contact with the high pressure mixture before discharge, whereby the cooling of the latter is effected by evaporation of the discharged liquid.

2. The method of simultaneously discharging and concentrating a high pressure, high temperature fluid reaction mixture, such mixture including a vaporizable constituent and a dissolved solid constituent, which comprises cooling such high pressure mixture by passing same in heat exchange relation with said mixture following discharge thereof, which heat exchange is accomplished by venting such cooled mixture with release of pressure and bringing said vented mixture into indirect heat exchange contact with the high pressure mixture before discharge, whereby the cooling of the latter is effected by the evaporation of the discharged liquid and controlling the rate of discharge in accordance with the pressure of the initial mixture.

3. The method of simultaneously discharging and concentrating a high pressure, high temperature fluid reaction mixture, such mixture including a vaporizable constituent and a dissolved solid constituent, which comprises cooling such high pressure mixture by exchange of heat with said mixture after discharge thereof, which heat exchange is accomplished by venting such cooled mixture with release of pressure and directing such vented mixture upon the external surface of the container for the high pressure liquid, whereby evaporation of such discharged liquid is effected by transfer of heat from the high pressure liquid.

4. In the manufacture of phenol, reacting chlorobenzene and an aqueous caustic alkali solution by heating at a high temperature and pressure and cooling the reaction mixture by passing the same in heat exchange relation with said mixture following discharge thereof, which heat exchange is accomplished by venting such cooled mixture with release of pressure and bringing such vented mixture into indirect heat exchange contact with the high pressure liquid before discharge, whereby the cooling of the latter is effected by evaporation of the discharged liquid.

5. In the manufacture of phenol, reacting chlorobenzene and an aqueous caustic alkali solution by heating at a high temperature and pressure, cooling the reaction mixture by passing the same in heat exchange relation with said mixture following discharge thereof, which heat exchange is accomplished by venting such cooled mixture with release of pressure and bringing such vented mixture into indirect heat exchange contact with the high pressure liquid before discharge, whereby the cooling of the latter is effected by evaporation of the discharged liquid, and controlling the rate of discharge in accordance with the pressure of the initial mixture.

6. In the manufacture of phenol, reacting chlorobenzene and an aqueous caustic soda solution at a temperature of approximately 350° C. and a corresponding pressure in excess of 3000 pounds per square inch and cooling the reaction mixture before discharge thereof by exchange of heat with said mixture after release of pressure thereon, which heat exchange is accomplished by venting such cooled mixture and directing such vented mixture upon the external surface of the container for the high pressure liquid, whereby evaporation of such discharged liquid is effected by transfer of heat from the high pressure liquid.

Signed by me this 10th day of March, 1927.

ALBERT P. BEUTEL.