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[33] **Germany**
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[54] **HEAT-EXCHANGING METHOD AND APPARATUS**
6 Claims, 1 Drawing Fig.

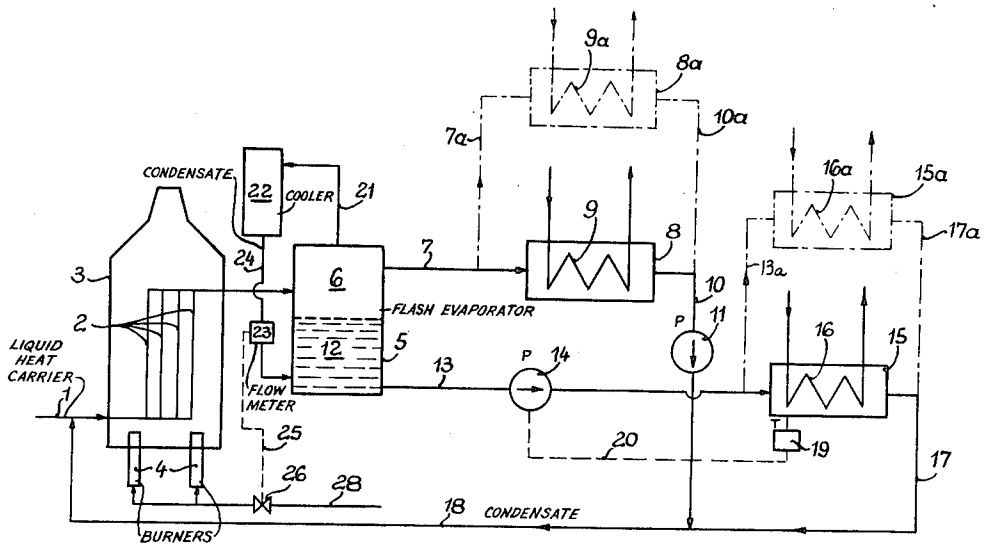
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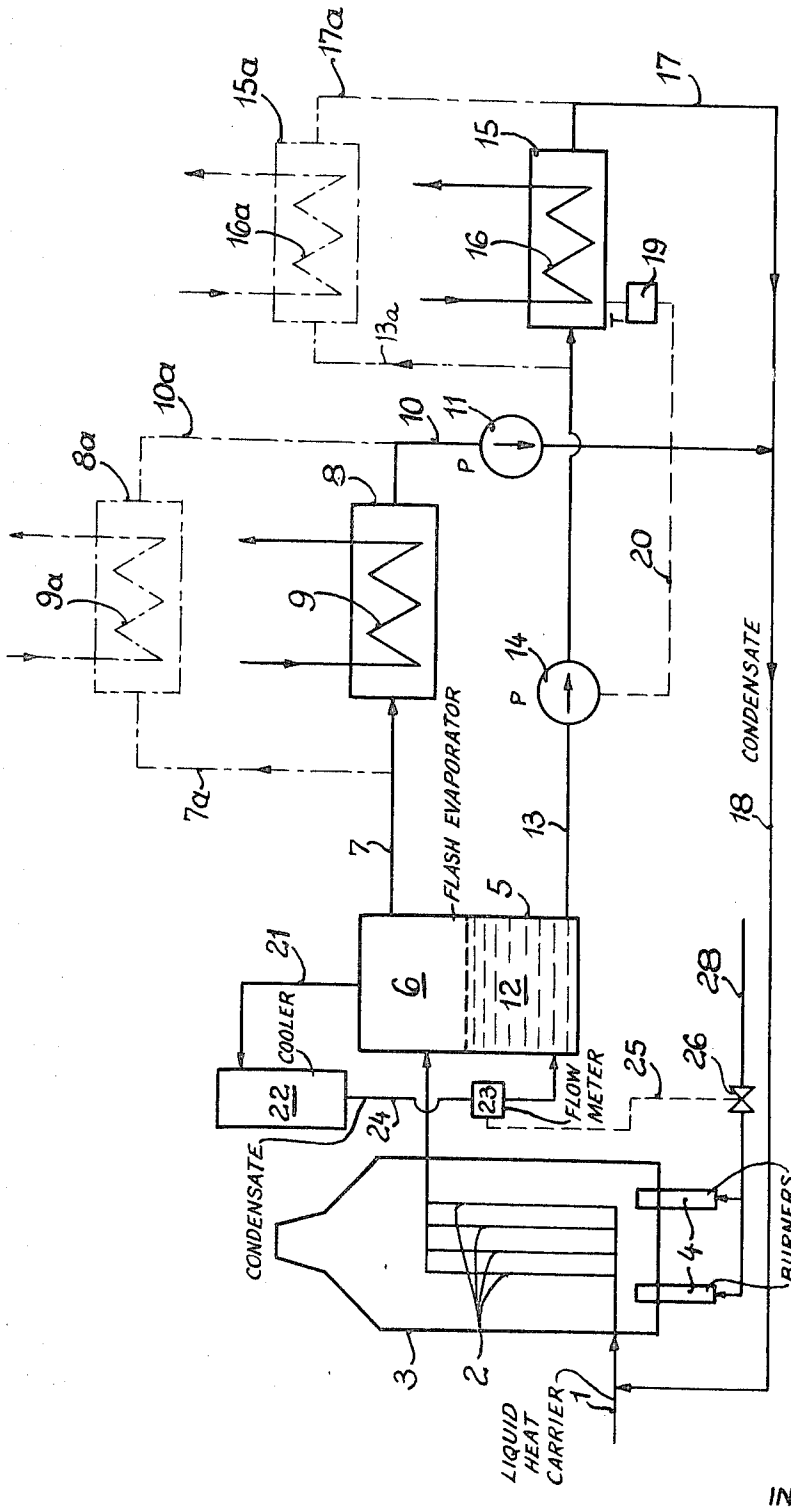
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ABSTRACT: Water is heated in a furnace at slight overpressure to saturation temperature and is thereupon discharged in a flash evaporator to form a vapor phase and a liquid phase. The gaseous phase is employed to heat one or more fluids in one or more first heat exchangers, and the liquid phase is used to heat one or more fluids in one or more second heat exchangers. Cooled liquid phase is pumped back into the furnace, together with the condensed vapor phase. The heating action in the furnace is regulated in dependency on the rate at which the vapor phase must be evacuated from the flash evaporator to maintain the pressure therein at exchangers. constant value, and the rate at which the liquid phase is caused to flow through the second heat exchanger or exchangers is a function of temperature in such heat exchangers.





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HEAT-EXCHANGING METHOD AND APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to improvements in a method and apparatus for effecting exchange of heat between a flowing heat carrier and two or more condensable vaporous of liquid fluids. More particularly, the invention relates to a heat-exchanging method and apparatus wherein the heat carrier is a liquid at normal temperature and pressure. Still more particularly, the invention relates to improvements in a method and apparatus for effecting indirect exchange of heat between a normally liquid heat carrier and two or more fluids which should be heated under different circumstances.

SUMMARY OF THE INVENTION

An object of the invention is to provide a simple, compact, inexpensive and long-lasting heat-exchanging apparatus which can be employed in petrochemical and/or other plants for controlled exchange of heat between an evaporable heat carrier and two or more fluids.

Another object of the invention is to provide a method of exchanging heat between a normally liquid heat carrier and two or more fluids which must be heated under different circumstances, e.g., to a different temperature and/or at a different speed.

A further object of the invention is to provide a method which utilizes a relatively small amount of heat carrier and wherein such heat carrier can be reused as often and as long as desired.

An additional object of the invention is to provide a method according to which the circumstances under which one or more fluids are heated by indirect exchange of heat with a heat carrier can be regulated within a desired range.

The improved method is employed to effect exchange of heat between a plurality of fluids and a heat carrier which is a liquid at normal temperatures and pressures. The method comprises the steps of conveying an evaporable heat carrier at elevated pressure through a heating zone where the carrier is heated to saturation temperature, conveying the thus heated carrier through an evaporating zone and simultaneously reducing the pressure upon the carrier so that it yields a gaseous phase and a liquid phase, conveying the gaseous phase through at least one first heat-exchanging zone and withdrawing heat from the gaseous phase by indirect contact with at least one first fluid (which is preferably heated rapidly to below a predetermined temperature) whereby the gaseous phase forms a stream of condensate, conveying the liquid phase through at least one second heat-exchanging zone and withdrawing heat from such liquid phase by indirect contact with at least one second fluid (which is preferably heated at a controlled rate), and returning the thus cooled liquid phase and the condensate to the heating zone.

In accordance with another feature of the invention, the method preferably further comprises the steps of measuring the temperature of liquid phase in the second heat-exchanging zone and regulating the rate at which the liquid phase is conveyed through the second heat-exchanging zone as a function of such temperature.

In accordance with still another feature of the invention, the method further comprises the steps of withdrawing from the evaporating zone a variable quantity of gaseous phase to maintain the pressure in the evaporating zone at a substantially constant value, cooling the thus withdrawn gaseous phase to produce a current of condensate, conveying the thus obtained condensate along a confining path and measuring the rate of flow in such path, and regulating the heating action in the heating zone as a function of the result of measurement of such rate.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved heat-exchanging apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will

be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE is a diagrammatic sectional view of a heat exchanging apparatus which embodies the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The apparatus which is shown in he drawing comprises a feed conduit **1** serving to supply water or another heat carrier which is a liquid at a normal temperature (about 20° C.) and normal pressure (1 atmosphere) into the coils or tubes **2** installed in a heating zone defined by a furnace **3** which further includes one or more burners **4**. The burners heat the water in the coils **2** under pressure to saturation temperature and the water is simultaneously maintained at a slight pressure which insures that evaporation does not occur before the thus heated water enters an evaporation zone accommodating a flash evaporator **5**. Due to sudden drop in pressure, the water yields a vapor phase which accumulates in the upper part **6** and a liquid phase which accumulates in the lower part **12** of the evaporator **5**. The gaseous phase is conveyed through a conduit **7** and a first heat-exchanging zone accommodating a first heat exchanger **8** wherein the gaseous phase indirectly exchanges heat with a fluid which is caused to flow through a coil **9**. The purpose of the heat exchanger **8** is to heat the fluid in the coil **9** to a temperature which should not exceed a predetermined value and/or to insure that such heating of fluid in the coil **9** takes place rapidly. The gaseous phase is cooled and is thus converted into condensate which forms a stream flowing in a conduit **10** which accommodates a suitable pump **11**. The conduit **10** discharges condensate into a return conduit **18** which supplies such condensate into the feed conduit **1**, i.e., back to the heating zone defined by the furnace **3**.

The liquid phase which accumulates in the lower part **12** of the flash evaporator **5** is conveyed along a confining path defined by a conduit **13**, a second heat exchanger **15** which is installed in a second heating zone, a further conduit **17**, and the return conduit **18**. A variable delivery pump **14** in the conduit **13** serves as a means for conveying the liquid phase at a desired rate. The heat exchanger **15** comprises a coil **16** for a fluid which should be heated at a controlled rate i.e., the fluid in the coil **16** should receive from the liquid phase heat in an accurately determined manner, for example, to avoid too sudden or too slow heating and eventual damage to such fluid. The thus cooled liquid phase then flows through the conduits **17**, **18** and back into the feed conduit **1** to be returned into the heating zone.

In order to insure that the fluid in the coil **16** is heated at a desired rate, the apparatus further comprises a detector **19** which measures the temperature in the liquid phase flowing through the heat exchanger **15** and transmits to the pump **14** signals by way of a suitable conduit or conductor **20** so that the rate of delivery of the pump **14** is a function of the temperature of liquid phase in the heat exchanger **15**.

A further conduit **21** communicates with the upper portion **6** of the flash evaporator **5** to convey from the latter such quantities of gaseous phase that the pressure in the flash evaporator remains constant. The thus withdrawn vapor phase is caused to pass through a cooler **22** to yield a current of condensate which is caused to flow along a confining path defined by a conduit **24** discharging into the lower part **12** of the flash evaporator. The conduit **24** contains a suitable flow meter **23** which measures the rate of flow of condensate therein and transmits signals by way of a conduit or conductor **25** which controls an adjustable fuel-admitting valve **26** in a supply conduit **28** which delivers fuel to the burners **4**. Thus, the heating action of burners in the heating zone defined by the furnace **3** is a function of the rate of condensate flow in the conduit **23**.

It is clear that the apparatus can and normally does comprise several additional parts, such as various gauges, pres-

sure-regulating devices and/or others, which were omitted for the sake of clarity.

The improved apparatus can be employed with equal advantage for effecting exchange of heat between the gaseous and/or liquid phase and two or more fluids. For example, and as indicated in the drawing by phantom lines, the conduit **7** may include at least one branch **7***a* which delivers gaseous phase into a heat exchanger **8***a* containing a coil **9***a* for a further fluid. A conduit **10***a* delivers condensate from the heat exchanger **8***a* into the conduit **10**. The liquid phase which is conveyed by the pump **14** can flow through at least one branch conduit **13***a*, through a heat exchanger **15***a* containing a coil **16***a* and through a conduit **17***a* into the conduit **17** or directly into the return conduit **18**.

The improved heat exchanging apparatus has been found to be particularly suited for use in plants wherein one or more fluids must be rapidly heated to a temperature which should not exceed a given value and wherein one or more fluids must be heated in such a way that the transfer of heat from the heat carrier to such fluids takes place in an accurately determined and readily adjustable way (i.e., the fluid or fluids should be heated with great care to avoid solidification, condensation, overheating, decomposition and/or other undesirable results). The apparatus of my invention can be used in petrochemical plants including refineries, distilling plants and/or others, as well as in many other industries where two or more fluids must be heated in the aforedescribed manner.

As stated above, the heat carrier may be water; however, it is equally possible to employ many other types of fluids which are liquids at normal temperature (about 20° C.) and at normal pressure (about one atmosphere). Several types of organic fluids can be used instead of water. The exact nature of the heat carrier depends on the desired range of temperatures in the heat exchangers. As a rule, the heat carrier is selected in such a way that its boiling point corresponds to or approximates the maximum permissible temperature to which the fluid in one or more heat exchangers can be heated. This insures that the phases of the heat carrier cannot cause overheating of fluids.

Another characteristic which is often important in selection of the heat carrier is the pressure to which the heat carrier must be subjected prior to entry into the evaporator. It is normally preferred to employ a heat carrier which can be maintained at a relatively low-overpressure because the apparatus employing such heat carrier are simpler, more compact, safe and cheaper because the devices which produce elevated pressures as well as the devices which insure safety of operation at elevated pressures can be dispensed with.

Vapor which is conveyed from the upper portion **6** of the flash evaporator **5** is particularly suited for rapid heating of one or more fluids to a temperature which does not exceed a given value. On the other hand, the hot liquid phase in the lower part **12** of the evaporator **5** is especially suited for controlled heating of one or more fluids to a temperature which should not exceed a given value, namely, that temperature at which the heat carrier would evaporate.

The heating action in the heating zone defined by the furnace **3** can be regulated with desired accuracy by the aforementioned flowmeter **23** which determines the rate of condensate flow per unit of time and sends appropriate impulses to the adjustable fuel admitting valve **26** in the supply conduit **28**. When the rate of condensate flow in he conduit **24** exceeds a certain value, this indicates that an excessive percentage of heated water entering the flash evaporator **5** is converted into the vapor phase, namely the temperature is too high. The valve **26** is then adjusted in a manner to reduce the delivery of fuel to the burners **4** and to thus reduce the heating action upon the heat carrier in the coils **2**. If the rate of condensate flow decreases the temperature is too low, the heating action in the furnace is insufficient and the flow meter **23** produces impulses which result in increased rate of fuel flow to the heaters **4**. The detector **19** is of well-known design; its function is to ascertain the temperature in the heat exchanger **15** and to regulate the delivery of the pump **14** in accordance with the result of such measurement, namely, high temperature reduces the pump speed and low temperature increases the pump speed. It is clear that a similar detector can be provided to determine the temperature in the heat exchanger **15***a* and that the pump **14** can be adjusted in response to signals from both such detectors.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of my contribution to the art.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

1. A method of exchanging heat between a plurality of fluids and a heat carrier which is a liquid at normal temperatures and pressures, comprising the steps of conveying an evaporable liquid heat carrier at elevated pressure through a heating zone where the carrier is superheated to saturation temperature; conveying the thus heated carrier into a flash evaporating zone under reduced pressure so that the carrier yields a vapor phase and a liquid phase; conveying a portion of said vapor phase through at least one first heat-exchanging zone and withdrawing heat from said vapor phase portion by indirect contact with at least one first fluid whereby the vapor phase portion forms a first stream of condensate; conveying the liquid phase through at least one second heat-exchanging zone and withdrawing heat therefrom by indirect contact with at least one second fluid; returning the thus cooled liquid phase and said first stream of condensate to said first-mentioned heating zone; discharging from said flash evaporating zone another variable portion of said vapor phase so as to prevent overpressure in said evaporating zone; cooling said other withdrawn vapor phase portion to produce a second stream of condensate; conveying he thus obtained second stream of condensate along a confined path and measuring its rate of flow in said path; and regulating the heating action in said first-mentioned heating zone as a function of the result of measurement of said rate to prevent overheating in the evaporating zone by decreasing the rate of fuel flow when the flow rate of said second stream of condensate exceeds a given amount.

2. A method as defined in claim **1**, wherein said vapor phase is conveyed through a plurality of first heat-exchanging zones.

3. A method as defined in claim **1**, wherein said liquid phase is conveyed through a plurality of second heat exchanging zones.

4. A method as defined in claim **1**, wherein said step of conveying said first stream of condensate to said first-mentioned heating zone comprises subjecting said first stream of condensate to a pumping action and wherein said steps of conveying the liquid phase through the second heat exchanging zone and to said first-mentioned heating zone comprises subjecting the liquid phase to a pumping action.

5. A method as defined in claim **1**, further comprising the steps of measuring the temperature of the liquid phase in said second heat-exchanging zone and regulating the rate at which the liquid phase is conveyed through said second heat-exchanging zone as a function of such temperature by increasing the liquid phase flow rate when the temperature falls below a given value and decreasing the liquid phase flow rate when the temperature rises above said given value.

6. Apparatus for effecting exchange of heat between a plurality of fluids and a heat carrier which is a liquid at normal temperature and pressure, comprising a first heating means for heating a stream of evaporable heat carrier as a liquid to a predetermined temperature at elevated pressure; flash evaporator means arranged to receive the thus heated liquid carrier from said heating means so that the carrier entering said evaporator means yields a vapor phase and a liquid phase; first conduit means passing from said evaporator means to and through a second heating means including at least one first heat exchanger wherein the vapor phase which leaves said

evaporator means by way of said first conduit means indirectly exchanges heat with at least one first fluid and forms a first stream of condensate which is returned to said first heating means for reheating; second conduit means passing from said evaporator means to and through a third heating means including at least one second heat exchanger wherein the liquid phase which is evacuated from said evaporator means by way of said second conduit means indirectly exchanges heat with at least one second fluid whereupon the thus cooled liquid phase reenters said first heating means for reheating; variable delivery pump means in said second conduit means; and detecting and control means arranged to measure the temperature of the liquid phase in said second heat exchanger and to regulate the delivery of said pump means as a function of such temperature by decreasing the delivery rate with increasing temperature, and vice versa.