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HEAT EXCHANGER

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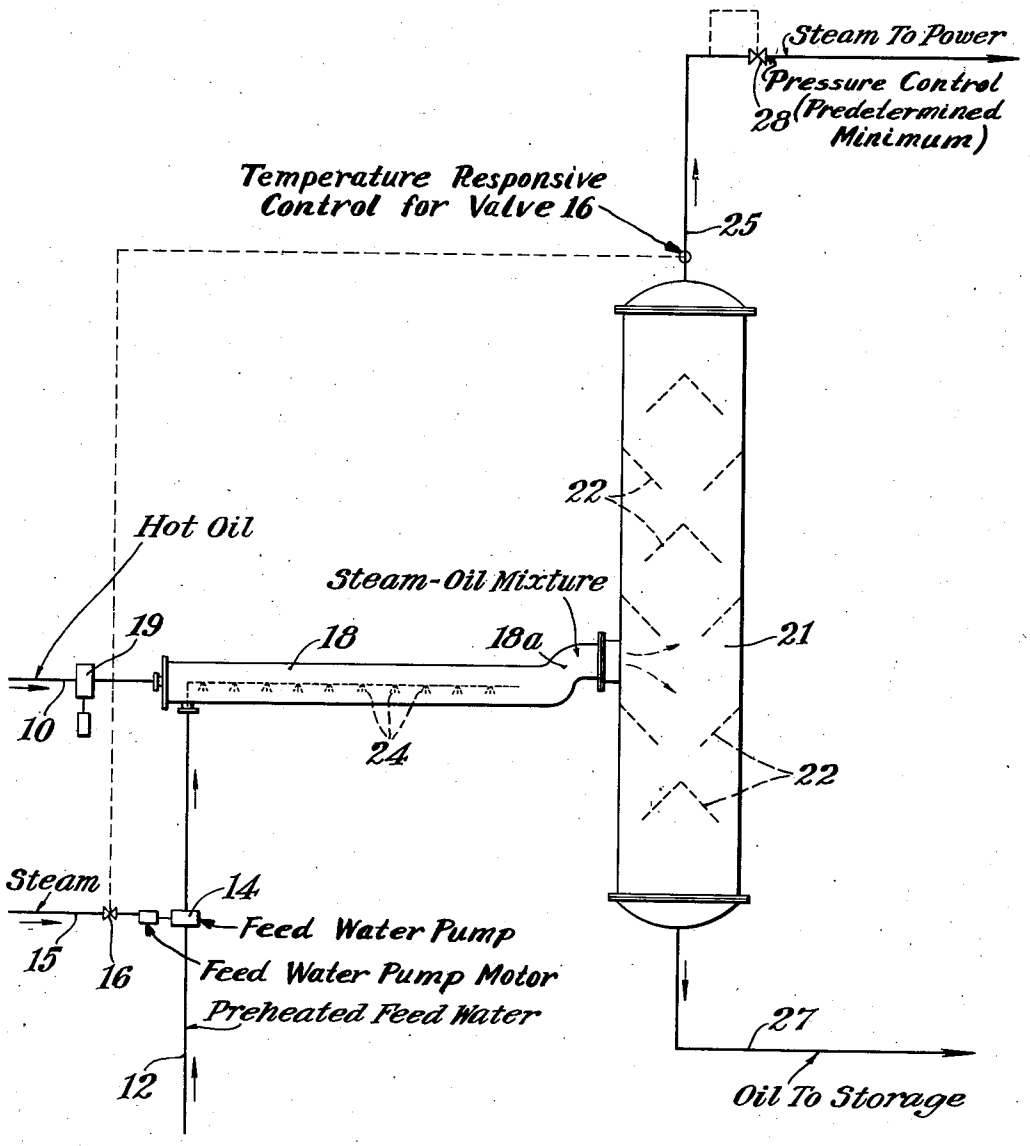

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HEAT EXCHANGER

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6 Claims. (Cl. 122—31)

This invention relates to improvements in waste heat economizers and more particularly to methods and apparatus for vaporizing water by the heat of petroleum products for the purpose of generating steam for power purposes and cooling the petroleum products.

In modern petroleum refining practise, liquid streams of high heat content are frequently cooled without heat recovery due to their coking or fouling tendency, which renders them impracticable for use in conventional heat transfer equipment. This is particularly true of cracked residuum or fuel oil streams which are available at high temperatures.

It is the principal object of my invention to provide an improved apparatus and method for generating steam by direct contact of the water with an available high temperature fluid, such as fuel oil, which it is desired to cool prior to storage.

A more specific object of the invention is to provide an improved control for the formation of steam by vaporization of water in direct contact with a relatively high temperature fluid with the water introduced in controlled quantities into the hot fluid so that the water is subject to complete evaporation as determined by temperature and pressure controls on the steam discharge line.

Another and more specific object of my invention is to provide an improved method for simultaneously cooling stripped fuel oil and forming dry and preferably superheated steam by mixing the water with the fuel oil in controlled amounts and subsequently separating the oil from the steam, such steam being substantially free of moisture or oil whereby it may be efficiently used for power.

Further objects and advantages of the invention will appear from the following description of a preferred form of embodiment of my invention taken in connection with the attached drawing which is a diagrammatic layout of apparatus by which steam can be generated as a waste heat by-product from a liquid to be cooled.

In accordance with a preferred form of embodiment of my invention, useful power steam is obtained by heat transfer with a high temperature petroleum product. Although not limited to any particular high temperature fluid and not necessarily a petroleum product, I find that the stripped fuel oil fraction from cracking stills, the cooling of which has offered many difficulties heretofore, is a most satisfactory heat source for this purpose. Not only is the temperature adequate, but the quantity is relatively great. Furthermore, the fuel oil having been stripped, does not contain volatile oils which would carry over with the steam.

Assuming, for the purpose of describing this invention that the incoming hot fluid which enters at 10 is a stripped fuel oil fraction and customarily at a high temperature (such as 650° F.), this material is used to generate steam from a preheated feed water entering at 12. The water is suitably pumped by feed pump 14 into the steam generator 18, such pump being conveniently operated from steam line 15 which is provided with control 16.

The steam generator 18 preferably consists of an elongated chamber into which the hot fuel oil is pumped at 19. The water is simultaneously discharged into this oil in a spray form as by a plurality of nozzles 24. The relatively high temperature of the fuel oil and the relatively fine spray of the water assure the immediate vaporization of the water and the steam is carried through the inclined portion 18a of the generator with the oil into expansion chamber 21. This inclined section 18a tends to prevent separation of steam and oil in the steam generator 18, thereby assuring an intimate mix of oil and water therein.

The expansion chamber 21 is provided with a plurality of suitably arranged baffles 22 above and below the entering zone and they tend to separate out all possible oil carried by the steam as well as to separate the steam from the oil. The oil free steam is then discharged overhead at 25. The temperature of discharge may be in the range of 365° F. which is approximately equivalent to steam at 110 #/sq. in. gage at 20° superheat. The reason for the superheat will appear hereinafter.

The safety of this type of direct contact steam generation is assured by the control of the product steam. The steam is under a predetermined pressure, set by pressure control 28. The feed water control 16 is then set in accordance with the temperature necessary for superheat at the predetermined pressure. It will be apparent that all the steam that discharges is thus necessarily superheated and no water can accumulate in the generator. If the steam temperature drops, the flow of water through feed pump 14 is reduced until the water is evaporated and the steam superheated. Under such conditions there can be no accumulation of water, and there is no possibility of a sudden vaporization of large quantities of water which might prove dangerous. If desired,

recording volume controls could also be used as a visual check to assume that the steam volume discharged at 25 was proportionately equal to the feed water inflow volume at 12.

Under normal conditions, such as heretofore described, approximately eight times as much oil, by weight, will pass through the generator as water. There is no difficulty in regulating the relative flow of materials and the fuel oil can be readily withdrawn at 27 for storage or further cooling as may be desired. Ordinarily, this temperature will be in the range of 450° F., which assures adequate heat transfer to make useful steam and also is a material saving in heat transfer requirements. It is of course obvious that the temperatures and pressures mentioned are purely suggestive and may be changed to suit conditions.

While I have shown a preferred form of embodiment of my invention, I am aware that other modifications may be made thereto and I therefore desire a broad interpretation of my invention within the scope and spirit of the disclosure herein and of the claims appended hereinafter.

I claim:

1. A waste heat economizer of the class described comprising a chamber for the reception of a heating fluid and water, means to pump water into said chamber for the formation of steam therefrom, a pressure control for said steam and a temperature control set for said pressure control, and means to interconnect said temperature control with the water pump means so that the water inflow is stopped unless the steam generated is dry.

2. The method of controlling the formation of steam by direct contact with a hot liquid which comprises the step of establishing a predetermined pressure for the steam, selecting a temperature in excess of the temperature of dry steam for the predetermined pressure, and controlling the water inlet by the selected temperature.

3. The method of forming power steam from the waste heat of a heavy residual petroleum having a low vapor pressure which comprises the steps of introducing said residual petroleum into a chamber, spraying water into contact with said residual petroleum, expanding said petroleum water mixture under conditions to vaporize the steam without substantial vaporization of the petroleum, removing said steam and controlling the inflow of water by the temperature of said steam discharge said temperature being selected with respect to the operating pressure so that water cannot concentrate in the system.

4. A waste heat economizer of the class described including a chamber for the reception of a heating fluid and water, means to continuously introduce hot heating fluid into said chamber, means to pump water into said chamber for the formation of steam therefrom, a steam discharge conduit for said chamber, a steam superheat control means interconnected between the steam discharge conduit and the water pump means, a pressure control for said chamber, said superheat control means being set for dry steam at the pressure set by said pressure control, and means effected by said superheat control means to stop the water inflow unless the steam generated has a temperature in excess of the temperature of saturated steam at the operating pressure, and means for the continuous removal of the cooled heating fluid.

5. A heat exchanger to cool a hot liquid and to vaporize water to form power steam which includes a steam generating chamber having a hot liquid inlet and a water inlet, said water inlet having spray forming devices to finely subdivide the water, an expansion chamber interconnected with the steam generating chamber for the separation of the generated steam from the liquid, means in the expansion chamber to separate entrained liquid from the steam, a steam discharge conduit for said expansion chamber, a pressure control in said steam discharge conduit, a temperature control means in said steam discharge conduit set for said pressure control, said temperature control means being adapted to stop the inflow of water unless the temperature of the steam generated is in excess of the temperature of saturated steam at the pressure of operation, and means to continuously remove the cooled liquid from the expansion chamber.

6. A steam generator including an elongated, horizontal chamber, means to introduce a hot, substantially non-volatile liquid thereinto, means to spray water into contact with said hot liquid, an expansion chamber in communication with said elongated chamber for the separation of the generated steam from the hot oil, a trap in said horizontal chamber adjacent the expansion chamber to prevent separation of the steam from the oil before entry of the mixture of steam and oil into the expansion chamber, means in said expansion chamber to knock out liquid entrained by the steam, a steam discharge conduit for said expansion chamber, means to control the pressure in said expansion chamber, a steam temperature control means set for said pressure control means, means controlled by said temperature control means to stop the water inflow unless the steam generated has a temperature in excess of the temperature of saturated steam at the operating pressure, and means to withdraw the cooled non-volatile liquid from the expansion chamber.

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