United States Patent

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[54] **GAS COOLING APPARATUS AND PROCESS**
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165/177, 285/187
[51] Int. Cl. **F28f 1/00**
[50] Field of Search 165/154, 1,
81, 177, 178, 155, 156, 138; 23/284, 292, 288.9;
122/32; 285/187

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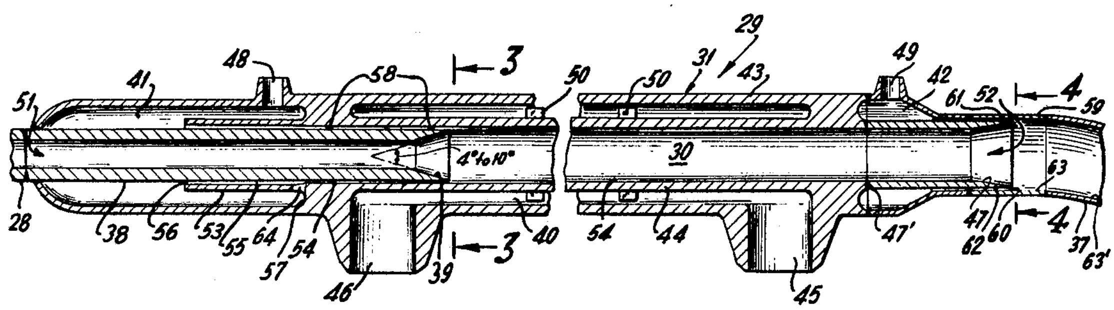
ABSTRACT: A gas cooling apparatus and process. Heat exchange apparatus having two stage gas expansion characteristics and an inherent thermal expansion structure with steam seals provided for the structure sections which move with respect to each other as a result of thermal expansion.



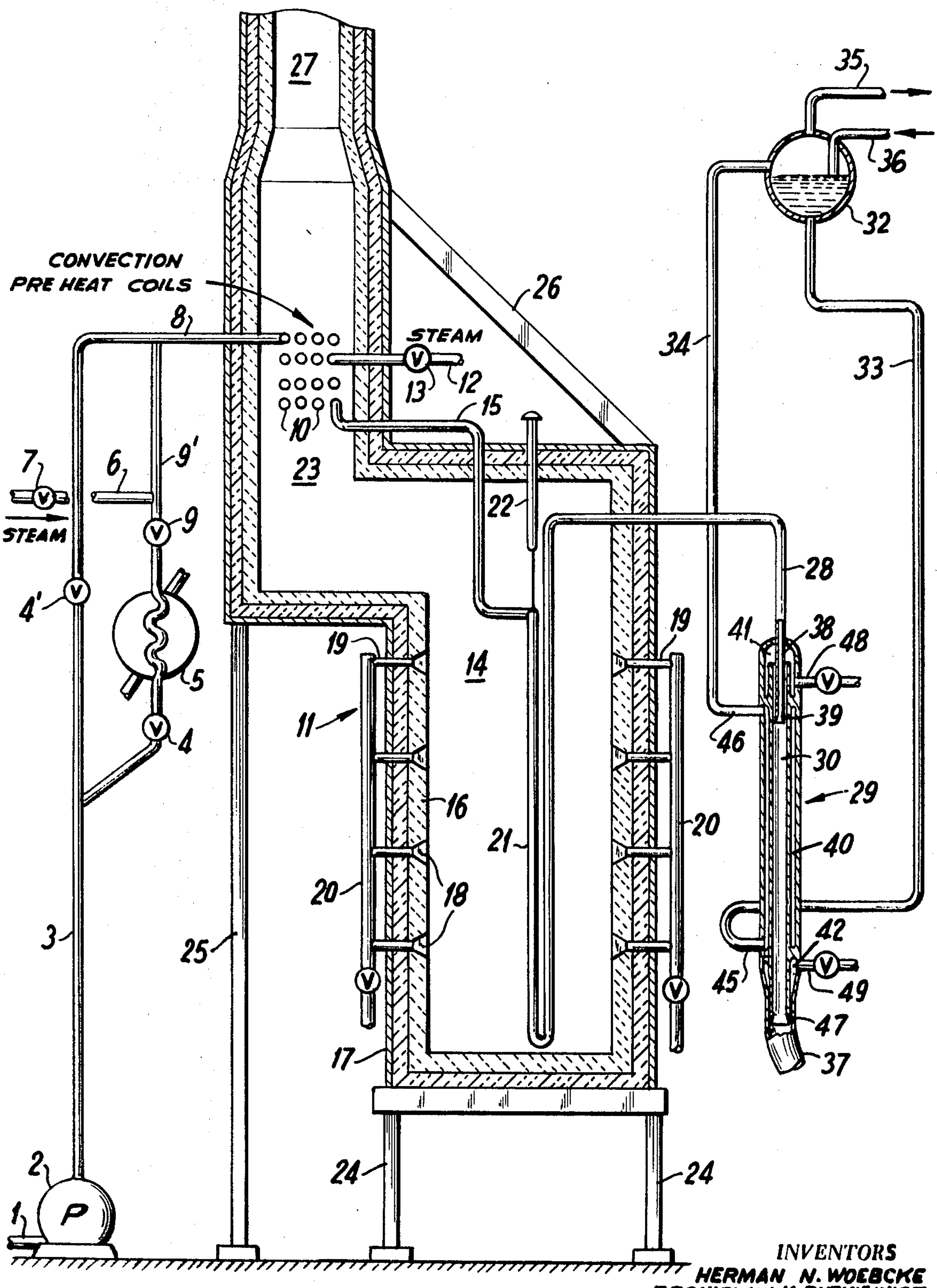


FIG. 1

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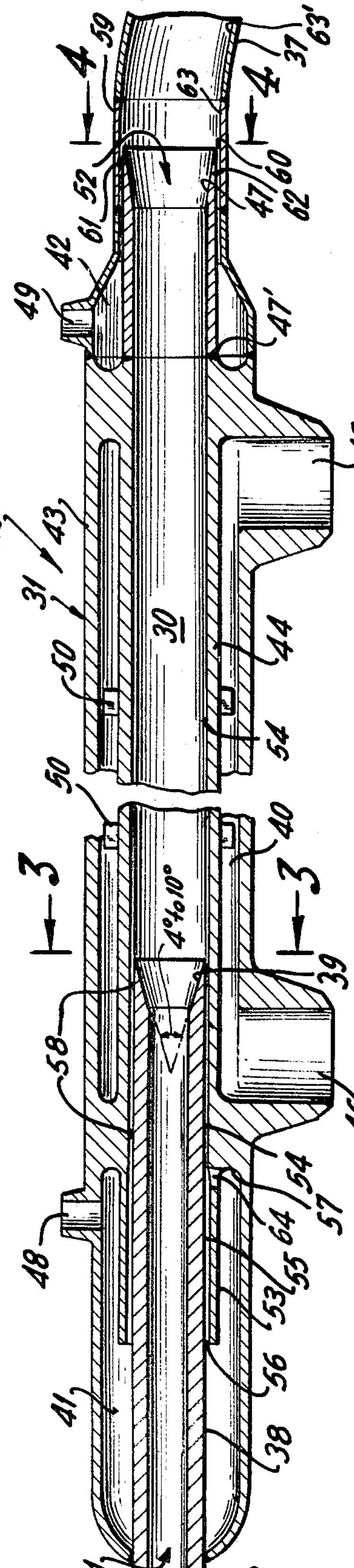

FIG. 2

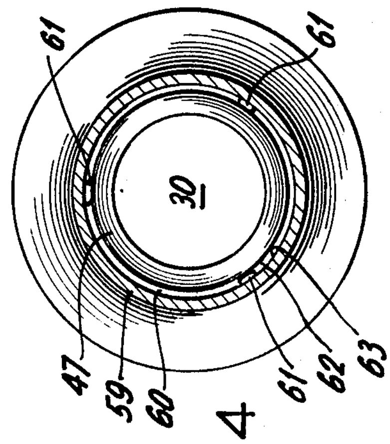

FIG. 4

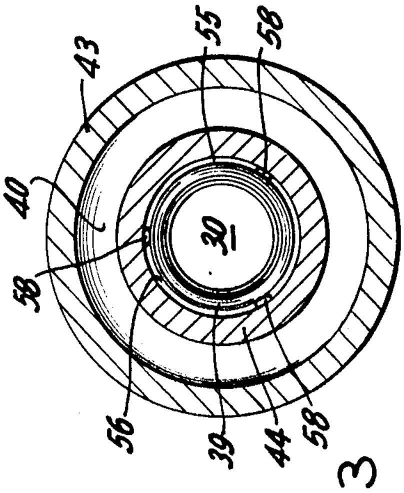

FIG. 3

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GAS COOLING APPARATUS AND PROCESS

CROSS REFERENCES TO RELATED APPLICATIONS

This invention relates to a series of applications having a common assignee. The related applications are "Cooling Apparatus and Process," Ser. No. 729,878 (Woebcke) filed May 10, 1968, now abandoned and "Cooling Apparatus and Process," Ser. No. 802,790 (Woebcke), filed contemporaneously with this application.

FIELD OF THE INVENTION

This invention relates basically to apparatus for cooling hot gas by indirect heat exchange with a coolant fluid. More specifically, the invention relates to a heat exchanger for cooling gaseous effluent from thermal cracking furnaces used to produce olefins from hydrocarbons.

DESCRIPTION OF THE PRIOR ART

In the field of producing olefins, the technique of noncatalytic thermal cracking of hydrocarbons has been long employed. Basically, hydrocarbon feed such as naphtha or gas oil is passed through a coil or coils in a cracking furnace during which time it is heated to temperatures in the range of 1500° F. and above. At these high temperatures the cracking reactions take place very rapidly; i.e., the hydrocarbon feed is converted to ethylene, propylene and a variety of other products in less that 1 second.

In order to minimize the production of undesirable byproducts prevent product degradation, and reduce fouling of downstream piping and equipment, it is necessary to rapidly cool the effluent product gases issuing from the cracking zone outlet at temperatures of 1500° F. and above to a temperature at which the cracking reactions substantially stop. Hence, it is necessary to cool the effluent in a suitable heat exchange apparatus to temperatures between 850° F. and 1400° F. immediately after it is discharged from the cracking furnace. Furthermore, it has been established that cooling of the furnace effluent must be performed in less than 30 milliseconds and preferably below 15 milliseconds to provide an optimum cooling operation. If the rapid cooling step is not performed within the 30 milliseconds, there may be substantial coke deposits in the interior passage of the cooling unit and downstream equipment.

However, the efficient operation of the entire olefin producing system also must be considered. Recovery of the waste heat during the cooling operation is one consideration. Another consideration is the minimization of the pressure loss in the system downstream of the cracking furnace.

Thus, a technique of cooling furnace effluent, characterized as quenching has been developed. Both direct and indirect heat exchange techniques are used to quench the effluent.

A variety of heat exchange equipment has been developed to perform the quenching operation which can be conveniently described as direct and indirect heat exchange. Direct heat exchange equipment is basically a chamber through which hot effluent passes and mixes directly with a coolant. Indirect heat exchangers are characterized by separate passages or chambers for the hot effluent and coolant respectively. Indirect heat exchangers provide an efficient means for recovering waste heat by converting the coolant to useable high-pressure steam. Typical of the indirect heat exchangers are single tubes provided with cooling jackets, and conventional multitube shell and tube exchangers.

Recently, indirect heat exchangers have been developed which minimize the pressure loss in the system. The copending applications referred to in the section, CROSS REFERENCES TO RELATED APPLICATIONS, disclose indirect heat exchangers with diffuser nozzles having a diverging angle or an equivalent diverging angle of between 4° to 10° located in the passage through which the hot effluent flows. The presence of a diffuser nozzle in the hot effluent passage minimizes large turbulent eddy currents in the gas flow and provides a gas velocity decrease attended by a pressure increase in the system.

SUMMARY OF THE INVENTION

Consequently, the problem faced in cooling furnace effluent is a composite of achieving rapid cooling in the order of 30 milliseconds without causing condensation of the high boiling fractions or adversely affecting the overall system efficiency. To achieve the optimum result, the transition from the temperature of a hot furnace effluent to a temperature sufficiently cool to stop the cracking reactions must be made. Therefore, temperature changes of several hundred degrees must be experienced in a very short period of time. It is therefore necessary to provide a quenching apparatus adapted to facilitate the rapid flow of hot fluid therethrough and to withstand violent temperature changes. It is also imperative that the heat exchange apparatus be constructed to insure rapid passage of the effluent therethrough and keep the pressure drop in the system to a minimum.

It is therefore an object of the present invention to provide a gas cooling apparatus which can withstand high temperature changes and facilitate the rapid cooling of effluent from a hydrocarbon cracking furnace.

It is another object of the present invention to provide a gas cooling apparatus capable of withstanding high temperature changes and maintaining as low a pressure loss as possible. To this end, a heat exchanger or gas cooling apparatus is provided which is comprised basically of a centrally disposed tubular structure and an outer housing which is provided with a cooling chamber. The outer housing is structured to include an axial inner passage which passage is formed with a divergent nozzle section near the exit thereof. Also included in the housing design is the cooling chamber and steam seal chambers. The centrally disposed tubular structure is formed of high heat resistant material and terminates in a divergent nozzle section. Both the divergent nozzle section in the housing passage and the divergent nozzle section on the centrally disposed tubular structure are sized to afford a total angle of divergence of from 4° to 10°, to insure optimum flow characteristics of the fluid passing therethrough.

In the assembled state, the centrally disposed tubular structure is arranged to extend from the furnace outlet into the axial passage of the outer housing. Therefore, the passage for the hot furnace effluent forms a two-stage diffuser structure. With a two-stage diffuser design, eddy currents are minimized in the flow of the gas during the quenching operation with a minimum resulting pressure loss. Additional detail of the assembled heat exchanger resides in the single connection between the centrally disposed tubular structure and the outer housing. The centrally disposed tubular structure extends directly from the furnace outlet to an intermediate location in the heat exchanger and is fixed only at the entry end of the heat exchanger. Hence, unimpeded slidable movement of the centrally disposed tubular structure with respect to the outer housing is afforded to compensate for the differential thermal expansion of the two sections which results from the presence in the heat exchanger of both hot furnace effluent and coolant. With the centrally disposed tubular structure arranged to slide axially with respect to the inner surface of the housing, a peripherally disposed annular passage therebetween is formed. Consequently, a steam purge or steam seal is provided to seal the annular passage. The steam seal is comprised of an annular steam chamber arranged around the effluent passage and communication means between the steam chamber and the annular passage to be sealed. Functionally, steam having slightly higher pressure than the pressure within the effluent passage is maintained in the steam chamber. Steam from the steam chamber travels through the annular opening into the heat exchanger axial passage to seal the annular passage and thereby prevent the flow of furnace effluent into the area between the centrally disposed tubular structure and the housing. In addition, a second diffuser nozzle is formed in the axial passage of the housing member and extends from the heat exchanger outlet into either the heat exchanger discharge line or an expansion joint connecting the heat exchanger and the discharge line. The second diffuser nozzle is fixedly secured only at the upstream end to afford axial expansion of the nozzle. As a result, a second annular passage is formed between the outer surface of the second nozzle and the inner surface of the discharge line on the expansion joint. A steam seal, comprised of a steam chamber and communication means extending to the annular passage is also provided to afford a steam seal for the second annular passage.

DESCRIPTION OF THE DRAWINGS

The invention will be described and understood more readily in connection with the attached drawings of which:

FIG. 1 is a sectional elevational view of a typical thermal cracking furnace used in the production of olefins from hydrocarbons;

FIG. 2 is a sectional elevational view of the gas cooling or heat exchange apparatus of the subject invention;

FIG. 3 is a cross-sectional view taken along line 3–3 of FIG. 2; and

FIG. 4 is a cross-sectional view taken along line 4–4 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The heat exchanger of the present invention is particularly suitable for use in cooling or quenching the hot gas effluent which discharges from a hydrocarbon cracking furnace. Typically, the furnace effluent discharging from a cracking or pyrolysis furnace is at a temperature in the order of 1500° F. or higher and must be cooled several hundred degrees in a matter of milliseconds. In addition, it is desirable to utilize the enormous heat exchange attending the effluent quenching to produce high-pressure steam. Consequently, the heavy duty heat exchanger of the present invention is ideally suited for the effluent quenching operation.

A typical cracking and heat recovery process in which the heat exchanger of the subject invention is used is described with reference to FIG. 1.

A continuous stream of feed is passed through line 1 and pump 2 via line 3 and valve 4 through a typical heat exchanger 5 wherein it is preheated to a temperature of about 600° F. The preheated feed is then passed through valve 9 and line 9′ to line 8. Superheated steam at a temperature of about 1000°—1200° F. is introduced into feed line 9′ via valve 7 through line 6 at a steam to hydrocarbon ratio of about 0.5 to 0.8 to vaporize and further heat the feed to about 700° F. The vaporized steam and feed mixture is introduced through line 8 into preheat convection coils 10 of furnace 11 and further heated to about 900° F. to 1200° F. The preheated feed is fed to the cracking zone 14 through crossover means 15.

In another embodiment, where lighter feeds are cracked all preheating may be carried out in the preheat convection zone. Accordingly, valves 4 and 9 may be closed and valve 4′ opened to allow the feed to bypass the heat exchanger 5 and enter line 8. Alternatively, the heat normally being supplied to the heat exchanger 5 may be discontinued. Under these conditions, steam may be introduced into the system through line 12 by opening valve 13.

The furnace 11 comprises refractory walls 16 enclosed in a furnace casing 17. The furnace walls contain burners 18 which receive combustion fuel through lines 19 and fuel manifolds 20. The steam and treated feed mixture is fed to cracking coils 21 and heated from about 900° F. to 1100° F. to a coil outlet temperature of 1500° F. to 1650° F., over which temperature range the cracking reactions take place at a residence time in the cracking zone of the furnace of about 0.2 to 0.4 second. The hydrocarbon partial pressure at the cracking coil outlet can be 9 to 16 p.s.i.a. The cracking coils 21 are supported by hangers 22. The hot combustion gases from burners 18 pass from cracking zone 14 through convection zone 23 in which the hot gases transfer heat to convection preheat conduits 10. The furnace is supported by legs 24 and supports 25. A cover for the furnace is provided by roof 26. The hot combustion gases pass from the furnace through stack 27.

The hot effluent gases at a temperature of generally above 1500° F. are passed through the furnace effluent heat recovery exchangers 29 of the present invention.

The hot gases from the furnace are passed through transfer line 28 at a temperature of about 1500° F. or above into the heat exchanger 29. The heat exchanger 29 has a passage formed therein for the passage therethrough of the furnace effluent and a chamber 40 for coolant such as water which acts to cool the hot effluent gases.

The gases are cooled rapidly in passage 30 to a temperature between 850° F. to 1400° F. Saturated water under high pressure is supplied to the coolant chamber 40 from steam drum 32 by down pipe 33, while the steam produced in admixture with unvaporized water is passed through the ascending line 34 to the steam drum 32. Steam at high pressure is taken off through line 35. This steam can be used to provide high temperature heating duties and/or can be used to drive turbines. Line 36 supplies the steam drum 32 with makeup water. The cooled effluent passes through line 37 beyond the jacketed cooling zone and is further cooled by suitable means, such as, circulating quench oil, before it is fed into a conventional primary fractionation and heat recovery system for a separation of cracked fuel oil product. It is then passed into a conventional compression and fractionation system for separation of specific components, including ethylene, propylene, and other products, as shown in the flow diagram.

As seen in FIG. 2, the heat exchanger 29 is comprised basically of an outer housing structure 31 and a centrally disposed inlet tube 38.

The inlet tube 38 extends directly from the heating furnace transfer line 28 and terminates in the diffuser nozzle 39. The diffuser nozzle 39 is formed with a total divergence angle of 4° to 10° to effect a reduction in the velocity of the hot effluent and a concomitant increase in the pressure of the effluent. Due to the high temperatures to which the inlet tube 38 is exposed, it has been found in practice that a tube made of INCOLOY 800 pipe will perform particularly well in this application.

The outer housing structure 31 if formed with an axial passage extending therethrough which, with the inlet tube 38, constitutes the passage 30 for the hot effluent. The passage 30 in the outer housing structure 31 is of uniform cross-sectional area except for an area near the heat exchanger outlet 52 wherein the passage 30 terminates in a diffuser nozzle 47. In addition, the outer housing structure 31 includes a coolant chamber 40 and steam chambers 41 and 42 all of which are arranged around the passage 30 with a common wall therebetween. Metals such as carbon steel are particularly suitable for the outer housing material. Carbon steel or low chromium alloys are suitable materials for the inner wall 44.

Structurally, the coolant chamber 40 is defined by an outer wall 43 and an inner wall 44 and has an inlet 45 for cooling fluid such as water and an outlet 46 for the high-pressure steam generated during the cooling process. The inner wall 44 of the coolant chamber also defines a portion of the hot effluent passage 30; hence indirect heat exchange occurs between the coolant in chamber 40 and the hot effluent in passage 30 through the wall 44. Spacers 50 are located in the coolant chamber 40 to maintain the heat exchanger annulus at an essentially constant width.

The coolant chamber 40 is depicted as a simple cooling jacket; however, any number of suitable cooling structures such as an array of tubular cooling members can be arranged with the only limitation being that indirect cooling be achieved between the coolant and the furnace effluent.

The steam chambers 41 and 42 are arranged around the passage 30 and in proximity to the openings which the steam emanating therefrom must seal. Basically, the steam chambers

41 and 42 are cavities in the housing through which steam is passed to seal the passage 30 at critical locations. Steam inlets 48 and 49 are provided for the respective steam chambers 41 and 42. Steam chamber 41 is located immediately downstream of the heat exchanger inlet opening 51 and is provided with a purge baffle 53 concentrically formed with the effluent passage 30 and arranged to extend from the downstream end of the steam chamber 41 forwardly to an intermediate point therein. Steam chamber 42 is located immediately downstream of the coolant chamber 40 and in proximity to a connecting piece 59 which connects the heat exchanger 29 to the cooled effluent discharge line 37. In the assembled state of the heat exchanger 29, the inlet tube 38 extends inwardly of the housing 31 through the heat exchanger inlet opening 51 and is not attached to any structure other than the housing at the heat exchanger inlet. In practice, it has been found that a peripheral weld will satisfactorily attach the inlet tube 38 to the outer housing 31 at the opening 51 and seal the steam chamber 41. As a consequence of the single connection between the inlet tube 38 and the outer housing 31, thermal stress cannot build up in the heat exchanger structure since there is an inherent freedom for the hot inlet tube 38 to expand relative to the cooler housing structure 31 as a temperature gradient develops in the heat exchanger 29. The inlet tube 38 extends inwardly of the cooling jacket from the heat exchanger inlet 51 to locate the diffuser nozzle 39 intermediately in the passage 30. Consequently, the outer surface 55 of the inlet tube 38 and the inner surface 54 of the coolant chamber inner wall 44 are in very close spaced relationship in the area of the diffuser nozzle 39. In addition, the purge baffle 53 which extends forwardly from an inner shoulder 57 on the housing interior also surrounds the inlet tube 38 and combines with the coolant chamber inner wall surface 54 and the inlet tube outer surface 55 to define an annular passage 56. Guides 58 located in the passage 56 serve to center the inlet tube 38 in the passage 30, as seen in FIG. 3. To obviate the possibility of effluent flowing from the effluent passage 30 into the annular passage 56, steam under pressure is provided to occupy the passage 56. Due to the presence of steam in the steam chamber 41, notched openings 64 may be located in the purge baffle to facilitate drainage of condensate which may be introduced or accumulate.

The steam used to seal the passage 56 is provided by steam introduced into the steam chamber 41 through inlet 48. The steam is maintained at a pressure above the pressure in the effluent passage 30; hence the flow of steam is from steam chamber 41 through annular passage 56 and ultimately into the effluent passage 30.

The diffuser nozzle 47 is located at the heat exchanger outlet 52 and extends into the connecting piece 59 about to the discharge line 37. The nozzle 47 may be integrally formed with the heat exchanger passage 30; however, in practice it has been found preferable to form the nozzle 47 from a separate tubular piece and attach by suitable means, such as welding, the upstream end thereof to the downstream end of the passage 30. The connecting piece 59 may alternatively be constructed to act as a simple joining member or as an expansion joint in the longitudinal direction. In any embodiment, the nozzle 47 is arranged with the inherent capacity to expand longitudinally and radially without undue restraint. Radial expansion of the nozzle 47 is inherent due to the changes in temperature which may exist as a result of the varying distance of the nozzle 47 from the cooling chamber 40. With this design, an annular passage 60 is defined by the outer wall 62 of the diffuser nozzle 47 and the inner wall 63 of the connecting piece 59 or the inner wall 63′ of the discharge line 37.

A steam seal similar to the steam seal for the annular passage 56 is provided for the annular passage 60. Steam enters steam chamber 42 through inlet 49 at a pressure above the pressure in the effluent passage 30 and passes through the annular passage 60 to the effluent passage 30. Guides 61 are provided in the annular passage 60 to locate the diffuser nozzle 47 centrally within the passage, as seen in FIG. 4.

Functionally, the steam chambers 41 and 42 serve also to shield the outer wall of the housing 31 from the hot effluent passing through the passage 30. In particular, steam chamber 41 located in the area of the hot effluent inlet 51 shields the outer housing member from the heat within the effluent passage 30. With the presence of the steam chamber 41, the only path through which heat can reach the outer housing member is a radiation path, thereby providing a much cooler outer metal temperature. In practice, it has been found that the housing 31 can be formed of a less expensive forging than would be necessary without the shielding.

In addition, the purge baffle 53, while serving primarily as a baffle for the purge steam to reduce thermal shock on the inner inlet tube 38, also functions to reduce heat flowing from the hot inlet tube 38 by radiation to the transition assembly. Heat from the inlet tube 38 is conducted along the length of the purge baffle 53 to the housing structure which is being cooled by the coolant in chamber 40.

In operation, the heat exchanger process is performed in the heat exchanger 29 as water is introduced into the coolant chamber 40 through inlet 45 while hot furnace effluent is discharged from the furnace into the inlet tube 38 and subsequently passed through passage 30 to the heat exchanger outlet. At the same time, steam, at a pressure slightly higher than the pressure in the passage 30, is continuously introduced into the steam chambers 41 and 42 through inlets 48 and 49 respectively. Since the pressure in the effluent passage is generally in the order of 25 p.s.i.a., the pressure in the steam chambers 41 and 42 must be in the order of 30 p.s.i.a., or at least 5 p.s.i. higher than the pressure in the passage 30. Under these conditions, steam from steam chambers 41 and 42 will pass through the annular passages 56 and 60 to the passage 30.

As the effluent flow is passed through passage 30, the pressure of the flow is increased and the velocity decreased at the nozzle 39 wherein the flow expands at a divergence angle of 4° to 10°. The flow continues through the passage 30 at a constant cross section to the heat exchanger outlet 52 wherein a second expansion of the effluent flow occurs. The effluent gas passes through the diffuser nozzle 47 effecting an expansion of from 4° to 10° of angle and thereby increasing the pressure in the gas and reducing the velocity thereof.

The two stage expansion of the effluent flow provides streamlined expansion of the gas and minimizes the formation of turbulence eddy currents at the locations wherein the velocity of the flow is changed. In addition, the pressure loss through the heat exchanger is minimized, thereby aiding the flow of effluent through the system. The pressure recovery is of great importance since any pressure loss must be compensated for by expensive pumping or compressing equipment downstream.

As a result of the heat exchanger operation, the hot effluent which enters the heat exchanger at temperatures of about 1500° F. or above is cooled by indirect heat exchange through wall 44 to temperatures as low as 850° F. The coolant in chamber 40 is heated to form high-pressure steam which ranges in pressure from 200 to 2500 p.s.i.

The invention has been described with reference to the preferred embodiment thereof. However, any variation in structure which does not depart from the spirit of the invention is, of course, comprehended thereby.

We claim:

1. A heat exchanger comprising:

an outer housing having a cylindrical passage for the flow of hot fluid therethrough which passage extends from the heat exchanger inlet to the heat exchanger outlet;

a coolant chamber in the outer housing;

an inlet tube fixed only to said heat exchanger inlet and extending therefrom to an intermediate location within the heat exchanger passage, whereby the surface of the passage and the outer surface of the inlet tube define a first annular passage;

a first diffuser nozzle having an angle of divergence of 4° to 10° at the end of the inlet tube inside the hot fluid passage; and means to seal the first annular passage from the hot fluid passing through the hot fluid passage and allowing differential thermal expansion of said inlet tube.

2. A heat exchanger as in claim 1 wherein the means to seal the first annular passage is a steam seal comprised of a source of steam at a pressure higher than the pressure in the hot fluid passage; a first steam chamber in communication with the source of steam and communication means from the first steam chamber to the first annular passage.

3. A heat exchanger as in claim 2 further comprising a purge baffle adapted to extend upstream from the upstream terminus of the first annular passage into the first steam chamber and around the outer surface of the inlet tube.

4. A heat exchanger comprising:

an outer housing having a cylindrical passage for the flow of hot fluid therethrough which passage extends from the heat exchanger inlet to the heat exchanger outlet;

a coolant chamber in the outer housing;

an inlet tube fixed only to said heat exchanger inlet and extending therefrom to an intermediate location within the heat exchanger passage, whereby the surface of the passage and the outer surface of the inlet tube define a first annular passage;

a first diffuser nozzle having an angle of divergence of 4°to 10° at the end of the inlet tube inside the hot fluid passage;

a second diffuser nozzle located at the outlet of the hot fluid passage, which diffuser nozzle has a total angle of divergence of 4° to 10°; and

an outlet line extending from the heat exchanger; the second diffuser nozzle extending into the outlet line, whereby the outer surface of the second diffuser nozzle and the inner surface of the outlet line define a second annular passage.

5. A heat exchanger as in claim 4 further comprising an array of guides attached to the outer surface of the inlet tube adapted to maintain the inlet tube and heat exchanger passage in spaced relationship and an array of guides attached to the outer surface of the second nozzle to maintain the second nozzle and the outlet line in spaced relationship.

6. A heat exchanger as in claim 1 wherein the inlet tube is formed of INCOLOY 800 and the outer housing is formed of carbon steel.

7. A heat exchanger comprising:

an outer housing having a cylindrical passage for the flow of hot fluid therethrough which passage extends from the heat exchanger inlet to the heat exchanger outlet;

a coolant chamber in the outer housing;

an inlet tube fixed only to said heat exchanger inlet and extending therefrom to an intermediate location within the heat exchanger passage, whereby the surface of the passage and the outer surface of the inlet tube define a first annular passage;

a first diffuser nozzle having an angle of divergence of 4° to 10° at the end of the inlet tube inside the hot fluid passage;

a second diffuser nozzle located at the outlet of the hot fluid passage, which diffuser nozzle has a total angle of divergence of 4° to 10°;

an outlet line extending from the heat exchanger; the second diffuser nozzle extending into the outlet line, whereby the outer surface of the second diffuser nozzle and the inner surface of the outlet line define a second annular passage; and

means to seal the first and second annular passages from the hot fluid passing through the hot fluid passage and allowing differential thermal expansion of both said inlet tube and said second diffuser nozzle.

8. A heat exchanger as in claim 7 wherein the inlet tube is rigidly attached to the heat exchanger outer housing at the inlet to the hot fluid passage in the outer housing.

9. A heat exchanger as in claim 8 further comprising an expansion joint adapted to connect the hot fluid passage to the outlet line and whereby the outer surface of the second diffuser nozzle and the inner surface of the expansion joint define the second annular passage.

10. A heat exchanger as in claim 1 wherein the means to seal the first annular passage is a steam seal comprised of a source of steam at a pressure higher than the pressure in the hot fluid passage; a first steam chamber in communication with the source of steam and communication means between the first steam chamber and the first annular passage, and the means to seal the second annular passage is a steam seal comprised of a source of steam at a pressure higher than the pressure in the hot fluid passage; a second steam chamber in communication with the source of steam and communication means between the second steam chamber and the second annular passage.

11. A heat exchanger as in claim 9 wherein the means to seal the first annular passage is a steam seal comprised of a source of steam at a pressure higher than the pressure in the hot fluid passage; a first steam chamber in communication with the source of steam and communication means between the first steam chamber and the first annular passage, and the means to seal the second annular passage is a steam seal comprised of a source of steam at a pressure higher than the pressure in the hot fluid passage; a second steam chamber in communication with the source of steam and communication means between the second steam chamber and the second annular passage.

12. A heat exchanger as in claim 10 further comprising a purge baffle adapted to extend upstream from the upstream terminus of the first annular passage into the first steam chamber and around the outer surface of the inlet tube.

13. A heat exchanger as in claim 11 further comprising a purge baffle adapted to extend upstream from the upstream terminus of the first annular passage into the first steam chamber and around the outer surface of the inlet tube.

14. A heat exchanger as in claim 13 further comprising an array of guides attached to the outer surface of the inlet tube adapted to maintain the inlet tube and heat exchanger passage in spaced relationship and an array of guides attached to the outer surface of the second nozzle to maintain the second nozzle and expansion joint in spaced relationship.

15. A heat exchanger as in claim 14 wherein the inlet tube is formed of INCOLOY 800 and the outer housing is formed of carbon steel.

16. A heat exchanger as in claim 15 wherein the purge baffle has a drainage opening formed therein.

17. A process for cooling hot fluid and generating high pressure steam comprising the steps of:

introducing hot furnace effluent from a hydrocarbon cracking process into a heat exchanger passage;

expanding the flow of hot fluid at an angle from 4° to 10° in the heat exchanger;

passing water through the heat exchanger in indirect heat exchange relationship with the hot fluid flowing therethrough; and

expanding the flow of hot fluid a second time at an angle of from 4° to 10° prior to discharge from the heat exchanger.