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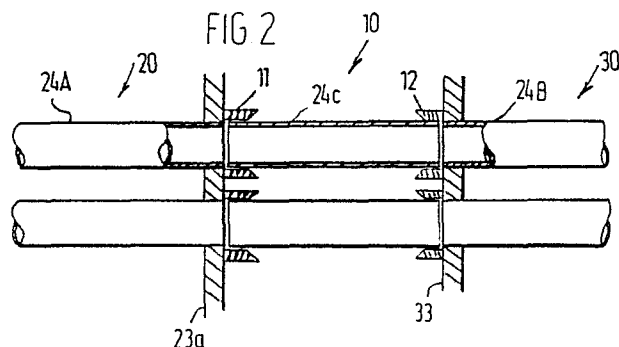
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(54) **Transfer-line cooler.**

(57) A transfer-line exchanger is disclosed having two separate heat exchanging zones (20,30) or compartments. Specifically, the transfer-line exchanger is comprised of a tube or tubes (24) through which the hot gas (61) being cooled is flowed. Each tube (24) is contained in a larger, outer tube or a number of tubes contained in the shell (21). Each outer tube or the shell (21) is divided into two compartments or zones (20,30) through which the cooling medium is flowed. The compartments or zones (27,37) in the outer tubes or shell are designed such that the hot gas flowing through the tube or tubes (24) is sequentially cooled by a cooling medium flowing through the first compartment (27) at a first temperature and a cooling medium flowing through a second compartment or zone (37) at a second and generally lower temperature. The tubes of the two sections are connected by intermediate tubes (24C) loosely held in guide sleeves (11,12) on the ends of the two sections.

Although the transfer-line exchangers of the present invention are described with reference to two heat exchanging zones or compartments, additional cooling by means of additional compartments or zones can be affected.



TRANSFER LINE EXCHANGER

TRANSFER-LINE COOLER

The present invention relates to a transfer-line cooler, and, more particularly, to a transfer-line cooler having two separate heat exchanging sections.

In the processing of hydrocarbons at elevated temperatures as well as in many other chemical reactions, it is often desirable to quickly and effectively cool the reaction product or other process stream to terminate or sufficiently reduce the rate of on-going chemical reactions. For example, in the cracking of hydrocarbon feed stocks such as naphtha, liquid propane gas (LPG) and the like, the cracking reaction is normally conducted at cracking temperatures between 700°C and 1100°C. Once the desired cracking reactions have occurred, to reduce the formation of undesirable by-products caused by additional cracking, it is desirable to cool the cracked reaction product to a sufficiently low temperature such that the cracking reactions are terminated or reduced to a desirable rate. The temperature required for this purpose is generally between 500° and 700°C. Provided the reaction product is cooled to a temperature sufficiently low to terminate the cracking reactions, the actual temperature to which the reaction product is cooled is not critical. The critical feature is the time required to sufficiently reduce the temperature, with the shortest time possible being preferred. For example, the cracked reaction product is advantageously cooled to the indicated temperatures in less than 0.1 second.

Heretofore, this rapid cooling of the cracked reaction product has generally been conducted in one or more heat exchangers, commonly referred to as "transfer-line" exchangers, which are designed to permit the desired rate of cooling. Conventionally, a transfer-line exchanger is a shell and tube type heat exchanger wherein the cracked reaction product flows through a distribution header into and through a plurality of tubes to a collection header at the opposite end. At each end, the tubes extend through and are welded to a tube sheet. In cooling the cracked reaction product, the cooling medium, commonly water or a water/steam mixture, is passed through the shell section, i.e., on the outside of the tubes, usually in a cocurrent flow to the cracked reaction product. In this operation, part of the heat from the higher temperature reaction product is transferred through the tube walls to the cooling medium. The overall effect of the heat

exchange operation is to raise the temperature of and/or vaporize a portion of any water used in the cooling medium while reducing the temperature of the cracked reaction product.

A heat exchanger of particular interest for use as a transfer-line exchanger is a double tube type heat exchanger described in "Recuperacion de Calor en Grandes Unidades Quimicas y Petroquimicas" by Hellmut Hermann, Ingeniera Quimica, May 1984 pps. 71-84. In the described double tube heat exchanger, an inner tube or conduit for carrying the cracked hydrocarbon reaction product is enclosed by a large diameter tube or conduit for carrying the cooling fluid.

In a conventional hydrocarbon cracking operation, a sufficiently large transfer-line exchanger to cool the cracked reaction product at a desired rate is employed to terminate the cracking reactions. The cracked reaction product is further cooled by quenching the reaction product such as by the direct addition of a hydrocarbon oil. In the cracking of a hydrocarbon as in other chemical process operations, conservation of energy and/or heat is always desired. The use of a single transfer line exchanger followed by a quench in the cooling of the cracked reaction product is not particularly effectively in producing heat and/or energy.

Therefore, for improved energy efficiency, two transfer-line exchangers -a primary transfer-line exchanger ("PTLE") and secondary transfer-line exchanger ("STLE") -are employed to cool the cracked reaction product. In said operation, the cracked reaction product flows sequentially through the PTLE and then the STLE, with the cracked gas collection header ("topcone") of the primary transfer-line exchanger being in fluid communication with the inlet or distribution header - ("undercone") of the secondary transfer-line exchanger. In the PTLE, the cracked reaction product is cooled to a sufficiently low temperature to stop or reduce the cracking reactions to a desirable slow rate. The water generally employed as a cooling medium in the PTLE is converted to a water/steam mixture at a high pressure. This generated water/steam mixture can subsequently be used to generate high pressure steam for use as a source of energy and/or heat. In the STLE, the cracked reaction product is further cooled. The water employed as a cooling medium in the STLE is converted to a water/steam mixture at low pressures.

In the cracking of a hydrocarbon, the pressure drop from initial feed of the hydrocarbon to the cracking furnace until final quenching is critical. Specifically, a low pressure drop throughout the

system permits improved cracked gas yields. In the current cracking operations, particularly those systems using a PTLE in combination with an STLE, the cooling of the cracked hydrocarbon reaction product is a source of considerable pressure drop.

Accordingly, the present invention is a transfer-line exchanger and a method for cooling of a fluid such as a cracked reaction product which reduces the pressure loss caused by the cooling operation and permits the effective use of the cooling media as a source of heat and/or energy. Specifically, the transfer-line exchanger of the present invention is a shell and tube type heat exchanger having two or more separate heat exchanging sections but only one inlet and one collection header, the separate sections being joined by intermediate tubes.

More particularly, the present invention is an improved transfer-line cooler which comprises two shell and tube heat exchange sections each having tube(s), tube sheets and shells, wherein the tube(s) of the first heat exchanger communicate a high temperature fluid being cooled to corresponding tube(s) in the second heat exchange section through intermediate tube(s), wherein the improvement comprises the intermediate tubes being positioned loosely in guide sleeves, the intermediate tubes being contained within a tight compartment. Preferably the guide sleeves are located on the tube sheets at the nearest ends of the shells of the two heat exchanger sections. Such a transfer line exchanger typically comprises an inlet header, a collection header and two heat exchanging sections. The inlet and collection headers are in fluid communication with each other by means of the tube or plurality of tubes (i.e., a tube bundle) for carrying the higher temperature fluid. Each tube passes through its heat exchanging zone and is open at its two ends. Each end of each tube is secured to a tube sheet. At the inlet of the first section, the tube sheet and tube(s) are in fluid communication with the inlet header. At the exit of the second section the tube end is secured to a second tube sheet in fluid communication with the collection header. In addition to the tube or tube bundle, the first heat exchanging zone of the heat exchanging section comprises an inlet and an outlet for a first cooling medium and a defined space for the passage of the first cooling medium through the first heat exchanging zone such that the cooling medium contacts at least a portion of the length of the tube or tube bundle containing the higher temperature fluid extending through the first heat exchanging zone. The second heat exchanging zone comprises an inlet and an outlet for a second cooling medium and a defined space therein for the passage of the second cooling medium from the second inlet to the second outlet such that the

second cooling medium contacts a portion of the tube or tube bundles containing the high temperature fluid extending through the second heat exchanging zone.

A third or "dummy" tube which is not mechanically bonded to either tube portion is positioned in guide sleeves between the first and second tube exchanging zones and provides fluid communication between the first and second tube portions.

In another aspect, the present invention is an improved process for cooling a cracked reaction product from a cracking furnace which comprises supplying the cracked reaction product to a two stage transfer-line cooler which comprises two shell and tube heat exchange sections each having tube(s), tube sheets and shells, wherein the tube(s) of the first heat exchange section communicate the high temperature cracked reaction product being cooled to corresponding tube(s) in the second heat exchange section through intermediate tubes. Preferably the intermediate tubes are positioned loosely in guide sleeves which are located on the tube sheets at the nearest ends of the shells of the two heat exchange sections and the intermediate tubes are contained within a tight compartment. In said method, the reaction product of a hydrocarbon cracker flowing through the tube or tube bundle is sequentially cooled by a first cooling medium at a first temperature flowing around the first heat exchanging zone or compartment and then with a second cooling fluid at a second temperature which is less than the temperature of the first cooling fluid flowing around the second portion of the tube or tube bundle in the second heat exchanging zone or compartment.

Using the double zone, transfer-line exchanger of the present invention, the temperature of a fluid can quickly and effectively be reduced to a lower temperature. Specifically, the efficiency of the heat exchanging operation is effectively increased by sequentially cooling the high temperature fluid using two or more cooling fluids having different temperatures. Moreover, when using water and/or steam as the cooling fluid in one or both of the heat exchanging zones or compartments, by properly selecting the pressure and temperature of the cooling fluid(s), the steam or water/steam mixture(s) having a desired temperature and pressure can be generated in the first and second heat exchanging zones or compartments. In such manner, the overall energy efficiency of the system using the described transfer-line exchanger can be improved. Moreover, the pressure loss in the transfer-line exchanger of the present invention is significantly less than that exhibited using the combination of primary and secondary transfer-line exchangers. Both cocurrent and countercurrent operations are

possible using the transfer-line exchanger of the present invention. In addition, the exchanger can be employed vertically, horizontally or even at an angle.

Due to the increased efficiency of the described transfer-line exchanger, a single transfer-line exchanger having two separate heat exchanging zones can effectively be employed in various cooling operations, including the cooling of a cracked reaction product exiting from a cracking furnace. In fact, the transfer-line exchanger of the present invention can be employed to cool the cracked reaction product to the same or lower temperature using significantly less physical space and capital expenditure than a combination of a primary transfer-line exchanger followed by a secondary transfer-line exchanger.

Understanding of the invention and its various embodiments is facilitated by reference to accompanying drawings in which

Fig. 1 is a general schematic representation, in cross-section, of the transfer line exchanger of the present invention;

Fig. 2 is a schematic representation, partly in cross-section, of a portion of the exchanger depicted in Fig. 1, and depicts the first and second portions separated by the third ("dummy") tube which is not physically bonded to either tube portion;

Fig. 3 is a schematic representation, in cross-section, of a portion of a transfer-line exchanger of the present invention having double-tube configuration; and

Fig. 4 is a schematic representation, partly in cross-section, of a side-view portion of the double tube type transfer-line exchanger depicted in Fig. 3 illustrating, in more detail, the connections between the first and second heat exchanging zones or compartments of the transfer-line exchanger.

One embodiment of the double zoned, transfer-line exchanger of the present invention is schematically illustrated in Figs. 1 and 2. The illustrated transfer-line exchanger consists of a first heat exchanging zone or compartment 20 and a second heat exchanging zone or compartment 30 separated by zone 10 in Figure 1. The transfer-line exchanger further comprises an inlet or distribution header or chamber 29 and an outlet or collection header or chamber 39.

Extending from a first tube sheet 23 through the first heat exchanging zone or compartment 20 to a second tube sheet 23a and then from a first tube sheet 33 through the second heat exchanging zone or compartment 30 and to a second tube sheet 33a are a plurality of conduits (e.g., tubes) 24. The plurality of conduits or tubes 24 is commonly referred to as a tube bundle. The conduits 24 are secured, generally by welding or brazing, to

the tube sheets. Although the tube sheets 23 and 33a are depicted as flat plates in the illustrated embodiment, the distribution and collection headers 29 and 39, respectively, can comprise a variety of different shapes. Specifically, cylindrical distribution and collection headers such as described in U.S. Patent No. 4 191 247; 4 163 473 and 4 336 642 can be employed. Alternatively, a spherical distribution or collection chamber can also be employed.

The conduits are open at both ends and are in fluid communication with an inlet conduit 22 via the distribution header 29 and in fluid communication with an outlet conduit 32 via the collection header 39. In Fig. 1, the conduits 24 are shown to occupy only a part of the heat exchanging zones or compartments 20 and 30. In the actual fabrication of the transfer-line exchanger, conduits 24 will occupy much of the cross-sectional area defined within the heat exchanging zones or compartments. Preferably, the conduits 24 extending through the first and second heat exchanging zones or compartments are supported by some adequate means (not shown) at various points throughout the zones or compartments. Such means are well-known in the art and reference is made thereto for the purposes of this invention.

The actual heat transfer is conducted in the first and second heat exchanging zones or compartments 20 and 30. In the first heat exchanging zone, the higher temperature fluid is initially cooled to a lower temperature. In the transfer-line exchanger depicted in Fig. 1, the first zone 20 is defined by the housing or shell 21 and the tube sheets 23 and 23a. Conduits 25 and 26 are provided in zone 20 for the introduction and removal of the first cooling fluid from the heat exchanging zone or compartment 20. Whether conduit 25 or 26 is an inlet or an outlet for the first cooling fluid is dependent on the type of operation, i.e., whether the heat exchanger is employed in a cocurrent or countercurrent type operation. For example, in countercurrent operation conduit 26 will act as an inlet and conduit 25 as an outlet for the cooling fluid. However, the transfer-line exchanger is normally more advantageously operated cocurrently. In this case, the conduit 25 acts as an inlet for the first cooling fluid and conduit 26 as an outlet for this fluid. In the transfer-line exchanger depicted in Fig. 1, the narrow spaces 27 defined by adjacent conduits 24 and the shell 21 provide for the passage of the first cooling fluid through the first heat exchanging zone or compartment of the transfer-line exchanger and the required contact between the first cooling fluid and the tubes or conduits carrying the higher temperature fluid.

The second heat exchanging zone or compartment 30 comprises that zone of the transfer-line exchanger wherein the partially cooled fluid running through tubes 24 is further cooled with a second cooling fluid. In general, the second cooling fluid is of a lower temperature than the cooling fluid used in the first heat exchanging zone or compartment 20. In the embodiment depicted in Fig. 1, the second heat exchanging zone or compartment 30 is defined by shell 31 and tube sheets 33 and 33a. Conduits 35 and 36 are provided for the introduction and removal of the second cooling fluid to and from the heat exchanging zone or compartment 30. In the normal cocurrent operation, conduit 35 acts as an inlet for the second cooling fluid whereas conduit 36 acts as an outlet. The space is defined by adjacent conduits 24 and the shell 31 provides for the passage of the second cooling fluid through the second heat exchanging zone or compartment 30 of the transfer-line exchanger and the required contact between the second cooling fluid and the tubes carrying the partially cooled, higher temperature fluid.

In the operation of the transfer-line exchanger depicted in Fig. 1, the tubes 24 carry the higher temperature fluid and the shell portions of heat exchanging zones 20 and 30 carry the lower temperature fluids. In this manner, the fluid flowing through the tubes is cooled by the transfer of heat through the tube to the lower temperature fluid flowing through the shell of the transfer-line exchanger. The heat exchange operation, in either or both the heat exchanging zones, can be conducted using cocurrent or countercurrent techniques. In general, in the transfer-line exchangers of the present invention, cocurrent techniques are most advantageously employed in both heat exchanging zones or compartments and, for purposes of illustration, the operation of the transfer-line exchanger depicted in Fig. 1 will be described with reference to cocurrent heat exchange operation. In such operation, the higher temperature fluid such as the cracked reaction product is flowed from inlet 22 into the distribution or inlet header 29. The flow of this higher temperature fluid is indicated by the arrow identified by numeral 61. The higher temperature fluid flows, as indicated by the arrows 62, from distribution header 29 into the conduits 24 and, via conduits 24, through the heat exchanging zones 20 and 30.

At or near the entrance of the high temperature fluid into the first heat exchanging zone 20, a first cooling (i.e., lower temperature) fluid is conducted, as indicated by the arrows identified by numerals 63 and 64, via inlet conduit 25 into the space 27 defined by adjacent conduits 24 and conduits 24 and shell 21. The lower temperature fluid flows through the space 27 cocurrently with the flow of

the higher temperature fluid through the conduits 24. The higher temperature fluid is cooled as it flows through conduits 24 by the lower temperature fluid flowing through space 27. The lower temperature fluid flows from the first heat exchanging zone 20, as indicated by the arrows identified as 65 and 66, via outlet conduit 26.

The partially cooled, high temperature fluid is flowed from the first heat exchanging zone 20 into the second heat exchanging zone 30. At or near the inlet of the conduits 24 into the second heat exchanging zone 30, a second cooling fluid, generally at a lower temperature than the first cooling fluid, is flowed, as indicated by the arrows identified by numeral 67, via inlet conduit 35, into the heat exchanging zone 30 and through space 37 defined by adjacent conduits 24 and conduits 24 and shell 31, as indicated by the arrow identified by numeral 68, cocurrently with the flow of the high temperature fluid through the conduits 24. As the two liquids flow cocurrently through the heat exchanging zone 30, the high temperature fluid is further cooled by the lower temperature cooling fluid flowing through space 37. The second cooling fluid flows, as indicated by arrows identified by the numerals 69 and 70, from the second heat exchanging zone via outlet conduit 36. As indicated by the arrows identified by numerals 71 and 72, the now cooled high temperature fluid is flowed from conduits 24 to the collection header 39 and from the collection header 39 from the transfer-line exchanger via outlet conduit 32.

In the operation of the described transfer-line exchanger, it is often desirable for the cooling (i.e., lower temperature fluid) to undergo a phase change as it flows through the transfer-line exchanger. Specifically, in the cooling of a cracked reaction product, water or a water/steam mixture is advantageously employed as the cooling fluid for cooling the high temperature, cracked reaction product and the water in the cooling fluid is vaporized to form steam during the heat exchanging operation. By properly selecting the temperature and pressure of the cooling medium, steam of a desired temperature and pressure can be formed by the evaporation of the water during the heat exchanging operation. For example, in the cooling of a cracked hydrocarbon product having a temperature from 750° to 900°C, in the first heat exchanging zone, high pressure steam (e.g., steam having a pressure of from 40 to 120 bar) can be produced using water at its boiling temperature and pressure as the cooling fluid in that zone. Alternatively, in the second heat exchanging zone, the partially cooled, cracked reaction product, having a temperature from 450° to 650°C can be further cooled to produce lower pressure steam (e.g., steam having a pressure from 3 to 35 bar).

The tubes 24 in the transfer line exchanger depicted in Fig. 1 are illustrated as being continuous from the first tube sheet 23 to the second tube sheet 33a. Due to the fact that the two cooling fluids in a transfer-line exchanger of the present invention are of different temperatures, thermal stresses can occur in the tubes if a single tube was to be employed to carry the high temperature fluid over the entire length of the transfer-line exchanger or if the separate tubes of section 10 were mechanically fixed or welded at both ends. In the present invention the transfer-line exchanger is designed such that the thermal stresses do not cause significant problems in cases, e.g., the cooling of a cracked reaction product, where the two cooling fluids have significantly different temperatures. In such cases, it is desirable to compensate for the thermal stresses developed in the tube(s). Although there are a number of different methods by which these thermal stresses can be reduced, the method of particular interest is the joint depicted for use at the entrance to a cooling section as described in European Patent Application, Publication No. 0 089 742 and is used in the transfer line exchanger of the present invention in Fig. 2.

Specifically, Fig. 2 depicts that the tubes 24 are not continuous over the length of both the first and second heat exchanging zones 20 and 30. In Fig. 2, the tubes are discontinuous with a first portion 24A extending through the first heat exchanging zone 20 and a second portion 24B extending through the second heat exchanging zone 30. In the intermediate zone 10, a third or intermediate portion 24C of the tube provides fluid communication between tube portions 24A and 24B. The intermediate tube 24C is not physically connected to either tube portions 24A or 24B (i.e., a totally loose connection is provided between tubes 24A, 24B and 24C) and is preferably of the same or substantially the same diameter as the tube portions 24A and 24B. Due to the fact that the tube portions 24A, 24B and 24C are not physically connected, thermal stresses developed during operation of the transfer-line exchanger are reduced. Moreover, this can be achieved without a significant and undesirable pressure drop.

More specifically, Fig. 2 depicts the outlet end of the first heat exchanger zone 20 and the inlet of the second heat exchanger zone 30 of the transfer-line exchanger depicted in Fig. 1. The depicted portion of the first heat exchanger zone comprises tubes 24A which terminate at or near the outlet of the first heat exchanger zone 20. The depicted portion of the second heat exchanger zone 30 comprises tubes 24B which terminate at or near the inlet end of the second heat exchanging zone 30. A tube 24C of the same size and shape as tubes 24A and 24B is placed between the ends of

tubes 24A and 24B. The tube 24C is of a length such that it is slightly shorter than the length between the ends of tube 24A and 24B. Guide sleeves or rings 11 and 12 fixed on tube sheets 23a and 33 enclose or encircle a part of the length of each tube 24C at that point where 24C meet the ends of tubes 24A and 24B respectively. The guide sleeve 11 is designed to correctly position the intermediate tube 24C in relation to tubes 24A and 24B. In addition to or as a supplement to the guide sleeves, a guide or support baffle (not shown) can also be employed for this purpose.

Due to the loose connection between tube 24C and tubes 24A and 24B, the high temperature fluid flowing through the tubes will leak from the tubes. To prevent excessive leakage, the intermediate tubes are positioned within a tight compartment. For example, in the transfer line exchanger depicted in Fig. 1, using the loose intermediate tubes to reduce thermal stresses, as opposed to continuous tubes extending, without interruption through both heat exchanging zones, the intermediate zone or compartment 10 defined by tube sheets 23a and 33 and flanges 13 and 14 forms a tight compartment having no or essentially no leakage to the environment. In addition to preventing leakage to the environment, once sufficient amounts of the high temperature fluid leak, via means of the loose connection, between tubes 24A, 24B and 24C, into compartment 10, the pressure in the tubes and the tight compartment 10 equalizes, at which point, further leakage through the tube ceases.

Fig. 3 depicts a transfer-line exchanger of the present invention having "double tube" type conduits for the heat exchange operation. Although the double tube type conduits can be placed in an outer shell, no outer shell encompassing the tube bundle is conventionally employed. The depicted transfer-line exchanger of the double tube type arrangement comprises a first heat exchanging zone 40, a second heat exchanging zone 50 and an intermediate zone 110. An inner conduit 43 for carrying the higher temperature fluid extends through the first heat exchanging zone 40, the intermediate zone 110 and the second heat exchanging zone 50.

As illustrated in greater detail in Fig. 4, the conduit 43 is discontinuous with a first portion 43A extending through the first heat exchanging zone 40, a second portion 43B extending through the second heat exchanging zone 50 and an intermediate portion 43C extending between 43A and 43B in the compartment 110. In the first heat exchanging zone 40, the conduit 43A is enclosed by outer conduits 42 which carry the lower temperature or cooling fluid. At opposite ends of conduit 42 are an inlet or distribution pipe or header 41 for receiving the first cooling fluid and an outlet or collection pipe or

header 44 for removing the first cooling fluid. In the second heat transfer zone 50, outer conduits 52 for carrying the second cooling fluid enclose the second tube portion 43B. At opposite ends of the outer conduits 52 is an inlet or distribution pipe or header 51 for distributing the second cooling fluid to the outer conduits 52 and an outlet or collection pipe or header 54 for removing the second cooling fluid. The depicted transfer line exchanger also comprises a distribution header 45, connected to an inlet 46, for distributing the high temperature fluid through the inner conduits 43 and a collection header 55, connected to outlet 56 for collecting the cooled, high temperature fluid flowing from the conduits 43.

In the intermediate zone 110, the thermal stresses occurring in the tubes 43 due to the different temperatures of the first and second cooling fluids are reduced in a manner similar to that described hereinbefore. This is illustrated in Fig. 3 and, in more detail, in Fig. 4 which depicts a portion of the outlet end of the first heat exchanging zone 40, the inlet end of the second heat exchanging zone 50 and the intermediate zone 110. The inner conduit 43A, is terminated at or near the outlet of the first heat exchanger zone 40. Similarly, the conduit 43B terminates at or near the inlet end of the second heat exchanging zone 50. A conduit 43C having the same or essentially the same size and shape as conduit 43A and 43B is placed between the end of conduit 43A and the end of conduit 43B. The conduit 43C is of a length such that it is slightly shorter than the length between the ends of conduits 43A and 43B. Guide or ring sleeves 150 and 152 enclose or encircle a small portion of each end portion of conduit 43C at that point where conduits 43A and 43C and 43B and 43C meet.

In the operation of the described "double tube" type transfer-line exchanger, the high temperature fluid is flowed, as indicated by the arrow identified by numeral 80, via the inlet 46 to distribution header 45. From distribution header 45, the high temperature fluid flows into the inner conduits 43 extending through the first heat exchanging zone 40. A first cooling fluid is flowed, as indicated by the arrows identified by numeral 81, from the first distribution pipe 41 through the outer conduits 42 cocurrent with the high temperature fluid flowing through inner conduits 43. As the cooling fluid flows through the outer conduit 42 it cools the high temperature fluid flowing through the inner conduit 43 and is simultaneously heated. The cooling fluid then flows, as indicated by the arrows identified by numeral 82, from the outer conduit 42 into the first collection pipe 44. This cooling fluid, which has

been heated and/or undergone a phase change in the heat transfer operation then flows from the transfer-line exchanger to a collection point for further use in producing energy or heat.

The now partially cooled high temperature fluid flows from the first heat exchanging zone 40 through the intermediate compartment 110 into the second heat exchanging zone 50. As indicated by the arrows 85, a second cooling fluid is flowed from the second distribution pipe 51 through the outer conduits enclosing conduits 43 in the second heat exchanging zone cocurrent with the flow of the partially cooled, high temperature fluid. As the cooling fluid flows through the outer conduit 52, the high temperature fluid is further cooled while the cooling fluid is heated. The cooled high temperature fluid flows, as indicated by the arrow identified by numeral 90, from inner conduit 43 into a collection header 55 and from the transfer line exchanger via outlet 56. The second fluid flows, as indicated by arrows 86, from the outer conduit 52 into collection pipe 54. From the second outlet header, the cooling fluid which has been heated to a higher temperature and/or undergone a phase change, is passed from the transfer-line exchanger for further use in the production of heat and/or energy.

With regard to the individual components of the transfer-line exchanger, the size and shape of the transfer-line exchanger, the first and second heat exchanging zones or compartments, and each element thereof, e.g., the conduits, tube sheets and housings, are selected on the basis of the end use application and operating conditions of the heat exchanger, including fluctuations in temperature and pressure expected in the operations using the transfer-line exchanger.

The materials employed in preparing each of the component parts of the transfer-line exchanger are dependent on a variety of factors including the specific fluids employed and the temperatures and pressures and the materials of construction are selected accordingly. Since the heat exchanger is particularly useful in cooling the cracked reaction product of a hydrocarbon cracker, the high temperature fluid will have an initial temperature of from 700 to 1100°C or greater. Therefore, the transfer-line exchanger and its component parts must be constructed accordingly. At these temperatures, nickel and nickel-based steel alloys and steel alloys of chromium and molybdenum can be employed in constructing the transfer-line exchanger. In general, steel alloys with molybdenum are sufficient in most applications.

Claims

1. An improved transfer-line which comprises two shell and tube heat exchange sections each having tube(s), tube sheets and shells, wherein the tube(s) of the first heat exchanger communicate a high temperature fluid being cooled to corresponding tube(s) in the second heat exchange section through intermediate tube(s), wherein the improvement comprises the intermediate tubes being positioned loosely in guide sleeves, the intermediate tubes being contained within a tight compartment.

2. The cooler according to claim 1 wherein the guide sleeves are located on the tube sheets at the nearest ends of the shells of the two heat exchange sections.

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3. An improved process for cooling a cracked reaction product from a cracking furnace which comprises supplying the cracked reaction product to a two stage transfer-line cooler which comprises two shell and tube heat exchange sections each having tube(s), tube sheets and shells, wherein the tube(s) of the first heat exchange section communicate the high temperature cracked reaction product being cooled to corresponding tube(s) in the second heat exchange section through intermediate tubes.

4. The process according to claim 3 wherein the intermediate tubes are positioned loosely in guide sleeves which are located on the tube sheets at the nearest ends of the shells of the two heat exchange sections and the intermediate tubes being contained within a tight compartment.

FIG. 1

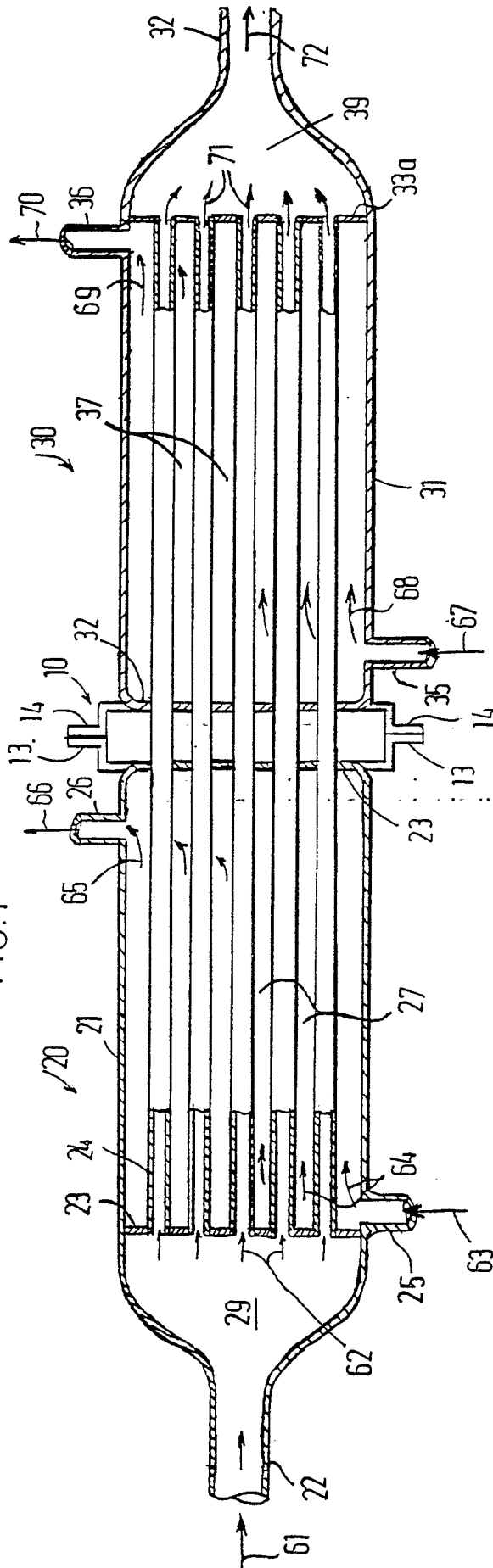
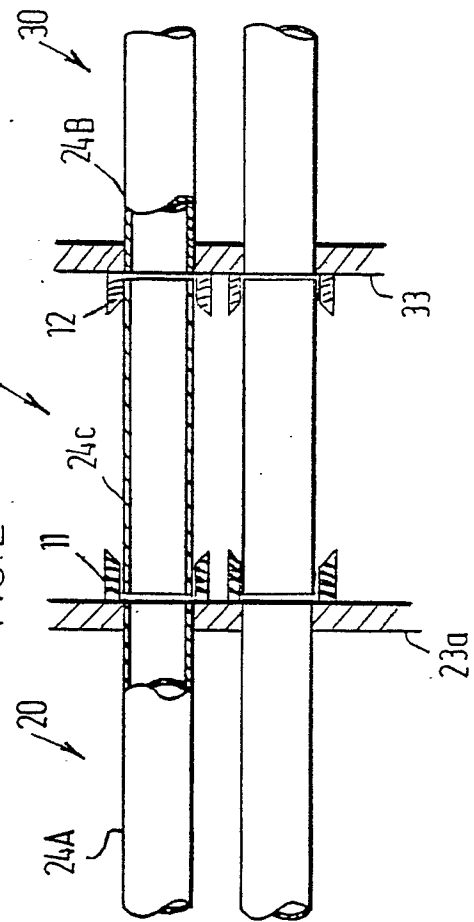
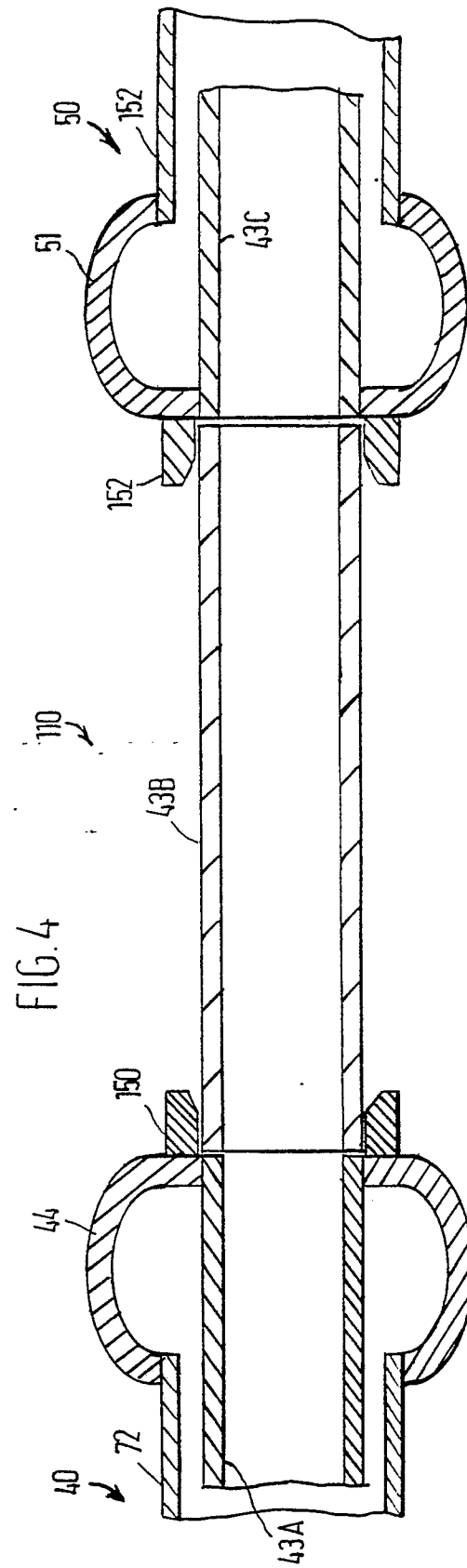
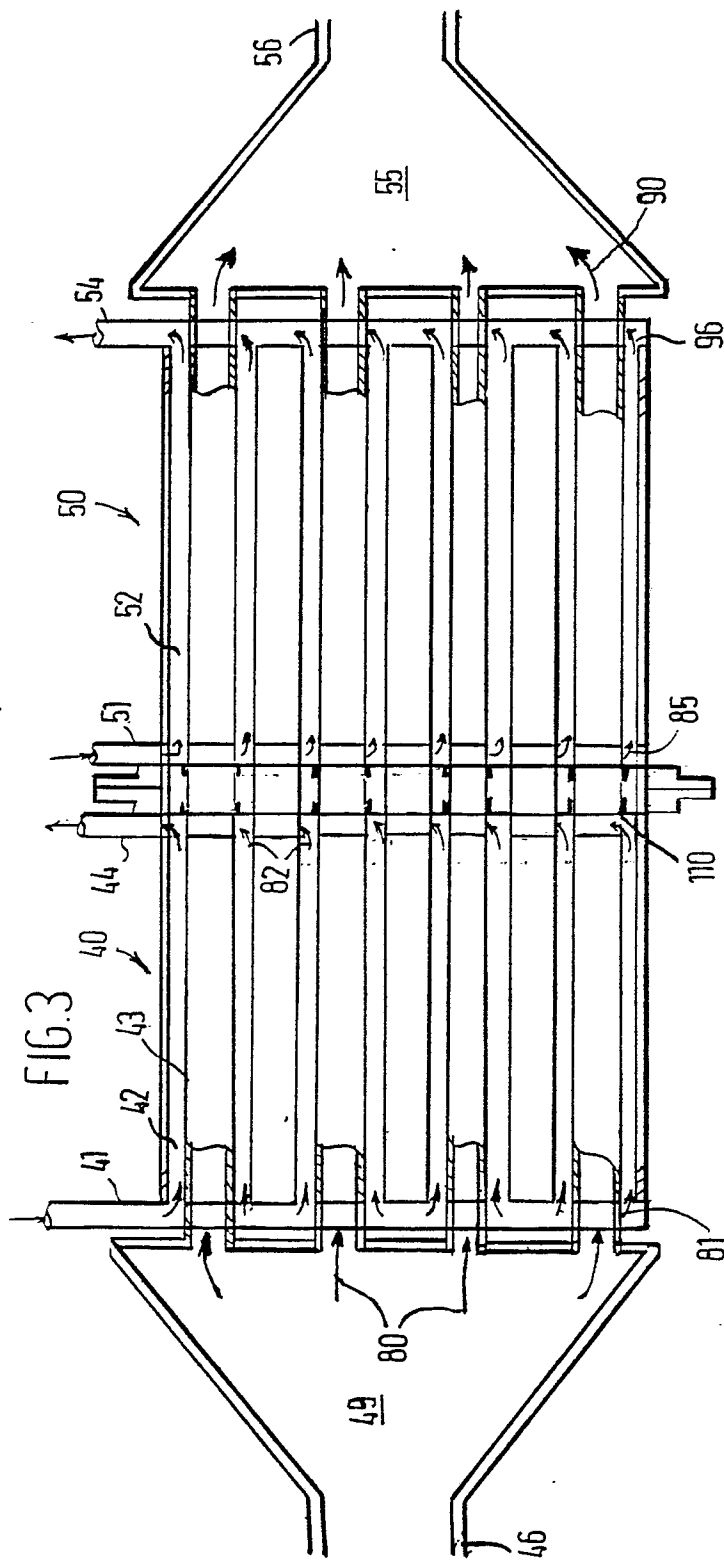


FIG. 2







DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
Y	FR-A-2 256 778 (SUN VENTURES INC.) * Whole document *	1-4	F 28 D 7/16 F 28 F 9/00
Y	--- US-A-4 103 738 (AYDELOTT et al.) * Figure 2 *	1-4	
D, A	--- EP-A-0 089 742 (EXXON) * Whole document *	1-4	
A	--- EP-A-0 118 134 (STORK) -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
			F 28 D F 28 F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 05-09-1986	Examiner SILVIS H.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	