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HEAT EXCHANGER

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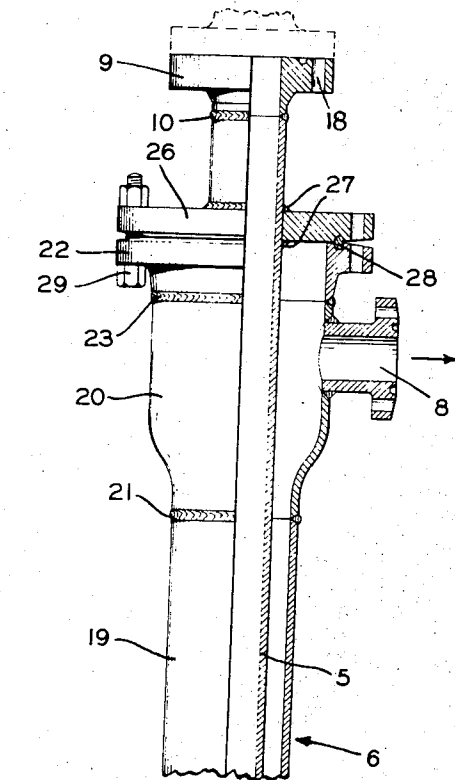
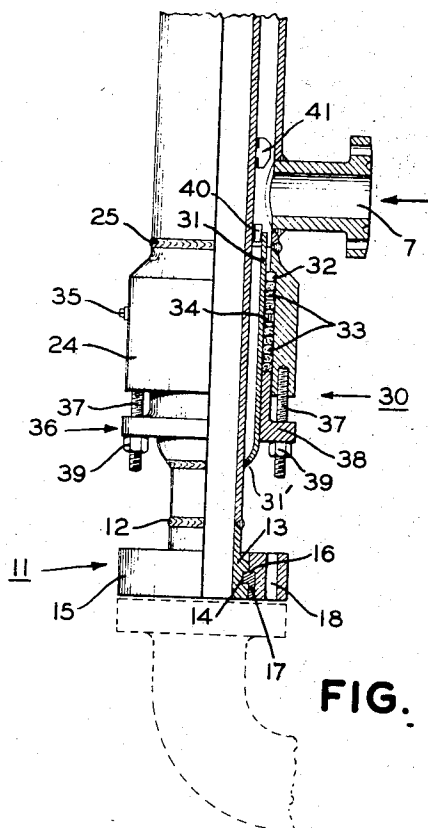
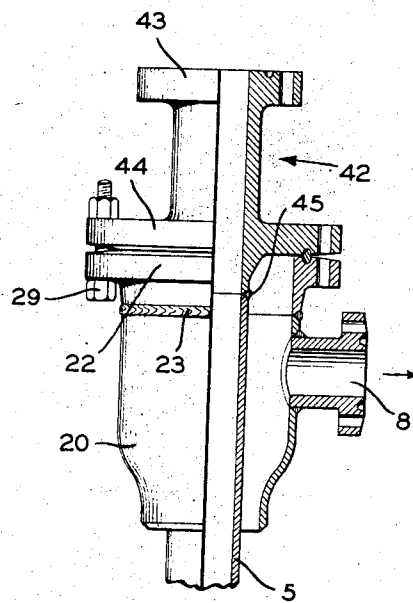


FIG. 2

FIG. 1

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HEAT EXCHANGER

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1 Claim. (Cl. 257-246)

This invention relates, in general, to a heat exchanger, and is particularly directed to improvements in transfer line heat exchangers of the type employed in the oil refining and other processing industries.

In the various processing arts in which high temperature fluids are handled, the practice of installing heat exchangers in the transfer lines for preheating fluids about to be processed, for generating steam, or for other purposes, is well known. When used as steam generators, the units are customarily placed in the transfer lines conducting fluids whose temperature is intended to be lowered. This practice makes it possible to utilize to advantage the excess heat in the transfer line, either as an economy measure, or for the purpose of speeding up the transfer of heat from the line.

It is a principal object of this invention to construct a heat exchanger, particularly adapted for use as a steam generator, of simple and sturdy construction, insertable as a unit, singly or in multiple, in a transfer line for high temperature fluids, capable of operation under particularly high temperature conditions, and which may readily be removed from the transfer line and completely dismantled for the purpose of cleaning or repairing.

A further and more specific object is to provide a fluid transfer-line heat exchanger, particularly adapted for use as a steam generator, that may readily be inserted as a unit in present transfer line installations; that includes a minimum of demountable connected elements which may easily be dismantled for the purpose of cleaning and repairing; and has improved connecting devices between the various elements for maintaining a fluid tight connection therebetween under extremely high temperatures and pressures.

In carrying out the present invention, the foregoing objects are attained in the construction of a single-tube-and-shell heat exchanger in which a tubular shell, having an inlet and an outlet adjacent its ends, encases an intermediate portion of a tube, the tube being disposed vertically and having its ends adapted to connect with the ends of a fluid transfer line. The upper end of the shell is rigidly connected to the tube by a fluid-tight flange connection; and the lower end of the shell is connected to the tube by means of a stuffing-box and gland which not only provides a fluid-tight connection, but also permits relative longitudinal movement between the shell and the tube to compensate for unequal expansion with changes in temperature. The construction of the

steam generator is such that it may easily be removed from the transfer line as a unit, and the tube may be withdrawn from the shell.

These and other objects are effected by this invention, as will be apparent from the following description and claim taken in connection with the accompanying drawing forming a part of this application, in which:

Fig. 1 is a half section of a complete heat exchanger unit constructed and assembled in accordance with the present invention; and

Fig. 2 is a fragmentary sectional view showing a modified form of flange connection between shell and tube.

In the following description, the heat exchanger will be considered as being used for the generation of steam, and will be referred to as a steam generator. The steam generator is inserted in a fluid transfer line which, for the purpose of this disclosure, may be taken as the transfer line of a polymerization unit that normally conducts fluids at a temperature as high as 1100° F. and a pressure as high as 1500 lbs.

The drawing shows the steam generator in its normal upright position comprising a main fluid passage, such as tube 5, for conducting the high temperature medium, and a longitudinally extending shell 6 encasing tube 5 for a portion of its length and adapted to receive a supply of water for conversion into steam.

Shell 6 has ports 7 and 8 at its lower and upper ends respectively. Lower port 7 admits a constant flow of water to the shell. This flow is preferably in excess of the conversion capacity of the steam generator. Upper port 8 will thus discharge a mixture of steam and water. This discharge may be separated in any desired manner and the water content may be fed back for recirculation. Obviously, the generator may also be operated in a manner to emit steam alone by providing suitable controls to maintain a substantially constant head of water in the shell.

The length and the diameter of shell 6 may be varied in accordance with the amount of heat available from the fluid transfer line and the steam output desired.

Tube 5 passes through shell 6 and extends a short distance beyond at each end. The tube may be made from plate material rolled to the desired shape and welded, or it may be in the form of seamless tubing. A flange 9, which is preferably a forging, is joined rigidly to the upper end of tube 5, as by weld metal 10. The lower end of tube 5 has a loose-ring flange 11 joined thereto by weld metal 12. Flange 11 comprises a short

tube length 13 upset at its outer end and provided with a circumferential key groove 14. A loose ring 15 encircles the upset portion of tube 13. Ring 15 has an annular shoulder 16 which engages the overhanging edge of a split key 17 placed in groove 14 to limit the forward movement of the ring. Bolt holes 18 are formed in the flanges 9 and 11 so that the steam generator may be attached as a unit to the flanges on the ends of the transfer line, shown in dotted lines.

In practice, the generator may be used singly in a line, or may be arranged in multiple by joining a series of them together with cross-over headers. In either case, the units may readily be removed from the line from time to time for inspection, repair, or replacement by removing the bolts of flanges 9 and 11.

Shell 6, in its present preferred form, is constructed of a plurality of connected tubular sections comprising a main tubular section 19 having a side opening adjacent the lower end accommodating a connector to form water inlet port 7; a swaged-out tubular section 20 joined to the upper end of tube section 19 by weld 21, both of which may be rolled to the desired shape from metal plates or formed of seamless tubing; a flange 22 joined by weld 23 to the end of section 20; and a stuffing-box housing 24 joined to the lower end of section 19 by weld 25. The swaged-out portion of section 20 has a side opening and a connector forming the outlet 8.

A flange plate 26 mounted on tube 5, and rigidly secured thereto by annular welds 27, is adapted for engagement with flange 22 of the shell. A gasket 28, accommodated in annular grooves formed on the faces of flanges 22 and 26, and bolts 29 are used to rigidly connect the upper end of the shell to the tube in fluid-tight engagement.

As stated, the lower end of the shell 6 is joined to the tube 5 by means of a stuffing-box and gland connection, generally indicated at 30. A loose sleeve 31 encases tube 5, its lower end being curved inwardly and rigidly joined to the tube by annular weld 31' at a point below the lower end of the shell. The free end of sleeve 31 extends within the shell the length of the stuffing box-housing 24. Its diameter is as large as may be freely accommodated within the shell, sufficient clearance being allowed for the withdrawal of the tube and its associated sleeve upwardly through the shell. A portion of the inner wall of housing 24 is recessed from the outer end so that, when the tube and shell are properly positioned, an annular packing channel will be formed between the wall and the outer surface of the sleeve. A metal packing ring 32 is placed in the bottom of the packing channel, followed by superimposed layers of packing material 33. A shaped metal ring or lantern 34 is placed between layers of the packing in alignment with a plug 35 in the housing 24. Through the plug opening a lubricant may be admitted to the lantern. A gland 36, having a cylindrical neck portion adapted to fit between the sleeve 31 and the housing 24, holds the packing in place. Stud 36 extends from the end of housing 24 through holes in a flange 38 formed on the gland 36. Nuts 39 hold the gland 36 in place and are adjustable to maintain a fluid-tight connection between the tube and the shell.

The free end of sleeve 31 is maintained concentric to tube 5 by means of wedges 40 equi-spaced about a circumference of the tube, and extending partly within the open end of the sleeve. Wedges 40 are joined rigidly, as by welding, to the outer surface of tube 5. The wedge taper is preferably

such that contact will constantly be maintained between the sleeve and the wedges during periods of longitudinal and radial expansion due to heating. With the reinforcement supplied by wedges 40, unequal pressures applied through the packing by gland 36 will not have the effect of distorting the sleeve, and the danger of damage to the latter by brushing against the sides of the shell or other objects while dismantling will be greatly lessened.

To further safeguard the sleeve 31 against damage, and to assist in guiding the tube in and out of the shell, equi-spaced plates 41, having their outer corners chamfered, are disposed longitudinally in a circumferential row about the tube 5 and are securely joined to the latter, as by welding. Plates 41, being disposed longitudinally, do not materially affect the water circulation in the space between tube and shell.

When desired, the steam generator unit may be removed from the transfer line and quickly dismantled by sliding flange ring 15 backward along tube 5 until split key 17 is cleared. The sections of key 17 are then removed from the key groove 14, and the flange ring 15 is slid off the end of tube 5. Nuts 39 are removed from studs 37 so that gland 36 may be removed and the packing 33 loosened in the stuffing-box. By removing bolts 29 from the flange connection at the upper end of the shell, the tube may be withdrawn upwardly from its shell.

In operation, the novel sealing arrangement provided for the lower end of the shell serves to maintain a fluid-tight connection under extreme temperature conditions. The difficulties ordinarily experienced in having the stuffing-box packing directly contacting the hot fluid transfer tube are obviated by the water-jacket formed by sleeve 31. Much of the heat in the lower portion of tube 5 will be absorbed by the water in the sleeve and used in the conversion of the water to steam, so that the temperature of the sleeve will be considerably lower than the temperature of the tube. By a proper selection of the size of the water-jacket in relation to the temperature of the transfer line, the temperature of the sleeve, and with it the temperature of the packing, may be kept below the point where deterioration of the packing will take place.

In addition to the protection provided for the packing, suitable precautions are taken to keep the stuffing-box and gland elements in good working order. To eliminate corrosion and the formation of scale in the stuffing-box, the exposed surfaces, such as the outer surface of sleeve 31 and the inner walls of housing 24, may be made corrosion resistant, as by chromium plating. The gland 36 may also be made corrosion resistant so that it may be moved easily on the sleeve 31.

Fig. 2 shows a modified form of connection between the upper end of the shell and the tube 5. Tube 5 is shortened so that, when assembled, its upper end is within the shell. Instead of the separate flanges 9 and 26 of Fig. 1, a single member 42 comprising a neck having a flange 43 formed at one end and a larger flange 44 set back from the opposite end, is joined to the upper end of the tube 5. Flange 44 is adapted for connection with flange 22 of the shell by bolts 29, and flange 43 is adapted to connect with the end of the fluid transfer line. The neck portion extending beyond flange 44 projects within the shell and is joined to tube 5 by weld 45. This type of connection may be used when it is believed, because of high temperature and pressure conditions, that

the separate flange welded to the tube as shown at 27 in Fig. 1 will not have the desired strength.

While the invention has been shown in the form of a single tube and shell, it is contemplated that a nest of tubes may be employed to conduct the hot fluid medium through the shell without departing from the spirit or essential attributes of the invention.

I claim:

- 10 A steam generator adapted for insertion in a high-temperature fluid transfer line comprising a vertical tube connectable at its ends to the transfer line, a tubular shell encasing a portion of said vertical tube, said shell having a water
15 inlet at the bottom and a steam outlet at the top, a flange on said tube forming a fluid-tight

cover for the upper end of said shell, and a packed slip-joint forming a fluid-tight connection between said tube and the lower end of said shell, said slip-joint including a sleeve between said tube and said shell radially spaced from both, the lower edge of said sleeve being turned inwardly and welded in fluid-tight relation to said tube, a packing in the space between the sleeve and the shell, and a pressure member adapted to press against said packing, the space between said sleeve and said tube forming an insulating jacket through which the incoming water may circulate.

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