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F. K. KELP

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HIGH PRESSURE PRE-HEATER FOR FEED WATER

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2 Sheets-Sheet 1

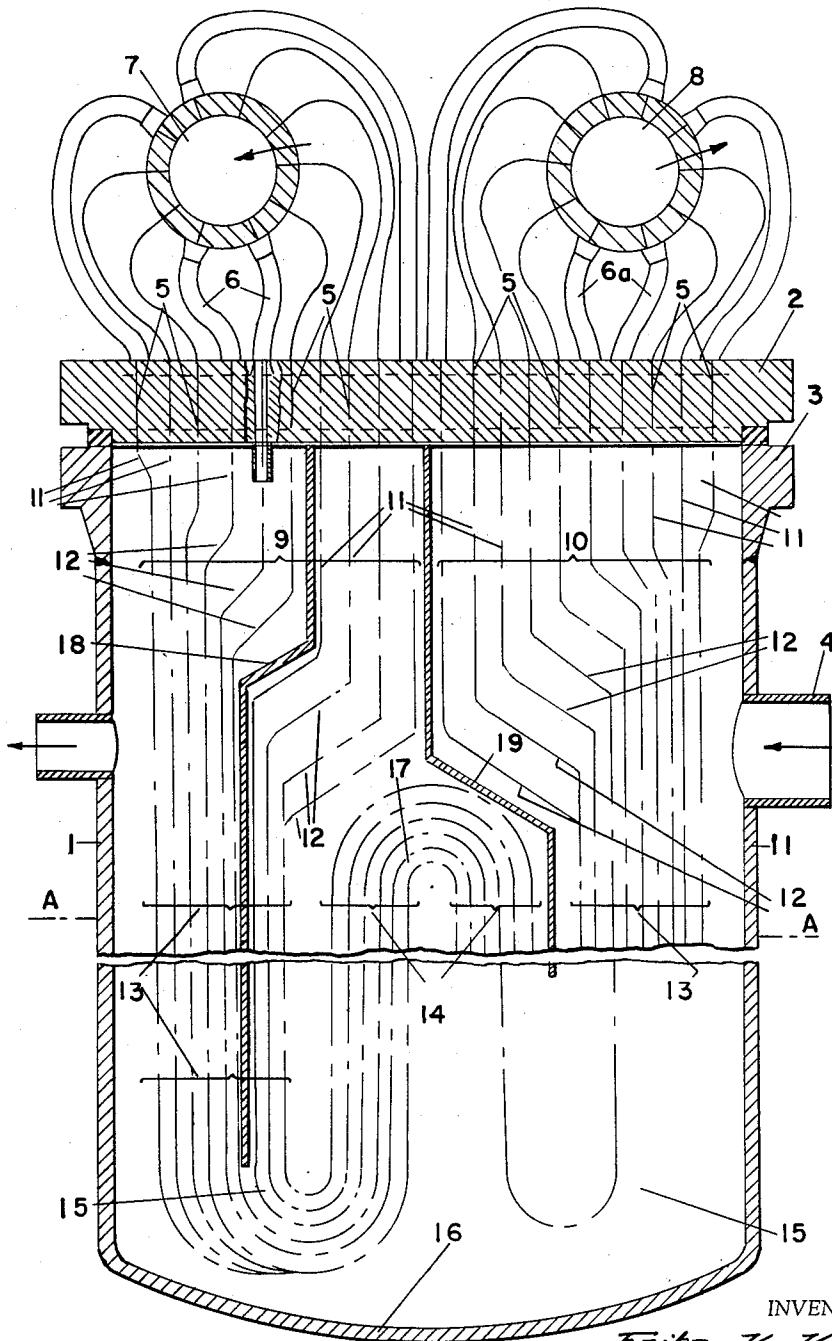


FIG-1

INVENTOR

Fritz H. Kelp

BY

Walter Beck

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F. K. KELP

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2 Sheets-Sheet 2

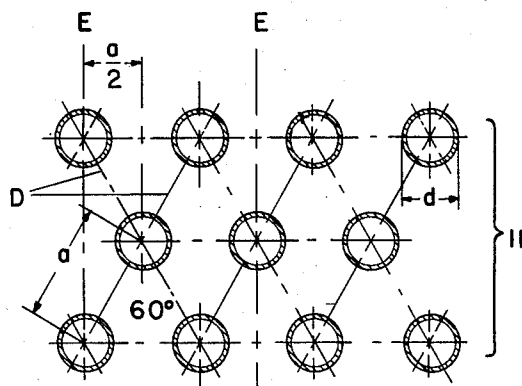


FIG-2

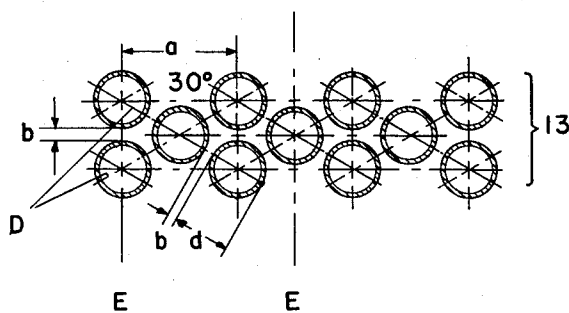


FIG-3

INVENTOR.

Fritz H. Kelp

BY

Walter D. Kelp

1

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HIGH PRESSURE PRE-HEATER FOR FEED WATER

Fritz K. Kelp, Nurnberg, Germany, assignor, by mesne assignments, to C. Aug. Schmidt Söhne G.m.b.H. Maschinenfabrik und Apparatebau, Hamburg, Germany
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9 Claims. (Cl. 165-74)

The present invention relates to a high pressure pre-heater for feed water. The present invention is based on the heretofore known type, according to which the tubes arranged in a steam cylinder and passed through by feed water are connected to a cover plate of said cylinder, and, furthermore, communicate with collectors for feeding and discharging the feed water, said collectors being arranged outside said cylinder. With this arrangement, within said cylinder and between the two pipe groups connected to the lid, there is provided an intermediate pair of pipe groups which extend through the cylinder over the entire length thereof so that the water will be passed through the steam cylinder or container along a four-fold path.

This type of construction is preferable because of the favorable conditions of operation which may be realized thereby. However, for special conditions, also, a second pair of intermediate pipe groups may be provided so that a six-fold path for passing the water through said steam cylinder will be obtainable.

Inasmuch as particularly with modern steam-producing installations employing high steam pressures and correspondingly high feed water pre-heating temperatures minimum costs are desired, it is an object of the present invention to provide a pre-heater for high pressure feed water, in which the boiler or the tube encasing container will have a minimum diameter per a certain output, while still making it possible to provide maximum tubular heating surfaces.

It is another object of this invention to provide a pre-heater, as set forth in the preceding paragraph, which will be relatively simple and inexpensive, and will also be safe in operation.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawings, in which:

FIG. 1 illustrates a central axial longitudinal section through a pre-heater according to the present invention.

FIG. 2 diagrammatically illustrates the arrangement of the tubes on the cover plate.

FIG. 3 shows the arrangement of the tubes within the container or steam cylinder of a feed water pre-heater according to the invention.

The objects according to the present invention have been realized primarily in that the connection of the tubes to the cover plate have been distributed so that they are spaced from each other by a distance which will permit the proper connecting work, whereas the tubes within the boiler have been bent so that their connecting ends can be concentrated at a relatively slight distance only between the respective connections.

Specifically referring to FIG. 1, the mantle of the pre-heater container is designated with the reference numeral 1 and is closed at the top by a cover plate 2 connected in any convenient manner to flange 3 of the mantle or housing 1. Near flange 3, the housing 1 is provided with inlet connection 4 for superheated steam. The tubes through which passes the feed water to be pre-heated are, for purposes of clarity, indicated merely by dot-dashed center lines. The passage of the tubes through the cover plate 2 may be effected in various manners. Thus, for instance, the plates 2 may be respectively provided with a bore 5 for each of said tubes. The

2

said bores may end on both sides of the plates in a nipple to which the heating pipe or a bent connecting pipe 6 is welded. These pipes respectively lead to collectors 7 and 8 outside the container 1 for the feed water passing into and out of the housing 1.

The bores are uniformly distributed over the entire surface of cover plate 2 and form two groups. One of these groups communicates with pipes 6 leading to collector 7, whereas the other group communicates with pipes 6a leading to collector 8. The nipples of bores 5 on the inside of cover plate 2 have the heating pipes welded thereto, said heating pipes being combined to an entrance group 9 and a discharge group 10 with corresponding connections to the two pipe groups 6, 6a leading to the collectors 7 and 8 respectively. The pipes of groups 9 and 10 have their ends 11 which are connected to cover plate 2 extend along a straight line and parallel to the longitudinal axis of the housing 1 and are provided with a bent inclined pipe section 12 by means of which they merge with their axis parallel main section 13 by means of which they extend through the entire length of the steam mantle.

The bent, inclined pipe sections 12 are so arranged and dimensioned that the pipe groups have their main sections 13 concentrated at a considerably shorter distance than their connections 11 or bores 5. The location of the bent pipe sections 12 may be so selected that both bent portions will be located in the same plane (namely, the drawing plane of FIG. 1), whereby the bending operation in the shop will be considerably facilitated.

The close arrangement of the main groups 13 of the pipe and their location toward the wall of the mantle 1 will provide sufficient space in the central portion of the housing 1 for two likewise closely arranged pipe groups 14 which are connected to the pipe groups 13 by bent sections 15 which are located close to the bottom 16 of said housing 1, and extend through the entire housing up to the pipe sections 12 where they are interconnected by bent sections 17. In this way, according to the present invention, a four-group heating pipe system may be mounted in the steam mantle or housing 1. This is a considerable advance over the heretofore known two-group pipe system, inasmuch as, according to the present invention, with the same dimensions of the mantle or housing 1 in the latter approximately a duplication of the heat transfer surfaces will be obtained or, if the size of said surfaces is maintained, a considerable reduction in the diameter of the housing will be possible. In the first instance, a corresponding increase in the pre-heating output will be obtained, whereas, in the last instance, a considerable saving in material will be realized for the container and its cover plate. Furthermore, the pipe arrangement according to the present invention makes it possible to provide customary cooling zones for the condensate. This may be realized by the installation of a partition 18 of an offset shape, which partition follows in its contour the contour of the bends 12 of the pipe group 9. With most of the individual pipes, also the sections 15 and 17 are located in the same plane as the bends 12, whereby the manufacture and installation of the coils will be greatly facilitated.

The present invention also makes it possible, while following the principle of the invention as outlined above, to provide a four or more group pipe system which will make it possible to arrange the coils as favorably as possible and to mount maximum heating surfaces in a steam housing of fixed diameter.

The advantage of the present invention will become even further evident from FIGS. 2 and 3.

Referring, first, to FIG. 2, it will be noted that the arrangement of the pipe ends 11 on the cover plate 2

3

shows that the central axes of the pipes are located at the corners of equilateral triangles with each side thereof equalling a . The distance between each two adjacent tubes at the cover plate naturally equals the length a . The magnitude a is thus determined by the pipe diameter d and the minimum value of the free space necessary between the pipes for a proper connection of the pipes, for instance their welding to the nipples of the cover plate 2. Accordingly, the pipes of each row are offset with regard to the adjacent row by $a/2$. This arrangement of the pipes in a network of identical equilateral triangles makes it possible at a given pipe diameter d and at a given distance a , to provide a maximum number of pipes on a given surface of the cover plate. The distance a of the pipes in the rows will also be maintained with regard to their concentrated portions 13, as will be evident from FIG. 3.

It will, thus, be evident that the two bends of each pipe 12, as well as the sections 15 and 17, will be located in the same plane, said plane being indicated by dot-dash lines E—E. In group 13 (see FIG. 3), the rows of tubes are arranged so close to each other that everywhere between each pipe and all of its adjacent pipes there will be identical free spacing b . The measurement b will assure the desired heat transfer giving the hot steam sufficient space to flow around the pipes. This, in turn, permits a highly advantageous exploitation of the surface of the cover plate and furnishes the further possibility to mount a maximum of pipes within the steam mantle or housing. In this connection, applicant has found that the measurement of crowding the individual pipes of groups 13 and 15 together while employing ordinary pipe diameters d will be made possible by inclining the diagonals D of the rows of pipes which within the range 11 extend at an angle of 60° to incline at 30° within the range 13. In this way, also the means for holding the pipe groups can easily be ascertained with regard to shape and dimensions.

The close arrangement of the tubes above all at the condensate cooling zone partitioned by wall 18 (FIG. 1), as well as the desuperheating zone of the pre-heater as defined by the wall 19 will, due to the improvement of the hydraulic radius, bring about an increase in the heat transfer from hot steam to the feed water. This, in turn, results in a saving of the heating area.

As will be evident from the above, the present invention makes it possible within the steam mantle or housing to arrange a pipe system of four or more groups and to crowd the system together so that a relatively small diameter will be obtained for said mantle or housing. It will also be evident from the above that, in conformity with the present invention, for a certain pre-heating output and the width and number of pipes pertaining thereto, the steam mantle or housing may be given a minimum inner diameter, and the thickness of the housing 1 which is determined by the inner diameter and the pressure and heat loads acting thereon may be selected so that it will be a minimum without affecting the rigidity or strength of the housing. Moreover, the invention makes it possible to obtain favorable mantle constructions according to which the pipes may be connected to the cover plate at a spacing which, while reduced to a minimum, still permits a careful connection of the pipes to the cover plate, which pipes are usually welded to the cover plate. This spacing and the spacing of the pipes within the steam housing may with high pressure feed water pre-heaters at heretofore customary operational data be adapted to each other in such a way that favorable flow of heat transfer conditions will be obtained within the steam mantle while simultaneously there will be sufficient space at the cover plates for connecting the tubes thereto while the outer diameter of the mantle will be reduced to a minimum.

In addition to saving valuable material in the steam mantle and its cover plate, the invention also brings about

4

heat technical advantages. The narrow arrangement of the pipes in that zone of the steam mantle in which the superheated steam is cooled and in the so-called condensate cooling zone, will bring about a more favorable hydraulic radius than is obtainable with heretofore customary pipe spacings. It is furthermore to be mentioned that the invention results in an advantageous effect upon the pipe heat transfer and, thereby, a considerable saving in the pipe heating surface.

In order to allow a proper connection of the pipes 11 to the passages 5 by welding, the minimum spacing between the passages 5 at a pipe diameter of 25 mm., i.e. the free spaces between two adjacent pipes of passages 5, should be 38 mm. The free spacing b (FIG. 3) between the pipes 13 or 14 respectively in the interior of housing 1 along the transverse plane A—A (see FIG. 1) would be a fifth to a fourth of the pipe radius. Of course, with a change in the diameter of the pipes, the said spacing will vary accordingly or proportionally.

It is, of course, to be understood that the present invention is, by no means, limited to the particular constructions shown in the drawings, but also comprises any modifications within the scope of the appended claims.

What I claim is:

1. In a high pressure pre-heater for feed water: a housing having an opening and also having a steam inlet and a drain outlet, a cover plate closing said opening and provided with a first group and a second group of passages therethrough and distributed in uniformly spaced relation thereof, first collector means arranged outside said housing and communicating with said first group of passages for conveying said water thereto, second collector means arranged outside said housing and communicating with said second group of passages for receiving heated feed water therefrom, and a plurality of tubes inside said housing having their ends connected to said first and second group of passages respectively and having their intermediate portions between said ends extending nearly through the entire length of said housing, said tubes extending from said first group of passages and also from said second group of passages first through at least the major longitudinal extension of said housing in a direction away from said cover plate and then extending substantially along straight lines at least once in the opposite direction through a portion of said housing up to a certain plane, the tubes in the portions leading away from said plate being offset angularly toward each other in the region of said certain plane so as to leave space in the center of the housing for portions of the tubes extending in the opposite direction, the spacing of said tubes from each other below said certain plane being a fraction of the spacing of said passages from each other in said cover plate.

2. In a high pressure pre-heater for feed water: a housing having an opening and also having a steam inlet and a drain outlet, a cover plate closing said opening and provided with a first group and a second group of passages therethrough and distributed in uniformly spaced relation thereof, first collector means arranged outside said housing and communicating with said first group of passages for conveying said water thereto, second collector means arranged outside said housing and communicating with said second group of passages for receiving heated feed water therefrom, and a plurality of tubes arranged within said housing and having their ends connected to said first and second group of passages respectively and having first and second sections intermediate said ends extending nearly through the entire length of said housing, the tubes of said first and second sections being offset angularly between said cover plate and a plane between said cover plate and the opposite end of said housing, said offset being such that the distance between the tubes of said first section and the distance between the tubes of said second section is considerably decreased over the region of said offset when looking in

5

the direction from said cover plate to the opposite side of said housing, the offsetting of said tubes being generally radially outwardly of the housing axis to provide an unobstructed center region toward the bottom of the housing, said tubes also comprising third and fourth sections arranged between said first and second sections and in serial communication therewith, and in said unobstructed central region the spacing of all of said tubes from each other at said plane being a fraction of the spacing of said passages from each other in said cover plate, the offset portions of said tubes being staggered in the direction away from said cover plate.

3. A pre-heater according to claim 2, in which the tube sections on both sides of the offset portions thereof are located in the same plane.

4. A pre-heater according to claim 2, which includes screening plates arranged between said third section and said fourth section on one hand and said first section and said second section on the other hand, said screening plates being offset similar to the respective adjacent tubes of said first and second sections.

5. In a high pressure pre-heater for feed water: a housing having an opening and also having a steam inlet and a drain outlet, a cover plate closing said opening and provided with a first group and a second group of passages therethrough and distributed in uniformly spaced relation thereover, first collector means arranged outside said housing and communicating with said first group of passages for conveying said water thereto, second collector means arranged outside said housing and communicating with said second group of passages for receiving heated feed water therefrom, and a plurality of tubes in said housing having their ends connected to said first and second group of passages respectively, said ends connected to said passages being located so as to form the corners of equi-lateral triangles arranged in rows, said tubes having their intermediate portions between said ends extending nearly through the entire length of said housing, the arrangement being such that the tubes extend from said first group of passages and also from said second group of passages first through nearly the entire length of said housing in a direction away from said cover plate and then have portions extending substantially along straight lines at least once in the opposite direction through a portion of said housing up to a certain plane, said tubes in the regions extending away from said cover plate and above said plane being angularly offset in a direction generally away from the longitudinal axis of the housing thereof to provide an unobstructed space along said axis near the bottom of the housing forming the said portion thereof in which said tube portions are located, the spacing of said tubes from each other at said certain plane being a fraction of the spacing of said passages from each other in said cover plate.

6. A pre-heater according to claim 5, in which the distance between each two adjacent tube ends connected to said passages is sufficient to permit a welding connection of said tube ends with said passages.

7. A pre-heater according to claim 5, in which the

6

distance between each two adjacent tube ends connected to said passages is approximately from 1.3 to two times the diameter of said tube ends.

8. In a high pressure pre-heater for feed water: a housing having an opening and also having a steam inlet and a drain outlet, a cover plate closing said opening and provided with a first group and a second group of passages therethrough and distributed in uniformly spaced relation thereover, first collector means arranged outside said housing and communicating with said first group of passages for conveying said water thereto, second collector means arranged outside said housing and communicating with said second group of passages for receiving heated feed water therefrom, and a plurality of tubes arranged within said housing and having their ends connected to said first and second group of passages respectively and having first and second sections intermediate said ends extending nearly through the entire length of said housing, the tubes of said first and second sections being offset in a region between said cover plate and a plane intermediate said cover plate and the opposite end of said housing, said offset being generally toward the outside of the housing and being such that the distance between the tubes of said first section and the distance between the tubes of said second section is considerably decreased over the distance between said tubes at their connecting points with said passages in such a way that the distance between adjacent tubes of said first and second sections decreases over the range of said offset when looking in the direction from said cover plate to the opposite side of said housing, said offset providing a central unobstructed region in the lower portion of the housing, said tubes also comprising third and fourth sections parallel to and arranged between said first and second sections below said offset region and in serial communication therewith and located in said region of the housing, the spacing of all of said tubes from each other at said plane being a fraction of the spacing of said passages from each other in said cover plate, said offset portions being staggered in the direction away from said cover plate, the tubes along said plane being arranged so as to form the corners of substantially identical isosceles triangles with the tubes defining the base of said triangles being located in rows, said base having a spacing substantially equalling the spacing of said tube ends at their connections with said passages.

9. A pre-heater according to claim 8, in which the base angles of said isosceles triangles are approximately 30°.

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