Jan. 2, 1951 B. N. McDONALD 2,536,072

STEAM GENERATOR

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Fig. 1

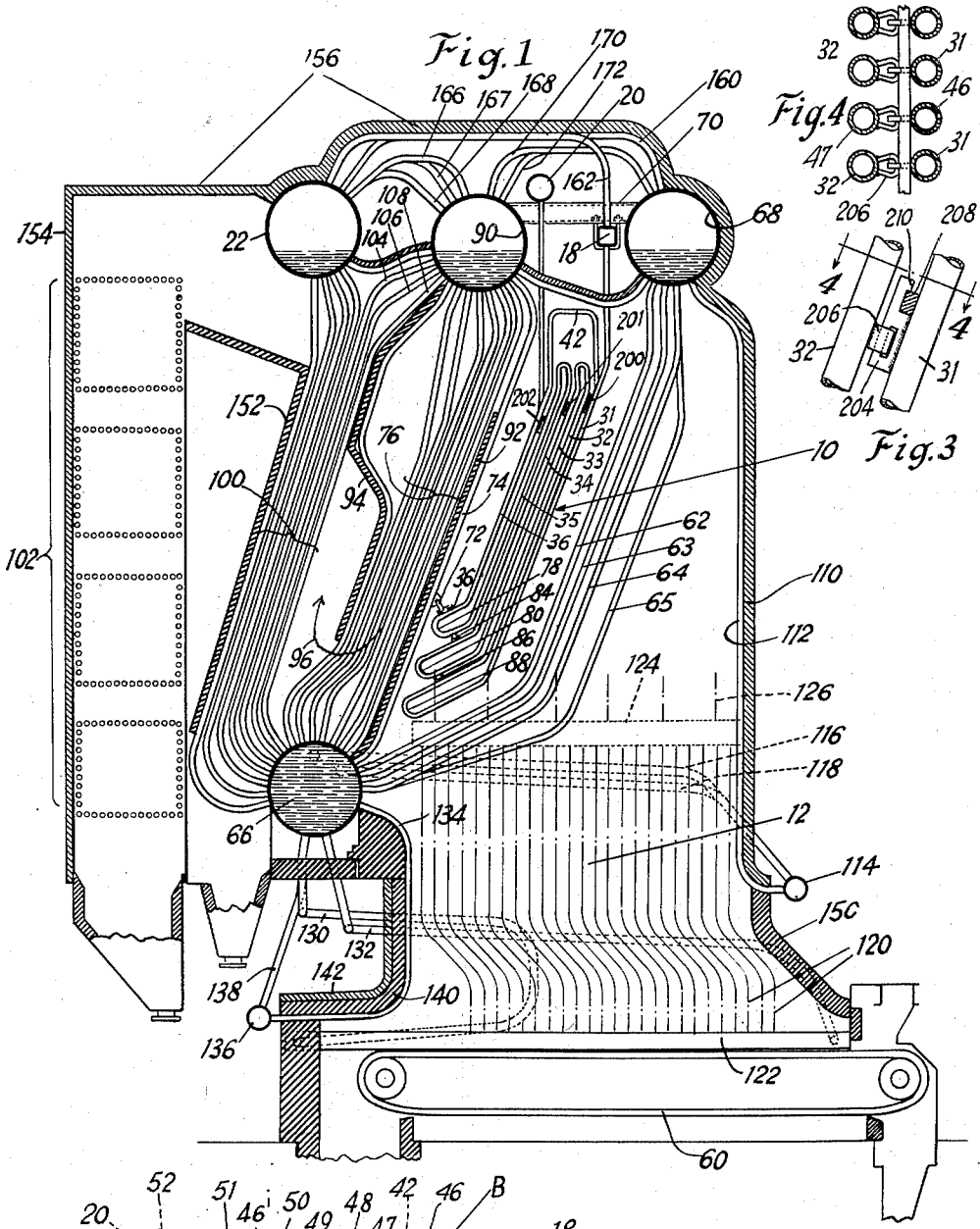
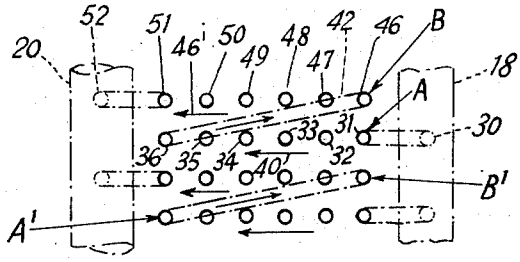


Fig. 4

Fig. 3

Fig. 2



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STEAM GENERATOR

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5 Claims. (Cl. 122—478)

1

This invention relates to steam generators, and it involves the particular construction and arrangement of a convection superheater, for a steam generator.

The invention more particularly relates to a steam superheater consisting of a bank of spaced fluid heating tubes, the bank of tubes being formed by return bend connected platens with the successive tubular sections of each platen connected at their ends for series flow of fluid therethrough from a single inlet of the platen to its outlet.

The invention also involves a steam superheater in which the successive platens are arranged structurally in parallel and with their planes transversely related to the longitudinal axis of an inlet header from which the platens receive fluid to be heated. Specifically, one embodiment of the invention involves a superheater of the above described type, in which successive platens of tubes (lengthwise of the inlet header, or transversely of the gas pass) are interconnected in series by pairs, at the top. Thus there is a continuous fluid flow through two connected platens, providing two fluid passes through a stream of heating fluid, i. e., a gas stream.

An object of the invention is to decrease metal temperatures, for the same fluid temperature outside the tubes and the same final fluid temperature inside the tubes of the platens. This is of primary importance in steam superheaters where gas temperatures and steam temperatures have reached such high values that, in many cases, expensive high alloy steels have been deemed necessary. The present invention provides for the use of much less expensive carbon steel tubes in installations which, without the invention, would require steel tubes of high alloy content and higher price.

Another object of the invention is to increase the overall rate of heat transfer so that less heating surface is required than would be the case with a conventional heater (or superheater) for the same steam and gas conditions.

Another object of the invention is to provide a fluid heater in which the number of tube holes in the header is materially reduced, thus affording a substantial reduction in the cost of manufacture. This also results in the additional advantage of increasing the header ligament efficiency, thereby permitting, in many cases, the use of headers having thinner walls.

The invention will be described with reference to the accompanying drawing in which a preferred embodiment is shown.

2

In the drawings:

Fig. 1 is a vertical section of a steam generator including the invention;

Fig. 2 is a diagrammatic view in the nature of a plan section, illustrating the manner in which adjacent superheater platens are interconnected in the superheater indicated generally at 10 in Fig. 1.

Fig. 3 is a detailed view showing connections employed between successive upright loops of the superheater tubes; and

Fig. 4 is a transverse section on the line 4—4 of Fig. 3.

The illustrative superheater consists of a bank of series flow connected tubular sections which are disposed in upright positions in the path of furnace gases proceeding from the furnace 12. These sections are connected at their ends to provide such interconnected platens as those shown at A and B in Fig. 2, the outlet tubular section 36 of platen A being connected to the inlet tubular section 46 of platen B to afford a continuous steam flow from the superheater inlet header 18 to the outlet header 20. The inlet header 18 receives its steam from the rear drum 22 of a four drum bent tube steam generator which will be later referred to.

It is to be understood that Fig. 2 is representative of a small section of the superheater and that there are successive arrangements of superheater platens similar to the arrangement of the platens A and B. One such successive arrangement is shown between the platens A' and B' each with 6 tubular sections, however a platen may consist of only 2 sections.

The steam flow from the superheater inlet header 18 through the successive tubular sections 31—36 of platen A is indicated by the arrow 40. From the tubular section 36 the steam flows through a tubular crossover connection 42 to the tubular section 46 and thence in the direction of the arrow 46' through the successive tubular sections 47—52 to the superheater outlet header 20. The crossover connection 42 is further shown in Fig. 1 as being disposed mainly above the bank of the superheater tubes.

The immediate result of the use of this arrangement of tubes is to double the velocity of the steam flowing through the tubes, as compared with a conventional arrangement of platens in which all of the steam flows through the platens in parallel from the inlet header to the outlet header. This increase in velocity has two major results. First, the overall rate of heat transfer is increased so that less heating surface is required than would be the case with the con-

ventional superheater arrangement of platens, for the same steam and gas conditions. Secondly, for the same gas temperature outside the tubes, and the same steam temperature inside the tubes, the increased steam velocity results in an appreciable lower metal temperature. This results from an increase in the conductance of the steam film on the inside of each tube, or tubular section, consequently decreasing the temperature differential between the steam and the metal. This reduction in metal temperature permits the use of relatively inexpensive carbon steel superheater tubes in place of expensive alloy steel tubes, in many installations. The invention also results in a substantial reduction in the number of tube holes to be drilled in the superheater headers and this reduces the cost of the superheater construction. It also results in the additional advantage of increasing the header ligament efficiency, permitting in many cases, the use of headers with thinner walls.

The invention, with its interconnected adjacent superheater platens also results in a marked improvement in steam distribution, and this in turn, results in a lower maximum tube temperature, and longer tube life.

Now, referring to the steam generator as indicated in Fig. 1, the furnace 12 is fired by a chain grate stoker 60 from which the gases pass upwardly over a first bank of steam generating tubes 62—65 directly connecting the submerged drum 66 with the front steam and water drum 68.

After passing over the front bank of steam generating tubes the gases pass over the superheater which is supported mainly from the inlet and outlet headers 18 and 20. These headers are supported in the manner indicated in the drawings from a beam such as 70. At the bottom of the superheater its rear tubular sections such as 36 are supported by a clevis arrangement including a connecting link 72 from the front tubes 74 of the middle bank of steam generating tubes 76. To maintain the successive loops of the superheater platens in their operative positions such loops 78 and 80 are connected by clevis devices such as that shown at 84. A similar clevis device 86 is shown connecting the loops 80 and 88.

To maintain optimum uniform gas flow between the superheater tube sections such as those indicated at 31—36 and 46—51 in Fig. 2, connecting structures such as those indicated at 200—202 are employed in the upper portion of the bank of superheater tubes. One of these connections is indicated in detail in Figs. 3 and 4. They are shown between the tubes of the first two transverse rows of the superheater, including such tubes as 31, 32, 46 and 47. Each of the tubes 31 or 46 is connected to the tube immediately in the rear thereof by the specific construction indicated in Figs. 3 and 4. This includes in each instance bracket 204 welded to the forward tubes such as 31, this bracket being provided with an opening through which extends a U-shaped element 206, the legs of which are welded to the rearward tubes such as 32. The brackets 204 are aligned horizontally transversely of the superheater on the tubes 31 or 46 and are provided with recesses for receiving a transverse aligning bar 208 which is locked in position against upward displacement by extensions 210 on the upper parts of brackets 204. The bar 208 is slidable into operative position from one side of the bank of superheater tubes and is

adapted to maintain the superheater tubes in their operative alignment, preventing shifting of the tubes downwardly or upwardly relative to each other. Thus, the clevis constructions such as shown in Figs. 3 and 4 together with those such as shown at 72, 84, and 86 maintain the integrity of the superheater as a separate bank of tubes and as a rigid unit supported from the headers 18 and 20 and from the forward tubes 74 of the middle bank of steam generating tubes.

The middle bank of steam generating tubes 76 directly connects the drum 90 to the submerged drum 66 and the furnace gases are caused to pass downwardly along the tubes of this bank by the construction and arrangement of baffles 92 and 94. Toward the lower end of the middle bank of steam generating tubes 76 the gases are turned as indicated by the arrow 96 and proceed upwardly over the rear bank of steam generator tubes 100 and thence to the gas inlet of the economizer 102. The first three rows 104, 106 and 108 of the tubes of the rear bank 100 directly connect the middle steam and water drum 90 with the submerged drum 66 while the remainder of the tubes of the rear bank directly connect the rear bank 22 with the submerged drum 66.

The front wall 110 of the installation is defined by furnace steam generating tubes 112 connecting the header 114 to the front steam and water drum 68, the header 114 being connected for circulatory purposes, with the submerged drum 66 by the circulators 116 and 118.

Other steam generating surfaces are provided by the furnace side wall tubes such as 120. These tubes, in Fig. 1, are shown as connecting the lower head 122 to the upper header 124, the latter being connected by tubes such as 126 to a steam and water drum. The lower header 122 is connected to the submerged drum 66 by circulators such as 130 and 132.

Toward the rear of the furnace additional steam generating surface is provided by the furnace wall arch tubes 134 which directly connect the drum 66 with the header 136 in the manner indicated in the drawing. The header 136 is also directly connected to the submerged drum 66 by the circulators 138.

Rearwardly of the arch tubes 134 is a stratum 140 of heat resisting material and a stratum 142 of thermal installation. Similar materials are provided for the front wall 150, the rear baffle 152, the rear wall 154 and the roof 156, encasing the pressure parts of the installation. The roof 156 is mainly supported by the circulators 160 and the superheater inlet tubes 162.

The circulators 160 extend from the steam space of the front steam and water drum 68 to the steam space of the rear drum 22. This space is connected to the superheater inlet header 18 of the tubes 162. Associated rows of circulating tubes such as 166—168, connect the same spaces of the drums 22 and 90 and the drums 90 and 68 are similarly connected by circulators such as 170 and 172.

What is claimed is:

1. In a steam generating installation, horizontally spaced upright steam generating tubes, a convection superheater including a plurality of upright parallel platens of return bend tubes connected for the series flow of steam through successive tubes, said platens constituting a bank of spaced upright superheater tubes disposed rearwardly of the steam generating tubes and transversely of the path of furnace gas flow, inlet and outlet headers above said bank of

superheater tubes, tubular crossover means interconnecting adjacent platens to form groups with the outlet tube of a first platen at the rearward part of the superheater connected to the inlet tube of a successive platen of the same group, said inlet tube being disposed at the forward part of the superheater, means including upright tubular extensions connecting the inlet tube of the first platen of each group of platens to the inlet header as a common source of steam, means including tubular outlet extensions connecting the outlet tube of each group of platens to the outlet header, and means tying together the return bend tubes and the platens of the superheater so that the superheater is supported by the inlet and outlet extensions.

2. A convection superheater including a plurality of upright platens of return bend tubes connected for the series flow of steam through successive tubes, said platens constituting a bank of horizontally spaced upright superheater tubes disposed transversely of the path of furnace gas flow, inlet and outlet headers above said bank of superheater tubes, tubular crossover means interconnecting adjacent platens to form groups with the outlet tube of a first platen at the rearward part of the superheater connected thereby to the inlet tube of a successive platen of the same group, said inlet tube being disposed at the forward part of the superheater, means including upright tubular extensions connecting the inlet tube of the first platen of each group of platens to the inlet header as a common source of steam, means including tubular outlet extensions connecting the outlet of each group of platens to the outlet header, said inlet and outlet extensions depending from and secured to the respective headers and means tying together the return bend tubes and the platens of the superheater so that the superheater is supported by the inlet and outlet extensions, said tying means including an aligning bar extending transversely through the platens of a plurality of groups and through brackets secured to the tubular components of the platens.

3. In a fluid heating installation, a bank of horizontally spaced upright tubes disposed transversely of the path of furnace gas flow and including a plurality of parallel upright platens each formed of return bend tubes connected for the series flow of fluid through successive tubes, tubular crossover means connecting the outlet tube at the rearward part of a first platen of each group with the inlet tube at the forward part of a successive platen of the same group, means including upright tubular extensions each connecting the inlet tube of the first platen of a group of platens to a common source of fluid, means including tubular outlet extensions each connecting the outlet tube of a group of platens to a common fluid outlet, said inlet and outlet extensions being supported at their upper ends, means tying together the return bend tubes and the platens of the bank so that the bank is supported by the inlet and outlet extensions.

4. In a convection fluid heater including a plurality of horizontally spaced upright platens of parallel tube lengths connected by return bends for the series flow of fluid through successive tube lengths in each platen, said platens constituting a bank of horizontally spaced upright tubes disposed transversely of the flow of a heating fluid, tubular crossovers each interconnecting adjacent platens to form a group of platens with the outlet tube length of a first platen near one side of the heater connected to the inlet tube length of a successive platen of each group, the outlet tube length being disposed near the side of the heater opposite the side near which the inlet tube length is disposed, the platens of each group being disposed in parallelism, and means tying together the adjacent return bend tubes and the adjacent platens of the heater so that the heater is supported by the inlet and outlet tube lengths, the inlet tube length of the first platen of each group of platens being connected to a common source of fluid to be heated and the outlet tube length of each group of platens being connected to a common fluid outlet.

5. In a convection fluid heater including a plurality of horizontally spaced upright platens of parallel tube lengths connected by return bends for the series flow of fluid through successive tube lengths in each platen, said platens constituting a bank of horizontally spaced upright tubes disposed transversely of the path of furnace gas flow, tubular crossovers each interconnecting adjacent platens to form a group of platens with the outlet tube length of a first platen near the front of the heater connected to the inlet tube length of a successive platen of each group, the connected outlet tube length being disposed near the rear of the heater, the inlet tube length of the first platen of each group of platens being connected to a common source of fluid to be heated and the outlet tube length of each group of platens being connected to a common fluid outlet, and means tying together the adjacent return bend tubes and the adjacent platens of the heater so that the heater is supported by the inlet and outlet tube lengths, said last named means including an aligning bar extending transversely through a multiplicity of platens and through brackets secured to the tubular components of the platens.

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