Sept. 2, 1941. I. L. LANGVAND 2,254,373

WATER TUBE STEAM BOILER

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Fig. 1

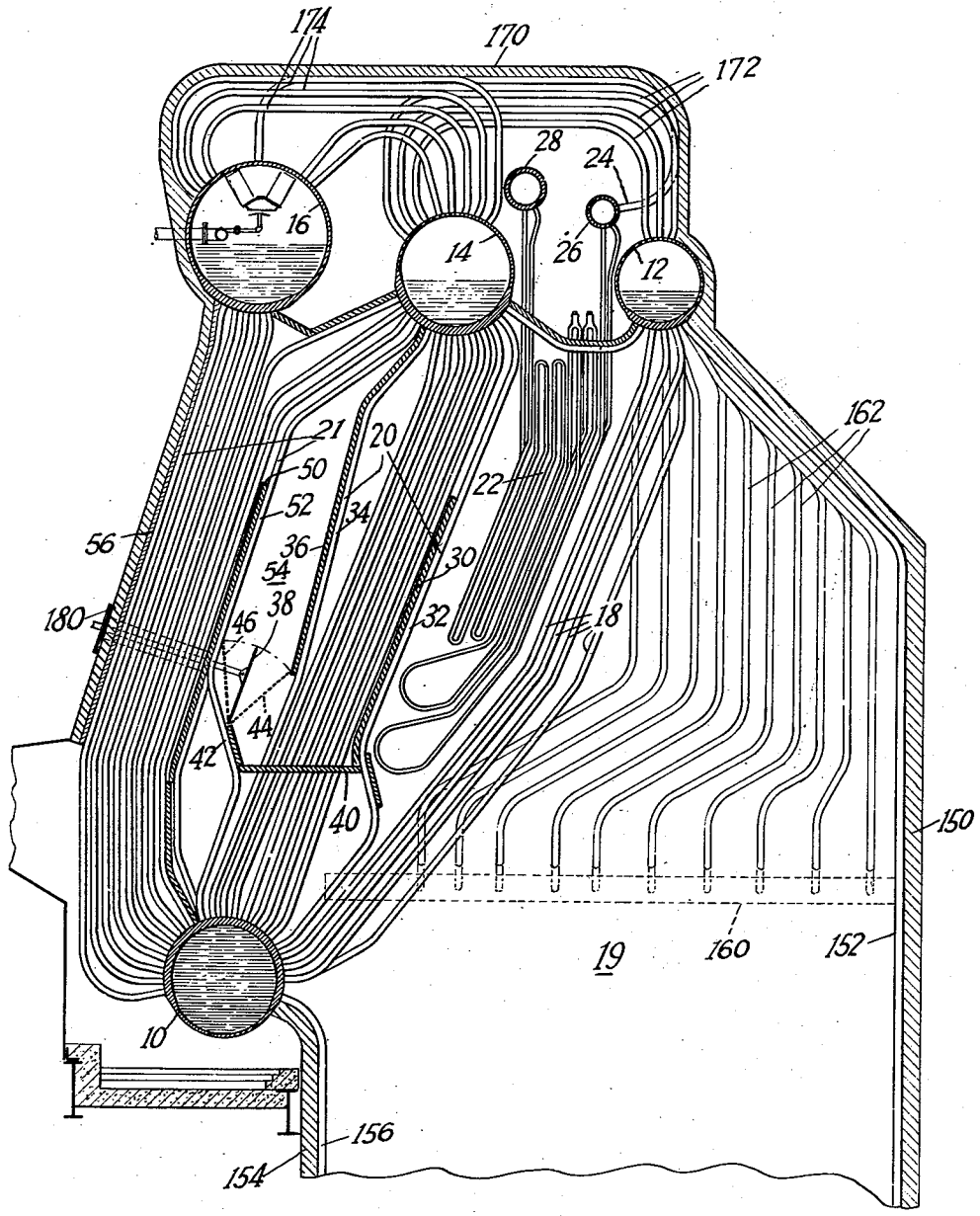

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Fig. 2

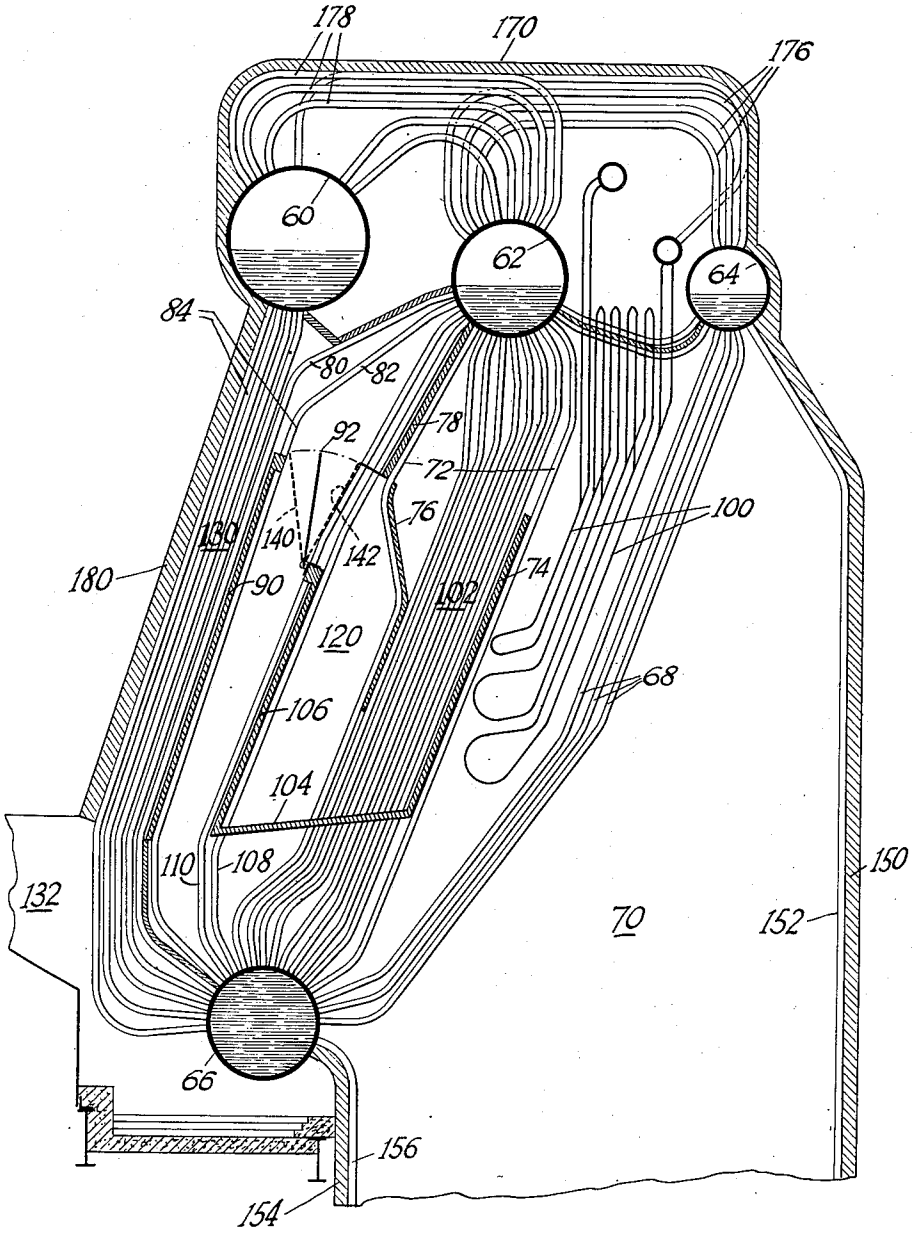

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Fig. 5

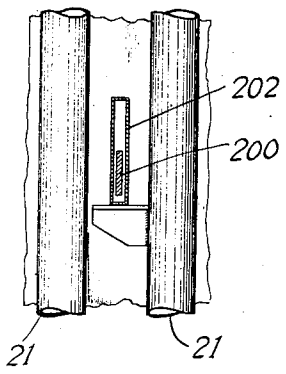


Fig. 4

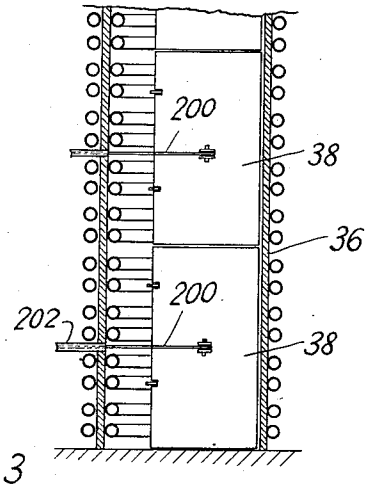
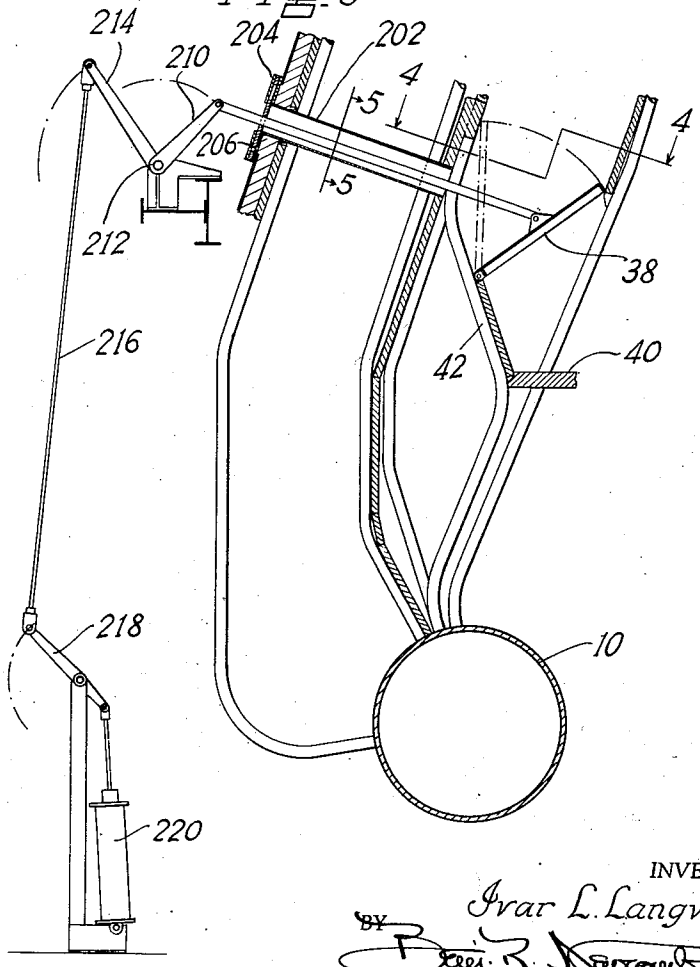


Fig. 3



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2,254,373

UNITED STATES PATENT OFFICE

2,254,373

WATER TUBE STEAM BOILER

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Application June 15, 1938, Serial No. 213,753

4 Claims. (Cl. 122—480)

This invention relates to improvements in fluid heat exchange apparatus, and it is more particularly concerned with the control of superheat in the operation of a high pressure and superheat water tube steam boiler.

The invention is particularly concerned with the maintenance of superheat within close limits under conditions which involve widely varying boiler loads, and the steam boiler with which the invention is concerned involves upright steam generating tubes arranged in one of more banks and connected to upper and lower drums. A superheater including spaced tubes, receives steam generated in said banks of tubes and subjects it to the heat from furnace gases. It is one object of the invention to provide such improvements in apparatus of this type that the requirements of modern high pressure and high temperature steam power plants may be effectively met. Such installations, in the interest of high efficiencies of associated prime movers, operate at high superheats, and, as the associated steam turbines are apt to be damaged by uncontrolled and excessively wide variations in steam temperatures, it is important that such variations be controlled and limited. A more specific object of the invention is to provide a particular means for regulating and limiting such variations in superheat in this type of boiler.

For high superheats, and especially for steam generators in which there is a high ratio of heat of superheat to heat of steam generation, a relatively large superheater tube surface is necessary, but excessive superheater costs are avoided, and the desired high superheats are obtained by locating the superheater in gas zones in which the temperatures are as high as practical consistent with safe metal temperatures and with the desired conditions of non-adherence of the particles of slag or ash suspended in the furnace gases. The invention also provides improvements whereby a superheater is adequately screened from the radiant heat of the furnace, in the interest of avoiding tube damage due to overheating by such radiant heat.

The invention also provides means for bypassing furnace gases about superheater surface in order to reduce heat input and control final steam temperature. This means is especially adapted for a 4-drum Stilring type boiler.

Other objects of the invention will appear from the following description referring to the accompanying drawings showing preferred embodiments of the invention.

In the drawings:

Fig. 1 is a view in the nature of a vertical section through an illustrative installation. This view shows a 4-drum boiler with upright tubes and with baffles arranged to provide for the flow of the furnace gases over the tubes and in a plurality of passes. These baffles also provide for the flow of furnace gases through a superheater bypass in which there are disposed parts of the steam generating tubes adjacent the submerged water chamber;

Fig. 2 is a vertical section of another embodiment of the invention;

Fig. 3 is a diagrammatic view in the nature of a vertical section showing apparatus for controlling the damper;

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

Fig. 5 is a detail view in the nature of a transverse section through a part of the damper control mechanism. This view is taken on the line 5—5 of Fig. 3.

In the drawings, Fig. 1 illustrates a 4-drum bent tube boiler in which the submerged drum 10 is connected to the upper drums 12, 14, and 16 by three spaced banks of tubes. The tubes of the front bank 18 directly connect the drums 10 and 12 and are exposed to the heat of the furnace 19. The tubes of the middle bank 20 directly connect the drums 10 and 14 and are disposed in a second gas pass in which the furnace gases pass downwardly over those tubes. A third pass, idle in so far as heat absorption is concerned, is incorporated in the installation to provide for the gas flow regulation hereinafter described. All of the tubes of the rear bank with the exception of the tubes of its foremost row are disposed in a fourth gas pass. The rearward tubes of this bank directly connect the drums 10 and 16, while the remainder of the tubes of the bank directly connect the drums 10 and 14.

A superheater 22, disposed between the tube banks 18 and 20, receives steam from the drum 16 through the intermediary of the saturated steam supply tubes 24 and the superheater inlet header 26. The superheater is contacted by the hot gases from the furnace 19 which may be fired by pulverized coal burners, and superheated steam passes from the superheater tubes to the superheater outlet header 28 and then to a point of use.

Furnace gases, after passing over the steam generating tubes 18 and the tubes of the superheater 22, turn downwardly around the upper edge of the baffle 30 which is preferably posi-

tioned along and supported by the tubes 32 of the middle bank 20. The rearmost tubes 34 of this bank support a baffle 36 which divides the second gas pass from a third gas pass and extends downwardly to the regulator 38.

At a position somewhat above the submerged drum 10 the by-pass baffle 40 extends from the lower end of the baffle 30 across the tubes of the bank 20 and then along parts of the tubes 42 to the lower edge of the regulator 38, and thus forms one side of a bypass through which some of the furnace gases may be directed around the superheater when superheat would otherwise be undesirably high. The regulator 38 is pivoted at its lower edge so that it may be moved to the dotted-line position 44 to permit all of the furnace gases to bypass the superheater, to the dotted-line position 46 to provide for the flow of all of the furnace gases over the superheater, or to any intermediate position which may be determined automatically by temperature or pressure responsive devices, some of which may position the regulator with reference to steam flow.

The baffle 50 is shown as extending along the tubes 52 of the rear bank 21 so as to form a rear wall of the superheater bypass. This baffle also extends upwardly past the regulator 38 so as to form one wall of the third gas pass 54. The furnace gases in this gas pass pass around the upper edge of the baffle 50 and downwardly over the tubes of the bank 21 in a fourth gas pass which is defined by the baffle 50 and the rear wall 56 of the boiler setting.

The superheater, being a convection superheater, has the inherent characteristic that the final steam temperature has a rising temperature when boiler rating increases. In the present installation this inherent characteristic is overcome by bypassing some of the furnace gases. When the boiler load increases and the tendency of the superheat is to become too high, the regulator 38 at the outlet of the superheater bypass is moved so as to permit a sufficient share of the gases to pass directly through the bypass to prevent an undesirable rise in superheat. When the boiler load is low, the regulator may be positioned as indicated at 46 in order that a greater proportion of the furnace gases shall pass over the superheater 22.

The installation indicated in Fig. 2 of the drawings includes a similar arrangement of upper steam and water drums 60, 62, and 64 connected by banks of spaced tubes to a submerged drum 66. The tubes of the front bank 68 extend over the furnace 70 and directly connect the drums 64 and 66, while most of the tubes of the second bank 72 are disposed in a second gas pass between the baffle 74 on one side, and the baffles 76 and 78, on the other side. These tubes directly connect the drums 62 and 66.

All except the forward rows of tubes 80 and 82 of the rear bank 84 directly connect the rearmost steam and water drum 60 with the submerged drum 66. The tubes of rows 80 and 82 directly connect the drums 62 and 66 with the tubes 82 supporting the baffle 90 which extends downwardly from the regulator 92 to the submerged drum 66.

In the Fig. 2 embodiment the furnace gases pass over the tubes of the bank 68 and then over the tubes of the superheater 100. From the superheater the gases pass around the upper end of the baffle 74 and downwardly through a second gas pass 102 between the baffles 74 and 76. The gases then are caused to turn upwardly around the lower edge of the baffle 76 by reason of the superheater bypass baffle 104 which extends from the lower edge of the baffle 74 to the lower edge of the baffle 106. The latter extends along and is supported by the tubes of at least one of the rows of tubes 108 and 110. These tubes directly connect the drums 62 and 66 and extend across the path of the furnace gases as they pass from the third gas pass 120, past the regulator 92 and around the upper end of the baffle 90. The gases then pass downwardly in the fourth gas pass 130 and over the tubes of the bank 84 in that gas pass. A flue 132 receiving the gases from the gas pass 130 may be arranged adjacent the submerged drum 66 as shown in the drawings.

The regulator 92 of the Fig. 2 embodiment may be automatically controlled in the same manner as the regulator 38 of the Fig. 1 modification and may be moved toward the dotted-line position 140 when boiler load is low, and toward the dotted-line position 42 when the boiler load is high, the regulator being moved to any intermediate position as determined by operating conditions.

In each one of the above described embodiments of the invention the boiler setting includes the furnace wall 150 extending alongside furnace wall tubes 152 from a position at the bottom of the installation to the corresponding upper drum 12 or 64. The opposite furnace wall 154 extends along the furnace wall tubes 156 to the submerged drum and the side walls of the furnaces may be defined by similar wall tubes connected into the boiler circulation through the intermediacy of an upper header 160 from which steam and water pass through the risers 162 to one of the upper drums. All of the furnace water walls are otherwise appropriately connected into the boiler circulation.

The boiler setting in each embodiment of the invention includes a roof 170 supported by steam circulators. In the Fig. 1 embodiment the circulators 172 directly connect the drums 12 and 14, whereas the rear steam circulators 174 directly connect the drums 14 and 16. Similar circulators 176 in the Fig. 2 embodiment directly connect the drums 62 and 64, while other circulators 178 directly connect the drums 60 and 62. In each embodiment the rear wall of the setting is indicated at 180.

In each embodiment of the invention there are a plurality of banks of upright tubes associated with a furnace and a superheater in such a way that the furnace gases are free to flow from the furnace toward the superheater and the steam generating tubes at a position near the upper part of the setting. This combination of elements is associated with a superheater bypass in which a part of the furnace gases may flow across parts of the tubes of the upright banks which are adjacent the submerged water chamber. Thus, there is an elongated gas flow path for the purpose of promoting heat absorption by cooling the gases, and it is necessary to so locate the bypass for gases around the superheater that these gases will be sufficiently cooled. Otherwise, the temperature of the bypassed gases would be excessively higher than the temperature of the gases which have passed over the superheater. For this reason the bypassing gases are lead into the main gas stream at a point in their flow sufficiently remote from the flue connection of the setting, and to meet this condition, the bypass, in each modification is adjacent the sub-

merged drum, and the outlet of the bypass is adjacent the regulator.

Another advantage of the invention arises from the passage of the bypassing gases over the lower parts of the water tubes rather than their upper parts. This advantage resides in the elimination of tendencies for the hot gases to overheat the upper parts of the tubes in which there is a maximum of steam. Such local intense heating by the hot gases in the event of bypassing gases at the tops of the steam generating tubes might cause these portions of the tubes to become dry and be thereby damaged.

In either of the embodiments shown the damper constitutes a single means simultaneously controlling gas flow through the bypass and controlling the main gas flow, restricting one flow while permitting a corresponding increase in the other flow.

The damper 38 is formed by a plurality of sections as indicated in Fig. 4 of the drawings. It might be said that the illustrative arrangement of elements includes a plurality of small dampers. This arrangement advantageously prevents cumulative expansion or contraction stresses which would otherwise exist. As shown in Fig. 3 of the drawings, each damper section 38 is pivotally connected to a link 200 which passes through a housing 202 extending across the fourth gas pass and between the tubes 21 in that pass. This housing also extends through the wall 180 which, at positions adjacent the housing, are provided with elements which form guideways 204 and 206 for a sliding plate 208. This plate is provided with an opening through which the link 200 passes.

Each link 200 has its end opposite the damper section 38 pivoted to a crank-arm 210 fixed to a shaft 212. Movement of this shaft is effected by the crank-arm 214 which has one end fixed to the shaft 212 and its opposite end pivotally connected to a link 216 which, in turn, is connected to a pneumatic control device 220 by the lever 218. Fluid flow to or from the device 220 may be controlled by devices which are responsive to steam temperature or steam flow in order that the superheat may be automatically controlled.

What is claimed is:

1. In a water tube steam boiler, upper drums, a lower drum, spaced banks of tubes connecting the lower drum to the upper drums, a furnace, a superheater, baffles forming two separate gas paths for the travel of the furnace gases in parallel from a position forwardly of the superheater to a position beyond the first bank of tubes, one of said gas paths constituting a superheater bypass leading from the gas space beneath the superheater and across said banks of tubes at a position adjacent the lower drum, and a gas flow regulator located rearwardly of the superheater and selectively movable to a flow restricting position for the outlet of said bypass or to a flow restricting position for the outlet of the other gas path to control the amount of bypassing gases, the superheater bypass confining the bypassing gases to contact the lower parts of the tubes of said banks adjacent the lower drum.

2. In a 4-drum bent tube boiler, upper drums, a lower drum, spaced banks of tubes connecting the lower drum to the upper drums, a furnace, a superheater, means connecting the inlet of the superheater to one of said upper drums, baffles providing for the movement of furnace gases over said tubes in a plurality of gas passes, said baffle means including a baffle disposed transversely of one of said banks and spaced vertically from the lower drum so as to provide a bypass through which some of the furnace gases may pass across the lower ends of some of the tubes and to an outlet flue while bypassing the superheater, said transversely disposed baffle extending laterally of and past the superheater and a single regulator disposed rearwardly of and across the bypass and the superheater for simultaneously increasing the proportion of the total gas flow which bypasses the superheater and decreasing the proportion of the total gas flow which flows over the superheater.

3. In a water tube steam boiler, upper and lower drums, a furnace, spaced banks of upright steam generating tubes extending across the path of the furnace gases with each bank connecting an upper drum to a lower drum, a superheater, baffle means so associated with said banks of tubes as to form two gas passes leading from the furnace to a common outlet position rearwardly of two of said banks of tubes, the superheater being disposed in one of said passes and the other of said passes constituting a superheater bypass, a gas flow regulator damper positioned rearwardly of two of said banks of tubes and so disposed with reference to the outlets of said gas passes that its movements may simultaneously and conversely affect and control the gas flow through the separate passes, means for moving said regulator toward or away from a flow restricting position for the outlet of either of said gas passes and thereby conversely affecting the flow of gases through the other gas pass.

4. In a steam boiler, upper and lower drums, upwardly extending banks of water tubes connecting said drums, a furnace, a superheater positioned between a front tube bank and a second tube bank and contacted by furnace gases passing from the furnace over said front tube bank, upwardly extending front and rear baffles associated with the second bank to define a downflow gas pass connected to the superheater space at its upper end, said downflow pass extending for a portion only of the height of said second bank, means forming an upflow gas pass disposed between the rear tubes of said second bank and a row of rearwardly spaced tubes connecting the lower drum and an upper drum, said upflow pass communicating with the outlet of said downflow pass, means forming a gas flow passage across the lower portion of said second tube bank communicating with the lower end of said upflow pass, and a damper extending transversely of the boiler and transversely of gas flow beyond the superheater and pivotally supported on tubes marginal to said upflow pass to control the gas flow over said superheater and through said downflow pass.

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