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STEAM BOILER WITH ECONOMIZERS

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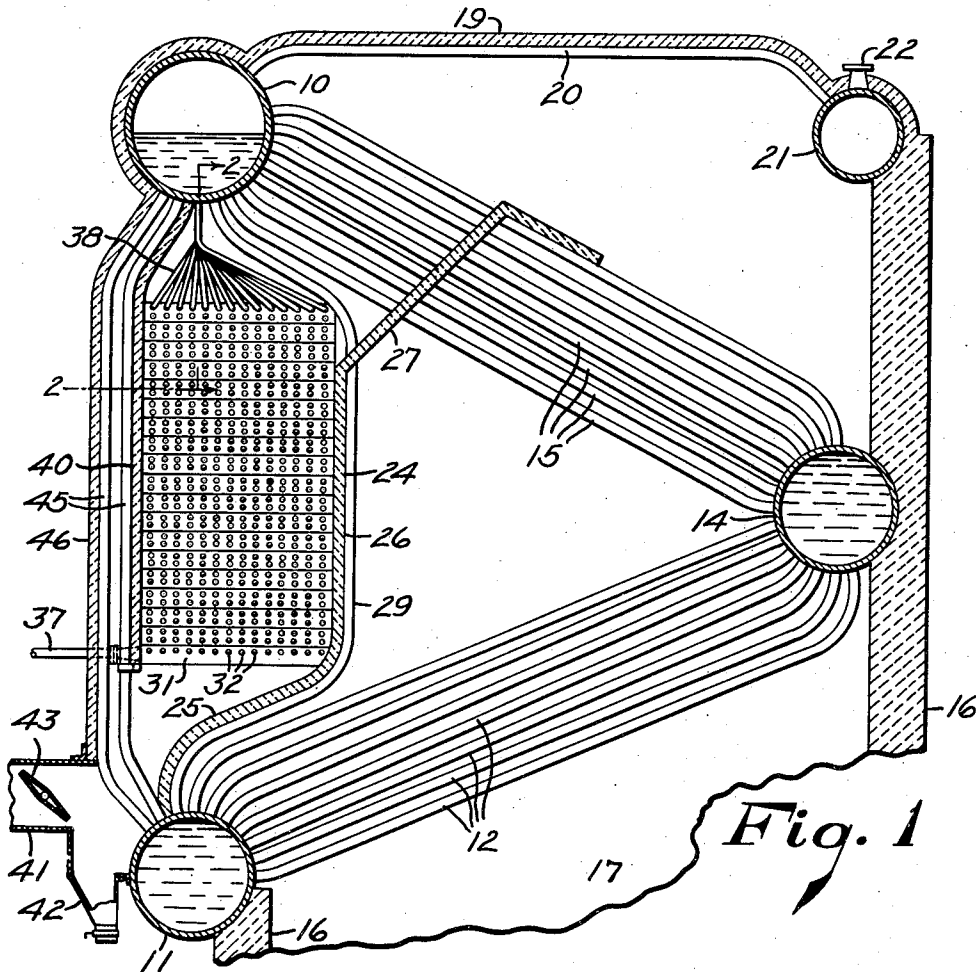


Fig. 1

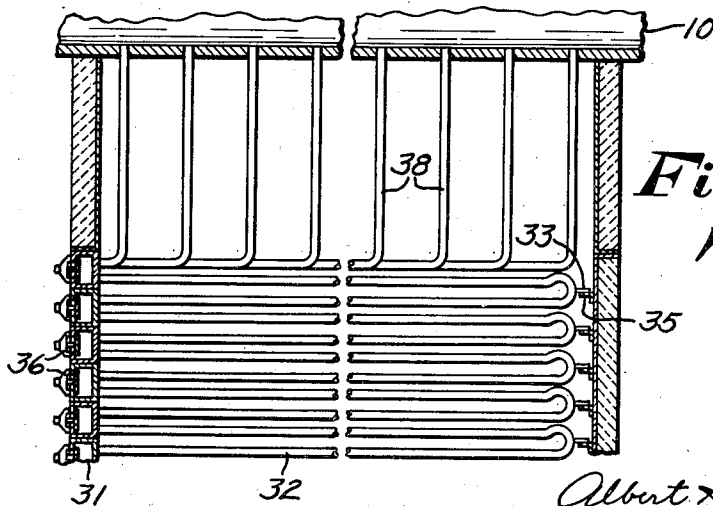


Fig. 2

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STEAM BOILER WITH ECONOMIZERS

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11 Claims. (Cl. 122-444)

This invention relates to steam boilers with economizers, and more particularly to boilers of the type having drums connected by water tubes to provide a path for the circulation of the water, and an economizer to heat the boiler feed-water.

It has been recognized heretofore that rapid circulation of the water is of the greatest importance in a boiler of this type. If the water is flowing with sufficient velocity it will sweep the steam bubbles away from the inner surfaces of the tubes as fast as they form. Otherwise, these bubbles will adhere to the walls and increase in size until a substantial area of the tube wall is in contact with steam rather than water. Since this steam is not moving, and since it is a poor conductor of heat as compared with water, there is serious danger of overheating the metal tube walls under these conditions.

Since the water in a steam boiler operating at high pressure is at a comparatively high temperature, it is not possible to reduce the heating gases to a very low temperature solely by transfer of heat to the boiler water. In order to overcome this difficulty and obtain efficient operation it has been proposed to employ a separate economizer which utilizes the gases leaving the boiler to heat the feed-water before it enters the boiler. Such separate economizers are effective in recovering heat, but they occupy valuable space in the boiler room and they require a casing or setting which is expensive and which radiates a substantial quantity of heat to the surrounding atmosphere.

It is accordingly one object of the present invention to provide a combined steam boiler and economizer which will be comparatively compact and inexpensive, and which will generate steam in a highly efficient manner.

It is a further object of the invention to provide a novel and compact combination of an economizer with a steam boiler, which can be operated efficiently at very high rates of steam generation, the parts being so constructed and arranged that a rapid circulation of the boiler water will be ensured.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

Referring to the drawing illustrating one embodiment of the invention, and in which like reference numerals indicate like parts,

Fig. 1 is a longitudinal vertical section through

a combined steam boiler and economizer; and Fig. 2 is an enlarged section on the line 2-2 of Fig. 1.

The embodiment illustrated comprises an upper rear transverse steam-and-water drum 10 and a lower rear transverse water drum 11 located a substantial distance therebeneath. These two drums are connected by water conduits which are exposed to direct contact with hot gases, so that steam is generated in these conduits and released in the upper drum 10. For this purpose I preferably utilize a lower bank of water tubes 12 which slopes upwardly and forwardly from the lower drum 11 to a front transverse water drum 14 positioned at an elevation intermediate that of the drums 10 and 11. An upper bank of water tubes 15 slopes upwardly and rearwardly from the front drum 14 to the steam-and-water drum 10. Suitable walls 16 are arranged to provide a furnace chamber 17 beneath the lower tube bank 12. The roof of the boiler may be formed by refractory material 19 supported on tubes 20 which extend forwardly from the steam-and-water drum 10 to a transverse steam drum 21 located above the front water drum 14. The steam may be withdrawn from the drum 21 through a suitable discharge nozzle 22.

Means is provided to direct the hot gases from the furnace chamber 17 into contact with the water tubes. For this purpose I preferably utilize a transverse baffle wall 24 of a suitable refractory material. This baffle wall extends upwardly and forwardly at 25 from the lower drum 11 and above the rear portion of the tube bank 12, thence vertically upward at 26 nearly to the upper tube bank 15, and thence upwardly and forwardly at 27 across the upper tube bank. A row of water tubes 29 extends from the lower drum 11 along the front surface of the baffle portions 25 and 26 to form a support therefor, the upper ends of the tubes being connected to the steam-and-water drum 10.

It will now be apparent that the hot gases from the furnace chamber 17 flow upwardly across the lower tube bank 12 and the lower portion of the upper tube bank 15 and into contact with the tubes 20. The gases then flow downwardly across the upper portion of the upper tube bank. At this point the temperature of the gases has been considerably reduced by transfer of heat to the water in the tubes 12, 15 and 29. However the gases still have a substantial heat content and if they are discharged

directly to the stack the efficiency of steam generation will be low.

In order to utilize more of the heat content of the gases, I provide a suitable economizer in the space at the rear of the baffle wall 24 and between the drums 10 and 11. In the embodiment illustrated the economizer comprises a series of horizontal headers 31 rectangular in cross-section arranged in superimposed formation at one side of the boiler and beneath one end of the drum 10, and horizontally positioned U-shaped tubes 32 connecting each header with the header thereabove. The tubes 32 extend transversely of the boiler, and their looped portions are provided with lugs 33 which rest on suitable ledges 35 on the boiler side wall. The tubes 32 are preferably somewhat smaller in diameter than the boiler tubes, and they are rather closely spaced both horizontally and vertically, so that a large economizer heating surface may be provided in the available space. The headers 31 are provided with suitable removal hand-hole plates 36. The boiler feed water is supplied to the lowermost of the headers 31 through a pipe 37, and the uppermost of the headers is connected to the steam-and-water drum 10 by means of a series of tubes 38.

A wall 40 extends downwardly from the drum 10 in the rear of the economizer tubes 32, so that the gases are forced to travel in a generally downward direction through the economizer. The bottom of the wall 40 is spaced from the portion 25 of the baffle 24 to provide an opening through which the gases leaving the economizer can escape to a gas outlet 41 located at the rear of the lower drum 11. A soot hopper 42 is provided between the drum 11 and the gas outlet, and a suitable damper 43 is mounted in the gas outlet.

In order that a rapid upward circulation of water may take place in the water tubes 12, 15 and 29, I provide downcomers for conducting water from the steam-and-water drum 10 to the water drum 11. For this purpose I preferably utilize water tubes so located as to be out of contact with the hot gases. In the embodiment illustrated I have shown two rows of water tubes 45 located in the rear of the wall 40 and connecting the drum 10 with the drum 11. The water tubes 45 are enclosed at the rear by means of suitable heat insulating material 46. The tubes 45 serve to support the insulating material 46 and the wall 40.

The operation of the invention will now be apparent from the above disclosure. The feed-water is supplied through the pipe 37 and flows in a generally upward direction through the tubes 32 and headers 31, finally passing through the tubes 38 into the drum 10. The hot gases from the furnace chamber 17 flow upwardly to the space above the tube bank 15 and thence downwardly in the rear of the baffle wall 24 to the gas outlet 41. The water in the economizer tubes 32 travels in a counterflow relation with the gases, so that highly efficient heat transfer is obtained, and the gases are at a very low temperature when they leave the economizer. Steam is generated in the water tubes 12, 15 and 29, and a steam-and-water mixture flows upwardly in these tubes at high velocity to the drum 10, where the steam is released. This steam travels forwardly through the tubes 20, where it is dried and slightly superheated, and enters the drum 21, being withdrawn through the nozzle 22. The water which enters the drum

10 from the tubes 15 and 29 mingles with the feed water supplied through the tubes 38, and the mixture flows downwardly through the tubes 45 to the lower drum 11.

Since the tubes 45 are out of contact with hot gases, no steam will be generated in them and they will contain nothing but water in liquid form. In fact this water will be at a temperature somewhat below the boiling point corresponding to the boiler pressure, because of the feed-water which is delivered to the drum 10. Moreover the pressure on the water increases as it flows downwardly, and this raises the boiling point. As a result the tubes 45 will serve as very effective downcomers, and a rapid upward circulation will be ensured in the steam generating tubes. This circulation will be maintained under all conditions, for not even at the highest rates of evaporation can steam be produced in the tubes 45 to cause a reversal of the flow. Since the volume of steam is much greater than the volume of an equal weight of water, it is not necessary to provide as many of the tubes 45 as there are tubes 12. The economizer is entirely enclosed within the boiler setting, so that the space requirements are comparatively small, and the cost and heat losses of a separate economizer setting are eliminated. The economizer is readily accessible for inspection or repair. The baffle construction is simple and without soot locks, and the baffle material is well supported and cooled by the water tubes.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A steam generating apparatus comprising a rear transverse steam-and-water drum, a rear transverse water drum located a substantial distance therebeneath, an economizer positioned between the drums, a front transverse water drum positioned at an elevation intermediate that of the other drums, a lower bank of water tubes connecting the front drum with the rear water drum, an upper bank of water tubes connecting the front drum with the steam-and-water drum, means to direct the hot gases successively into contact with the lower bank, the upper bank and the economizer, and downcomers connecting the steam-and-water drum with the rear water drum.

2. A steam generating apparatus comprising a rear transverse steam-and-water drum, a rear transverse water drum located a substantial distance therebeneath, an economizer positioned between the drums and connected at its upper end to the steam-and-water drum, means to pass feed water through the economizer in a generally upward direction, a front transverse water drum positioned at an elevation intermediate that of the other drums, a lower bank of water tubes connecting the front drum with the rear water drum, an upper bank of water tubes connecting the front drum with the steam-and-water drum, means to direct hot gases successively into contact with the lower bank, the upper bank and thence downwardly in contact with the economizer, and downcomers connecting the steam-and-water drum with the rear water drum.

3. A steam generating apparatus comprising a rear transverse steam-and-water drum, a rear transverse water drum located a substantial distance therebeneath, an economizer positioned between the drums, a front transverse water drum positioned at an elevation intermediate that of the other drums, a lower bank of water tubes

connecting the front drum with the rear water drum, an upper bank of water tubes connecting the front drum with the steam-and-water drum, a transverse baffle wall extending upwardly and forwardly from the rear water drum above the rear portion of the lower bank and thence upwardly in front of the economizer, and downcomers connecting the steam-and-water drum with the rear water drum.

4. A steam generating apparatus as covered by claim 3, in which a row of water tubes connects the steam-and-water drum with the rear water drum and serves as a support and cooling means for the baffle wall.

5. A steam generating apparatus comprising a rear transverse steam-and-water drum, a rear transverse water drum located a substantial distance therebeneath, an economizer positioned between the drums and connected at its upper end to the steam-and-water drum, means to pass feed water through the economizer in a generally upward direction, a front transverse water drum positioned at an elevation intermediate that of the other drums, a lower bank of water tubes connecting the front drum with the rear water drum, an upper bank of water tubes connecting the front drum with the steam-and-water drum, a transverse baffle wall extending upwardly and forwardly from the rear water drum above the rear portion of the lower bank and thence upwardly closely adjacent to the front of the economizer, and downcomers connecting the steam-and-water drum with the rear water drum.

6. A steam generating apparatus as covered by claim 5, in which a gas outlet is provided adjacent to the rear water drum, and a wall extends downwardly in the rear of the economizer from the steam-and-water drum.

7. A steam generating apparatus comprising a rear steam-and-water drum, a rear water drum located a substantial distance therebeneath, an economizer positioned between the drums and connected at its upper end to the steam-and-water drum, means to pass feed water through the economizer in a generally upward direction, a front water drum positioned at an elevation intermediate that of the other drums, a lower bank of water tubes connecting the front drum with the rear water drum, an upper bank of water tubes connecting the front drum with the steam-and-water drum, a transverse baffle wall extending upwardly and forwardly from the rear water drum above the rear portion of the lower bank and thence upwardly closely adjacent to the front of the economizer, a gas outlet adjacent to the rear water drum, a wall extending downwardly in the rear of the economizer from the steam-and-water drum, and downcomer water tubes located in the rear of the economizer and connecting the steam-and-water drum with the rear water drum, said downcomer water tubes serving as a support for the last-mentioned wall.

8. A steam generating apparatus comprising a rear steam-and-water drum, a rear water drum located a substantial distance therebeneath, a group of substantially horizontal tubes located in the space between the drums, a front water

drum positioned at an elevation intermediate that of the other drums, a lower bank of water tubes connecting the front drum with the rear water drum, an upper bank of water tubes connecting the front drum with the steam-and-water drum, means to direct hot gases successively into contact with the lower bank, the upper bank and the horizontal tubes, downcomers connecting the steam-and-water drum with the rear water drum to complete a circulatory system including the drums and tube banks, and means to pass feed-water through the horizontal tubes and then into the circulatory system.

9. A steam generating apparatus comprising a rear transverse steam-and-water drum, a rear transverse water drum located a substantial distance therebeneath, a series of horizontal headers arranged in superimposed formation beneath one end of the steam-and-water drum, horizontally positioned U-shaped tubes located in the space between the drums and connecting each header with the header thereabove, a front water drum positioned at an elevation intermediate that of the other drums, a lower bank of water tubes connecting the front drum with the rear water drum, an upper bank of water tubes connecting the front drum with the steam-and-water drum, means to direct hot gases successively into contact with the lower bank, the upper bank and the U-shaped tubes, downcomers connecting the steam-and-water drum with the rear water drum to complete a circulatory system including the drums and tube banks, and means to pass feed-water through the headers and U-shaped tubes and then into the circulatory system.

10. A steam generating apparatus comprising a rear transverse steam-and-water drum, a rear transverse water drum located a substantial distance therebeneath, an economizer positioned between the drums, a lower bank of water tubes extending upwardly and forwardly from the rear water drum, an upper bank of water tubes extending downwardly and forwardly from the steam-and-water drum, means connecting the front ends of the two tube banks, means to direct hot gases successively into contact with the lower bank, the upper bank and the economizer, and downcomers connecting the steam-and-water drum with the rear water drum.

11. A steam generating apparatus comprising a rear transverse steam-and-water drum, a rear transverse water drum located a substantial distance therebeneath, an economizer positioned between the drums, a lower bank of water tubes extending upwardly and forwardly from the rear water drum, an upper bank of water tubes extending downwardly and forwardly from the steam-and-water drum, means connecting the front ends of the two tube banks, means to direct hot gases successively into contact with the lower bank, the upper bank, and then in a generally downward direction in contact with the economizer, means to pass feed water through the economizer in a generally upward direction, and downcomers connecting the steam-and-water drum with the rear water drum.

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