

Aug. 4, 1936.

C. E. LUCKE

2,049,455

FLUID HEAT EXCHANGE APPARATUS

Filed Oct. 21, 1933

2 Sheets-Sheet 1

Fig. 1

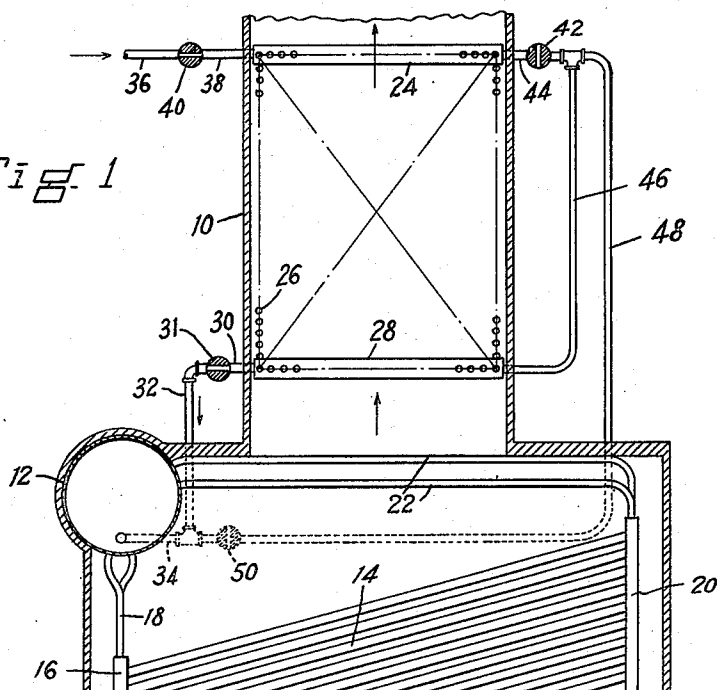
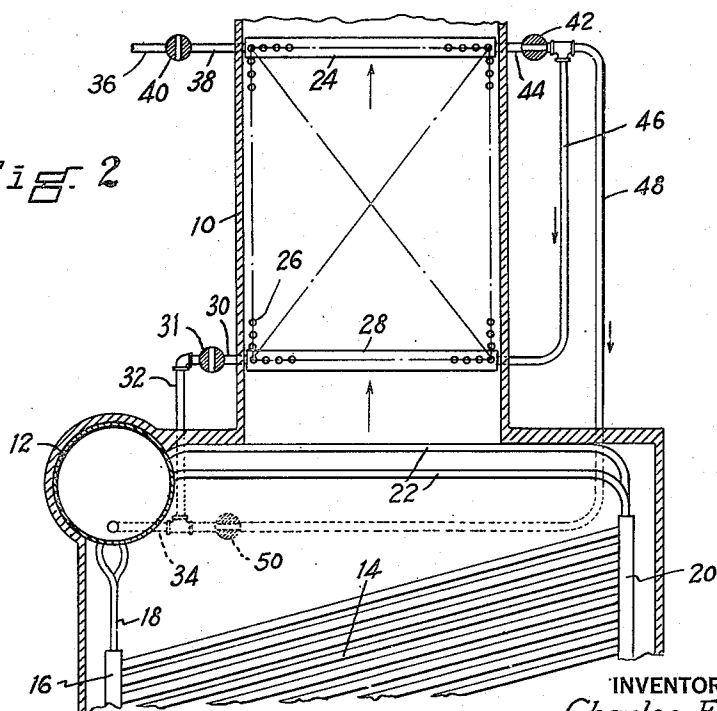


Fig. 2



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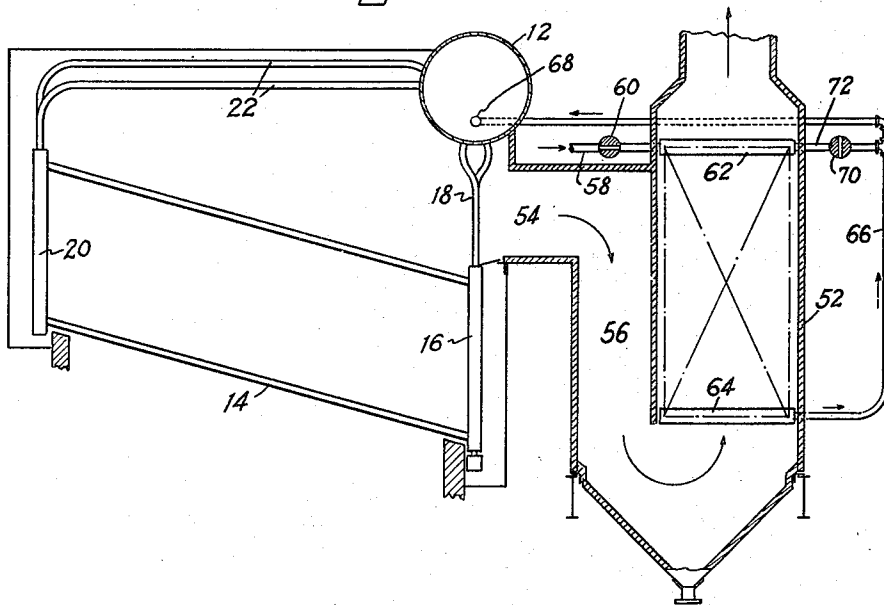
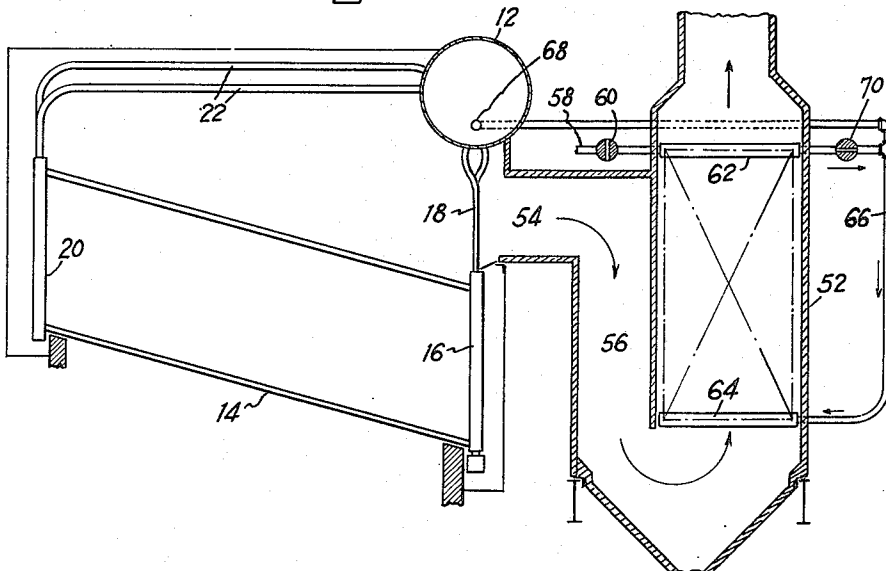


Fig 4



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FLUID HEAT EXCHANGE APPARATUS

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8 Claims. (Cl. 122-421)

This invention relates to steam boilers, and is more particularly concerned with improvements in the construction and operation of economizers.

In many cases there are important installation advantages resulting from the use of counterflow economizers arranged for an upflow of heating gases especially when located above the boiler. For example, marked saving in construction costs are made by the elimination of constructions separated from the boiler setting, and draft losses are minimized by the elimination of gas turns.

This arrangement requires a down flow of water to maintain the counter-current relation with upflowing gases, and the progressive heating of the water as it reaches successively lower levels involves some difficulties which it is an object of this invention to overcome.

One of the difficulties arises from the natural tendency for hotter water to rise and colder water to fall in an interconnected system between two different levels. The hotter water being at the bottom of the economizer, its buoyancy with reference to the colder water at the top tends to resist down flow and to set up a local circulation in the economizer. When feed water is shut off there is nothing to resist the rise of water, and, in fact, steam may be formed and the steam so formed is still more buoyant than the hot water and will rise to the top and there collect. Any water below the boiling point that is thus met by the rising steam bubbles will condense them and cause them to collapse and produce "water hammer" which may destroy tubes or connections by shock stresses. It is frequently advantageous to proportion the economizer surface with reference to weight and temperature of gases, as to insure that steam be formed in the economizer under normal conditions, after the water has been brought to the boiling point. When this is done in an economizer having down flow of water, the lighter steam can be resisted in its tendency to rise and downflow is everywhere maintained by a sufficiently high flow velocity at normal loads. However, at reduced loads for which the flow velocity is less, it will not be possible to maintain the downflow everywhere as is desirable without some special means. An object of the invention is to prevent this action by reversing the flow of water during lay-over or light load periods, from down to up, and venting the top of the economizer to the drum.

Other objects of the invention will appear as the accompanying description proceeds.

The invention is described with reference to the accompanying drawings, in which:

Fig. 1 is a view in the nature of a diagrammatic vertical section showing the normal operation of a counterflow economizer positioned above a boiler and having an upflow of heating gases.

Fig. 2 is a view similar to Fig. 1 but indicating the operation of the economizer with its own convection circulation when there is no boiler load and feed water is shut off.

Fig. 3 is a diagrammatic vertical section showing an economizer positioned at the side of the boiler, the arrows indicating the fluid flow under normal boiler load conditions.

Fig. 4 is a view of the same kind as Fig. 3, but it shows the economizer circulation when there is no boiler load and feed water is shut off.

In Figs. 1 and 2 there is shown a counterflow economizer 10 mounted above a boiler so as to receive the heating gases therefrom. This boiler includes the steam and water drum 12 connected to a bank of steam generating tubes 14. At one end of this bank of tubes there are downtake headers 16 connected by nipples 18 to the drum 12. At the upper ends of the steam generating tubes uptake headers 20 connect the tubes to the steam and water circulators 22 which enter the drum.

Under normal operating conditions the header 24 functions as the inlet header for the economizer and there is a generally down flow of water in zig-zag fashion through the economizer tubes 26. These tubes preferably extend back and forth across the economizer gas pass so as to deliver separated streams of water to the economizer outlet header 28. This outlet header is connected through pipe sections 30, 32 and 34 to the water space of the drum 12. Feed water is supplied to the header 24 through pipe sections 36 and 38 shown as connected by the valve 40.

The normal operative conditions referred to immediately above are indicated in a diagrammatic way in Fig. 1, the arrows indicating clearly the path of the fluid proceeding to the steam and water drum. The flow is directly from the header 24 through the tubes 26 and the header 28 to the boiler drum 12. In other words, feed water delivered to the header 24 flows countercurrently downward with respect to heating gas flow, directly to the boiler.

Fig. 2 shows the illustrative economizer as it is operated when the boiler is not under a load. In this case the valve 40 is closed so that no feed water is supplied. The valve 31 also is closed so that there is no opportunity for water to pass

from the bottom of the economizer directly to the steam and water drum of the boiler. To provide for convection circulation upward through the economizer under these conditions, the upper header 24 of the economizer is directly connected to the lower header 28 by the valve 42 and associated connections 44 and 46 providing a downflow of water outside of the economizer flue. In order that the economizer may be vented to the steam and water drum to avoid excess pressure under these conditions, the upper end of the economizer is connected by the valve 42 to a line 48 leading through the valve 50 and a pipe section 34 to the steam and water drum. In the normal boiler and economizer operation indicated in Fig. 1, the valves 42 and 50 are closed as indicated.

In the event that it is desired to accelerate the flow of water through the economizer during light load or layover conditions a pump may be used.

In Figs. 3 and 4 the boiler is indicated as the same type as that shown in Figs. 1 and 2, but the economizer 52 is located at such a position that all of its fluid heating surfaces are below the steam and water drum 12. The economizer is at the side of the boiler and receives the boiler heating gases through flues 54 and 56 connecting the last gas pass of the boiler with the lower end of the economizer flue for upflow over the economizer as clearly indicated.

Fig. 3 indicates the arrangement of elements and the flow of fluid in the economizer under normal boiler load conditions. At such a time feed water is supplied at 58. It passes through the valve 60 to the upper header 62 of the economizer and then downwardly through the economizer tubes to the lower header 64. From that header it passes through the line 66 which is connected to the water space of the steam and water drum at 68. Under these conditions the valve 70 interposed in the line 72 connecting the header 62 to the line 66 is closed.

When the boiler and economizer organization of Fig. 3 is not subjected to boiler load the valve 60 is closed as indicated in Fig. 4, and no feed water supplied to the upper economizer header 62. The valve 70 is open so that there may be a separate economizer convection circulation which is vented to the drum through the line 66.

The normal operation of the economizer with upflow of water is changed during the no load period when feed water is shut off, to upflow of water, by the valves and piping connections, described and illustrated.

While the invention has been described with reference to the particular apparatus disclosed in the drawings, it is to be understood that it is not limited thereto, but that it is of a scope commensurate with the scope of the subjoined claims.

What is claimed is:

1. In a steam boiler installation, a bank of steam generating tubes, an economizer normally conducting a fluid including water back and forth across an upright gas pass and in a downflow from the top to the lower portion of the economizer, a first set of tubular connections providing for said fluid flow through the economizer and thence to said bank, a set of water flow reversing connections reversing the flow through the economizer and providing for a local natural circulation for the economizer, and means for rendering the first set of connections inoperative so as to prevent said downflow, said water flow

reversing connections being so arranged that the normal flow through said bank is unaffected.

2. In a steam boiler, a bank of steam generating tubes; a counterflow economizer connected to said bank and having an upflow of heating gases and a downflow of water under normal operating conditions, and water flow reversing connections between parts of the economizer for reversing the flow of water through the economizer when the boiler is under a light load to provide for a natural local convection circulation through the economizer with an upward flow of water, said connections including means regulating the flow at the normal inlet of the economizer and flow controlling means in the reversing connections, said water flow reversing connections being so arranged that the normal flow through said bank is unaffected.

3. In a steam boiler installation, a bank of steam generating tubes, a furnace from which hot gases pass across said tubes, a counterflow economizer through which the heating gases flow upwardly, the fluid space of the economizer being connected to the fluid space of said tubes, tubular connections communicating with the inlet and outlet of the economizer to provide for the normal downflow of water therethrough, said connections including a feed water pipe section leading to the inlet, and means providing for an independent local circulation circuit through the economizer during a lay-over period, the inlet being near the top of the economizer and the outlet being normally at the bottom of the economizer.

4. In a power generating installation, a bank of vaporizing tubes, means providing an upright gas pass, a fluid preheater normally conducting a fluid to be heated back and forth across the upright gas pass and from the top to the lower portion of the preheater where it is discharged into the bank of tubes, first tubular connections providing for said fluid flow through the preheater, and a second set of water flow reversing connections between parts of the economizer reversing the flow of the fluid to be heated during a lay-over period and including some of the first connections, said connections including means regulating the flow at the normal inlet of the economizer and flow controlling means in the reversing connections, said connections being such that a local circulation is set up in the economizer when said reversal takes place and said reversal taking place without affecting the flow through said bank.

5. In a steam boiler installation, a bank of steam generating tubes, a furnace from which hot gases pass across said tubes, gas pass wall structure providing for the passage of furnace gases to the bottom of an economizer, a counterflow economizer through which the heating gases from the furnace flow upwardly, the fluid space of the economizer being connected to the fluid space of said tubes, tubular connections communicating with the inlet and outlet of the economizer to provide for the normal downflow of water therethrough, said connections including a feed water pipe section leading to the inlet, and means including some of said connections for reversing the flow of water through the economizer and providing a local circulation in the economizer to prevent water hammer, the inlet being near the top of the economizer and the outlet being normally at the bottom of the economizer, said water flow reversing connections

tions being so arranged that the normal flow through said bank is unaffected.

6. In a steam boiler, a bank of steam generating tubes; a counter-flow economizer, means providing for an upflow of heating gases through the economizer, the fluid space of the economizer being connected to the fluid space of said tubes, means providing a downflow of water through the economizer under normal operating conditions, and water flow reversing connections between parts of the economizer for reversing the flow of water through the economizer during lay-over periods, or when the boiler is operating under a light load, said connections including means regulating the flow at the normal inlet of the economizer and flow controlling means in the reversing connections, said connections being so arranged that said reversal of flow takes place without a corresponding change in said bank of tubes.

7. In a power generating installation, a bank of vaporizing tubes, an economizer normally conducting a fluid to be heated back and forth across an upright gas pass and from the top to the lower portion of the economizer where it is discharged into the bank of tubes, first tubular connections providing for said fluid flow through the economizer, and a set of valved connections between parts of the economizer reversing the flow of the fluid to be heated during a lay-over pe-

riod and including some of the first connections, said second set also providing for an independent and complete circulation circuit through the economizer during a lay-over period, the reversal of fluid flow taking place in the economizer and said connections including means regulating the flow at the normal inlet of the economizer and flow controlling means in the reversing connections, said water flow reversing connections being so arranged that the normal flow through said bank is unaffected.

8. In a steam boiler, a bank of steam generating tubes, an economizer, means providing for a flow of heating gases through the economizer, the fluid space of the economizer being connected to the fluid space of said tubes, means providing a counterflow of water and heating gases through the economizer under normal operating conditions, and water flow reversing connections between parts of the economizer for reversing the flow of water in the economizer and causing a local economizer circulation during lay-over periods or conditions of light load, said connections including means regulating the flow at the normal inlet of the economizer and flow controlling means in the reversing connections, said water flow reversing connections being so arranged that the normal flow through said bank is unaffected.

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