

June 21, 1960

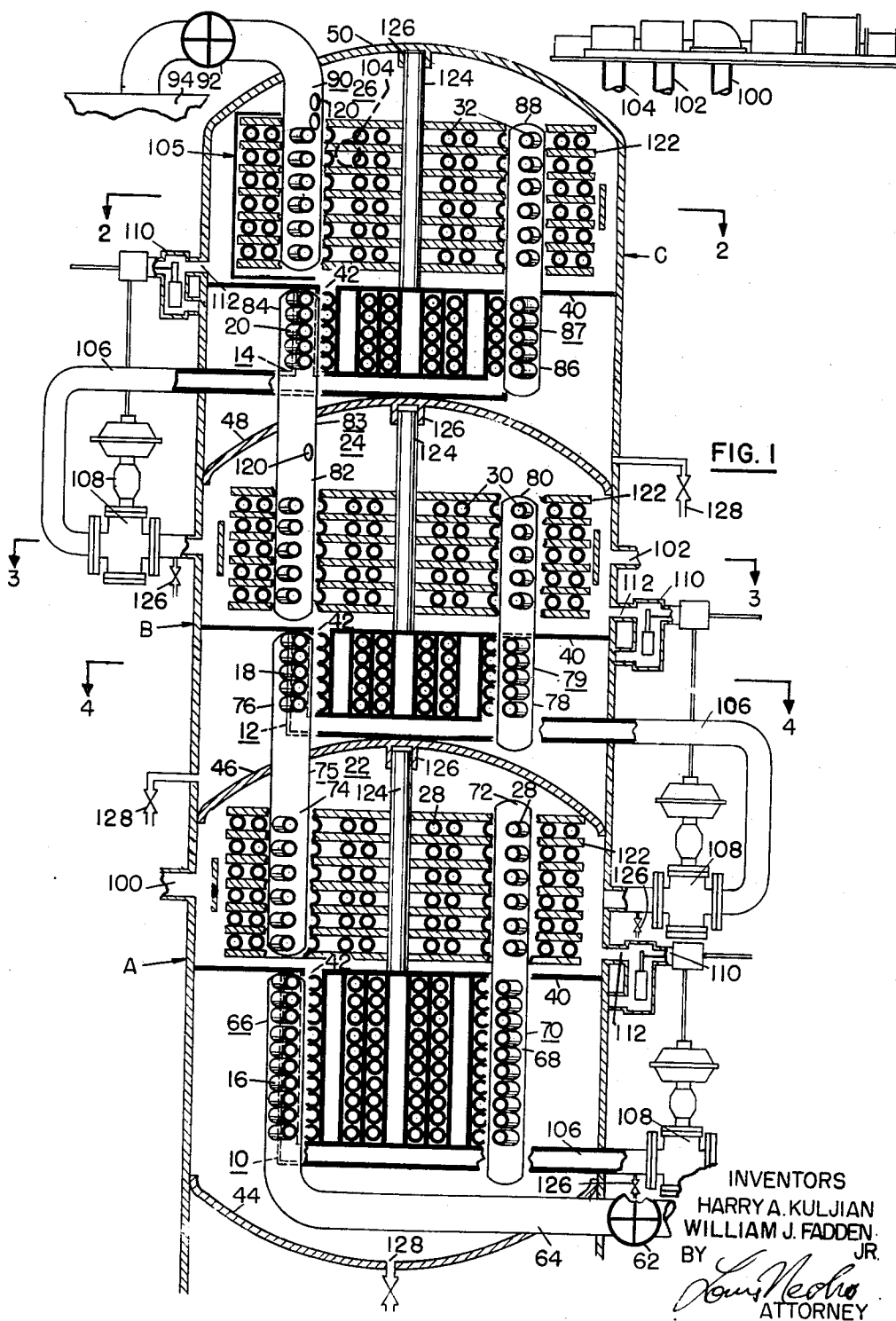
H. A. KULJIAN ET AL

2,941,786

BOILER FEED WATER HEATING APPARATUS

Filed Dec. 10, 1958

3 Sheets-Sheet 1



June 21, 1960

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3 Sheets-Sheet 2

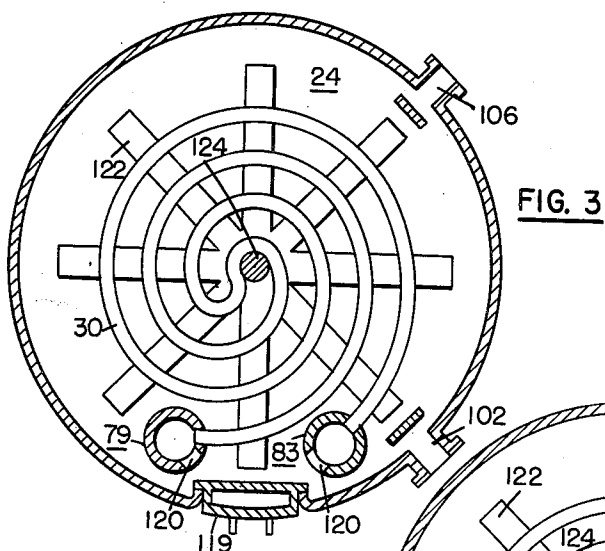


FIG. 3

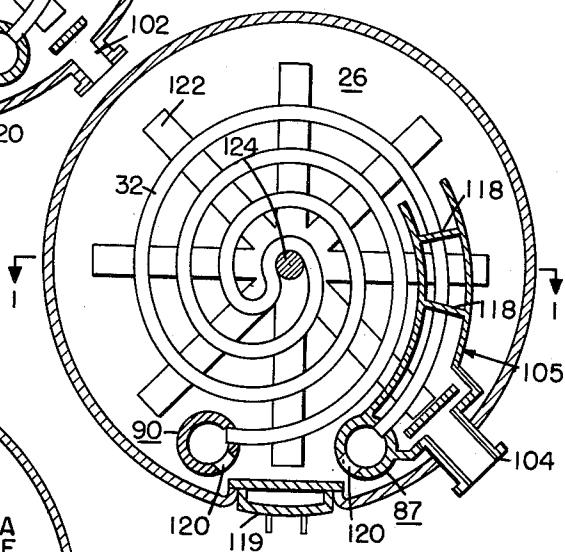


FIG. 2

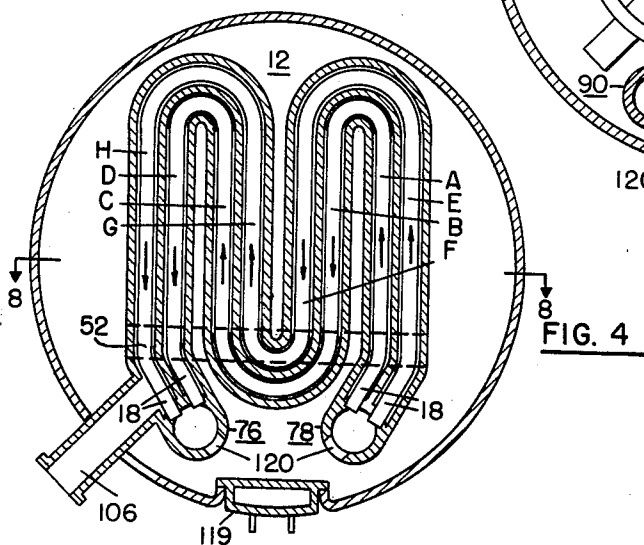


FIG. 4

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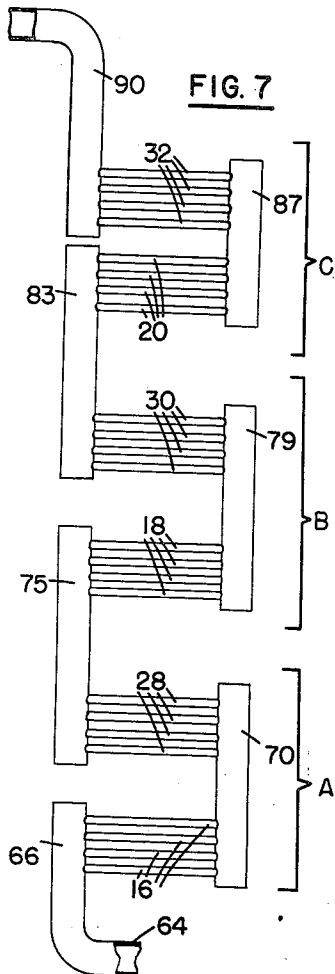


FIG. 7

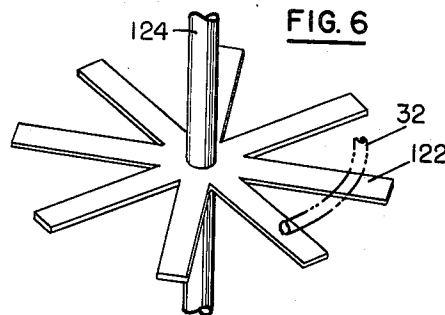


FIG. 6

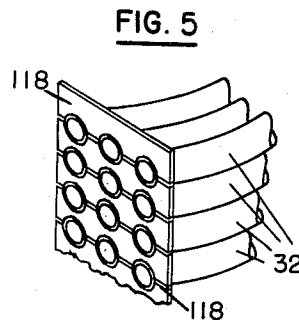


FIG. 5

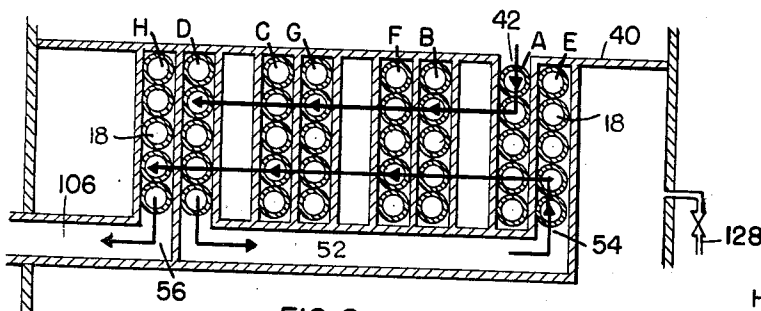


FIG. 8

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2,941,786

BOILER FEED WATER HEATING APPARATUS

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2 Claims. (Cl. 257—32)

In steam power plants, it is customary to preheat the boiler feed water by passing it through a series of coils and by bringing the coils into heat exchange relation with extraction steam derived from different stages of a multi-stage turbine or other prime mover.

The object of this invention is to produce an improved boiler feed water heating apparatus of the type set forth.

A further object is to produce a boiler feed water heating apparatus which is efficient, compact and inexpensive to make, install and maintain.

The full nature of the invention will be understood from the following specification and the accompanying drawings in which:

Fig. 1 is a diagrammatic view, partly in elevation and partly in vertical section, of a boiler feed water heating apparatus embodying the invention, the view being taken on line 1—1 on Fig. 2.

Fig. 2 is a sectional view taken on line 2—2 on Fig. 1.

Fig. 3 is a sectional view taken on line 3—3 on Fig. 1.

Fig. 4 is a sectional view taken on line 4—4 on Fig. 1.

Figs. 5 and 6 are fragmentary perspective views showing details of construction.

Fig. 7 is a diagrammatic view better to show the arrangement and relation of the coils and headers shown in Fig. 1.

Fig. 8 is an enlarged sectional view of the sub-cooler forming part of the uppermost stage heater which is shown in Fig. 1, certain parts being omitted better to show the structure of the sub-cooler itself.

The apparatus for carrying out the invention includes a number of sub-cooling compartments 10, 12 and 14, for accommodating sub-cooling coils 16, 18 and 20, and condensing compartments 22, 24, and 26, for accommodating condensing coils 28, 30 and 32. Each sub-cooling compartment is separated from the condensing compartment thereabove by means of a partition 40 which has an opening 42 therein for permitting condensate to flow from each condensing compartment to the sub-cooling compartment therebelow.

As will be seen from Fig. 1, sub-cooling compartment 10 and condensing compartment 22, and their respective coils 16 and 28, are enclosed between bottom wall 44 and top wall 46 and co-act to form lowermost stage heater A; sub-cooling compartment 12 and condensing compartment 24, and their respective coils 18 and 30, confined between wall 46 and wall 48 to form intermediate stage heater B, and sub-cooling compartment 14 and condensing compartment 26, and their respective coils 20 and 32 therein, are confined between wall 48 and wall 50 and co-act to form uppermost stage heater C.

It will be understood that the number of stage heaters forms no part of the invention and that any number of intermediate stage heaters B can be interposed between lowermost stage heater A and uppermost stage heater C. By this arrangement, all of the stage heaters are assembled in a vertical column thus effecting considerable economy in space, in piping, in building materials, and in maintenance.

2

It will be seen from Fig. 7 that the condensing coils are connected to the sub-cooling coils by means of headers only and, therefore, by severing the headers leading into, and from, a stage heater, the stage heater is completely isolated from those above and below it. This facilitates repairs because the workmen can enter through the man-holes, which are hereinafter described and can disconnect and remove the coils in one stage heater without disturbing the stage heaters thereabove and therebelow.

The boiler feed water to be heated, be it derived from a condenser, not shown, or other source, is delivered by pump 62 and pipe 64 to a header 66 which is wholly enclosed in sub-cooling compartment 10 and is connected in flow relation to the intake ends of sub-cooling coil 16, the discharge ends of which are connected to the lower portion 68 of a header 70, the upper portion 72 of which projects into condensing compartment 22 and is connected to the intake ends of condensing coil 28. The discharge ends of coil 28 are connected to the lower portion 74 of a header 75, the upper portion 76 of which projects into sub-cooling compartment 12 of stage heater B and is connected to the intake ends of sub-cooling coil 18. The discharge ends of sub-cooling coil 18 are connected to the lower portion 78 of a header 79, the upper portion 80 of which projects into the condensing compartment 24 of stage heater B and is connected to the intake ends of condensing coil 30. The discharge ends of condensing coil 30 are connected to the lower portion 82 of a header 83, the upper portion 84 of which projects into sub-cooling compartment 14 of a stage heater C and is connected to the intake ends of the sub-cooling coil 20 of uppermost stage heater C. The discharge ends of sub-cooling coil 20 are connected to the lower portion 86 of a header 87, the upper portion 88 of which projects into the condensing compartment 26 of stage heater C and is connected to the intake ends of condensing coil 32 in stage heater C. The discharge ends of coil 32 are connected to header 90 which leads to the intake side of a pump 92 for delivering the feed water to a boiler 94 or other point of use.

By this arrangement, the water to be heated moves upwardly through the superimposed coils and the steam condensed in the various condensing compartments flows through openings 42 from each condensing zone into the sub-cooling zone therebelow.

Extraction steam from a suitable source, such as one, or more, stages of a multi-stage turbine, which is only diagrammatically shown at the top of Fig. 1, is admitted to the various stage heaters in counterflow relation to the passage of the feed water to be heated. Thus, relatively low temperature steam is delivered through pipe 100 to lowermost condensing compartment 22; higher temperature steam is delivered through pipe 102 to condensing compartment 24 and still higher temperature steam is delivered by pipe 104 to a desuperheater 105 which forms part of uppermost condensing coil 32 and which will be hereinafter further referred to.

In order to control the level of condensate in the various sub-cooling compartments, and to transmit condensate from an upper to a lower stage heater, the sub-cooling compartment of each stage heater is connected to the condensing compartment of the stage heater therebelow by means of a pipe 106, and, in order to control the level of the condensate in the various stage heaters, each pipe 106 is provided with a diaphragm-operated valve 108 which is opened and closed by a "Levetrol" 110, which is available on the market, and the structure of which is disclosed in United States Patent Nos. 2,259,846 and 2,356,970. For the purpose of this disclosure it is sufficient to say that the "Levetrol" referred to is a liquid level responsive device which is connected to the corresponding stage heater by means of opening 112, and

that, when the level of the condensate reaches opening 112 in any one heater, the corresponding "Levetrol" opens the corresponding valve 108 and permits condensate to flow from an upper stage heater to the condensing compartment of the stage heater immediately therebelow, and that, when the level of the condensate in a stage heater is below opening 112, the corresponding "Levetrol" closes corresponding valve 108 and so on. The condensate collecting in sub-cooling compartment 10 is delivered through a pipe 106 to the condenser to be pumped into header 66 by pump 62. It will be noted that coil 16, in the lowest sub-cooling compartment 10 is relatively large and that sub-cooling coil 16 is also relatively large so as to afford the incoming, relatively low temperature feed water ample contact with the condensate reaching the lowermost sub-cooling compartment which is also at a relatively low temperature.

It will be seen from Fig. 2 that desuperheater 105 in uppermost condensing compartment 26, is formed with vertical baffles 118 which cause the superheated steam delivered through pipe 104 to circulate sinuously through uppermost coil 32. This increases the efficiency of the heat transfer by removing most of the superheat component of the steam.

The structure of the sub-cooling compartments is shown in Figs. 4 and 8 from which it will be seen that each compartment is partitioned off to form communicating sections A, B, C, D, E, F, G and H, so that the condensate entering the compartment through opening 42 will pass from section A to section B, to section C, to section D. From section D the condensate goes through passage 52 back to section E from which the condensate goes to section F, to section G and to section H. From section H, the condensate flows into pipe 106.

It will be seen from Figs. 2, 3 and 4, that the various headers are located near the vertical walls of the stage heaters so as to be readily accessible through man holes 119 in the walls of the stage heaters and that they are provided with normally closed man holes 120 which afford access to the interiors of the headers.

The tiers of condensing coils are supported by spiders 122 which are carried by uprights 124, the upper ends of which are received in sockets 126.

Each pipe 106 is provided with a drain 126 for emptying the corresponding sub-cooling compartment and each stage heater is provided with a drain 128 for removal of condensate which leaks into the bottoms of the stage heaters from the respective sub-cooling compartments. The provision of drains 128 makes it unnecessary to make sub-cooling compartments 10, 12 and 14 water tight, thereby reducing the cost of manufacture and maintenance.

The operation is as follows:

The highest temperature extraction steam to be used is admitted through pipe 104 into upper desuperheating compartment 105 where the steam is desuperheated and condensed at the saturation point prevailing in condensing compartment 26 of stage heater C. The condensate flows down through opening 42 in partition 40 to be heat-exchanged with the water in sub-cooling coil 20 of this stage heater and, when the level of condensate reaches opening 112, "Levetrol" 110 opens valve 108 to allow the condensate to flow through pipe 106 into condensing compartment 24 of stage heater B and so on. Due to the lower pressure prevailing in condensing compartment 24

of stage heater B, a portion of the condensate reaching it from stage heater C flashes into steam according to the saturation point prevailing in condensing compartment 24 and so on, for successive stage heaters, until the condensate finally reaching lowermost condensing compartment 12 will have given up its superheat and most of its sensible and latent heat.

What we claim is:

1. A heat exchange apparatus for heating the feed water of a boiler, said apparatus including a first stage heater, a second stage heater superimposed on said first heater, a horizontal partition dividing each of said stage heaters into a lower sub-cooling compartment and an upper condensing compartment, a first header disposed wholly within the sub-cooling compartment of said first heater, a second header having its lower portion disposed in said sub-cooling compartment and its upper portion disposed in the condensing compartment of said first heater, a third header having its lower portion disposed in the condensing compartment of said first heater and its upper portion disposed in the sub-cooling compartment of said second heater, a fourth header having its lower portion disposed in the sub-cooling compartment of said second heater and its upper portion disposed in the condensing compartment of said second heater, a first sub-cooling coil in the sub-cooling compartment of said first heater with one end thereof connected to said first header and its other end connected to the lower portion of said second header, a first condensing coil in the condensing compartment of said first heater with one end thereof connected to the upper portion of said second header and with its other end connected to the lower portion of said third header, a second sub-cooling coil in the sub-cooling compartment of said second heater and having one end thereof connected to the upper portion of said third header and the other end thereof connected to the lower portion of said fourth header, a second condensing coil in the upper compartment of said second heater and having one end thereof connected to the upper portion of said fourth header, means delivering feed water to be heated to said first header, means connected to the other end of said second condensing coil and extending outwardly from said second heater to remove the heated feed water, means for delivering steam, at a temperature of a first value, to the condensing compartment of said second heater, means for delivering steam at a temperature of a lower value to the condensing compartment of said first heater, there being openings formed in the partitions of said first and second heaters for the flow of condensate from each of said condensing compartment into the sub-cooling compartments therebelow, respectively, means delivering the condensate from the sub-cooling compartment of said second heater to the condensing compartment of said first heater and means for removing condensate from the sub-cooling compartment of said first heater.

2. The structure recited in claim 1 in which the first sub-cooling coil is substantially larger than the second sub-cooling coil.

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