United States Patent

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[54] **DIRECT CONTACT CONDENSER**
4 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **261/113,** 165/114
[51] **Int. Cl.** **F28b 3/04**
[50] **Field of Search** ..... 261/113, 118; 165/116, 112—115

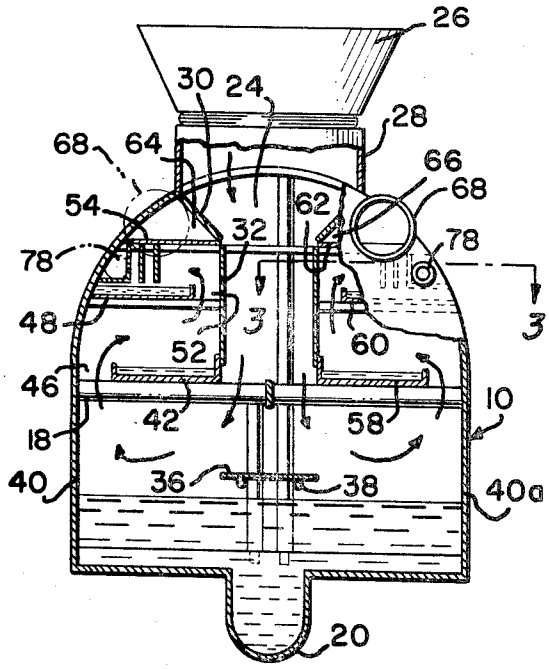
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ABSTRACT: A direct contact condenser wherein a plurality of vertically spaced, apertured elements are disposed on each of two opposing sides of the condenser inlet. The apertured elements of each plurality cooperate to provide a tortuous steam flow passage communicating with the condenser inlet, and are provided with a cooling liquid whereby the liquid is discharged in streams through the steam flow passages and forms the primary condensing medium of the condenser.



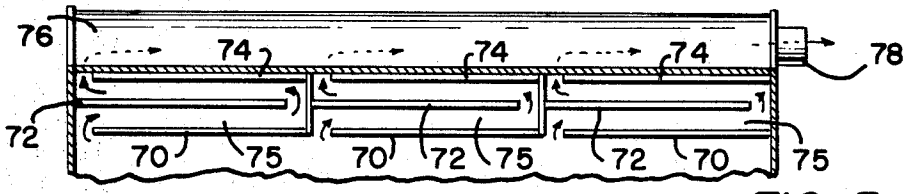


FIG. 3

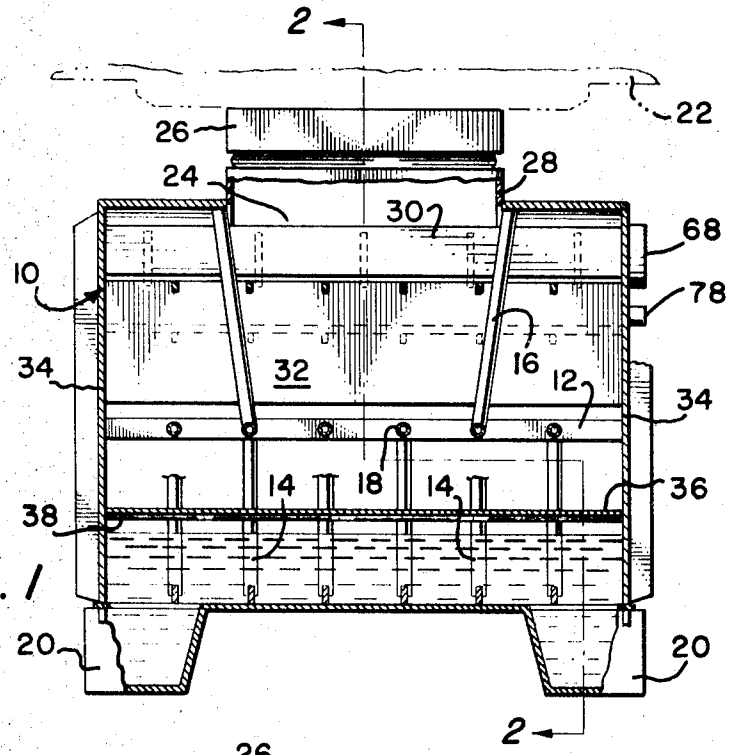


FIG. 1

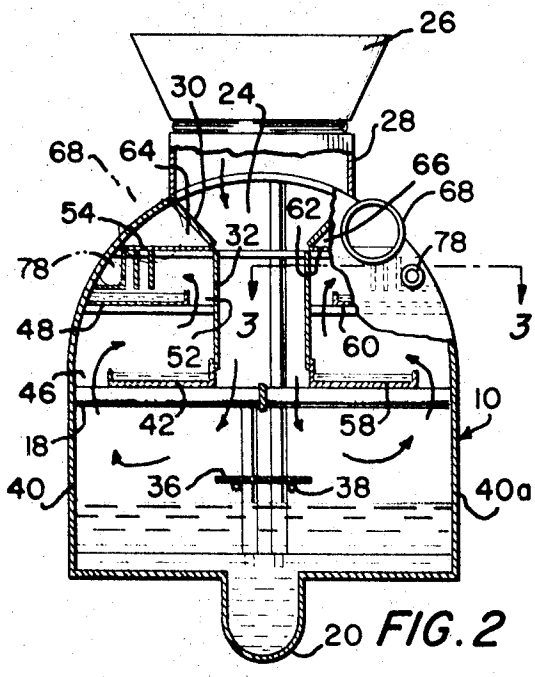


FIG. 2

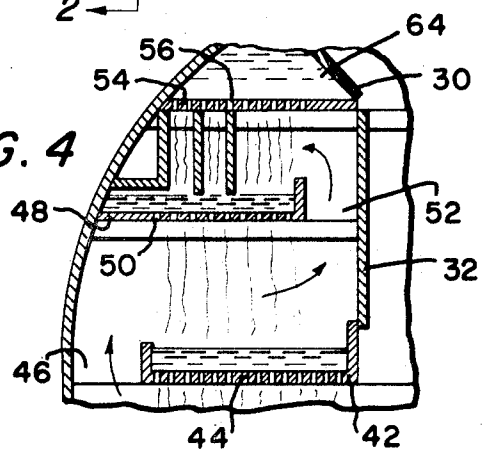


FIG. 4

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DIRECT CONTACT CONDENSER

THE DISCLOSURE

The present invention relates to condensers and more particularly to the provision of a new and improved direct contact condenser wherein the primary condensing medium is formed by streams of cooling liquid discharged through tortuous steam flow passages.

An object of the present invention is to provide a new and improved direct contact condenser which is relatively simple in construction and highly efficient and reliable in operation.

Another object of the invention is to provide a new and improved direct contact condenser which is particularly constructed and arranged to be suitable for installation beneath the apparatus from which it receives steam.

These objects, and those other objects and advantages of the invention which will be apparent from the following description taken in connection with the accompanying drawings, are attained by the provision of a direct contact condenser comprising a shell and inlet means for introducing steam to the shell. A first plurality of vertically spaced, apertured elements are disposed in the shell on one side of the inlet means and cooperate to provide a tortuous first steam flow passage which communicates with the inlet means and extends successively below such apertured elements. A second plurality of vertically spaced, apertured elements are disposed in the shell on another side of the inlet means and cooperate to provide a tortuous second steam flow passage which communicates with the inlet means and extends successively below such apertured elements. A means is provided for supplying a cooling liquid to the apertured elements whereby the latter discharge streams of cooling liquid through the steam flow passages, such streams of liquid being the primary condensing medium of the condenser.

Referring to the drawings:

FIG. 1 is an elevational sectional view of a direct contact condenser constructed in accordance with one embodiment of the present invention;

FIG. 2 is an elevational sectional view of the condenser shown in FIG. 1 taken on line 2–2 of FIG. 1, looking in the direction of the arrows, wherein the flow of steam is depicted by arrows;

FIG. 3 is an enlarged sectional view taken along line 3–3 of FIG. 2, looking in the direction of the arrows, wherein the flow of noncondensable gases is depicted by arrows; and

FIG. 4 is an enlarged fragmentary, elevational sectional view showing the details of construction of the apertured elements defining one of the steam flow passages, wherein the steam flow is depicted by arrows.

Referring more particularly to the drawings wherein similar reference characters designate corresponding parts throughout the several views, FIG. 1 illustrates a direct contact condenser comprising a shell or housing designated generally as **10** which is provided with suitable internal bracing by bracing elements **12**, **14**, **16**, and **18**. The shell **10** is elongated in the horizontal direction to form the condenser with a high capacity for a relatively low overall height; and each of the longitudinal horizontal ends of the shell **10** is provided with a condensate outlet **20** arranged to discharge condensate from the bottom or lower end of the shell **10**. The condensate outlets **20** are, as will be understood, during the operation of the condenser suitably connected to conventional piping or conduits (not shown) adapted to discharge condensate to a boiler or other conventional condensate receiver.

The shell **10** is provided with an inlet means arranged to receive steam from a source, such as the turbine **22** fragmentarily shown in broken lines in FIG. 1, above the shell **10** and to direct the steam downwardly into the shell **10** centrally of the latter. This inlet means comprises a generally vertical, steam inlet duct **24** peripherally defined at its upper end by a collector **26** and an annular wall **28** appended to the upper end of the shell **10**, and adjacent its lower end bounded along its sides by baffle plates **30**, **32** and at its ends by the end walls **34** of the shell **10**. This arrangement, as will be noted, causes the steam inlet duct **24** to discharge steam into the shell **10** centrally of, and substantially midway between the upper and lower ends of, the shell **10**. A baffle means or plate **36** is mounted by supports **38** beneath the lower end of the steam inlet duct **24** and serves to divide the steam flowing therethrough into a pair of lateral steam flows towards the sidewalls **40**, **40***a* of the shell **10**. The baffle plate **36**, as will be noted from FIG. 1, extends the full length of the shell **10**; and the supports **38** are connected at their opposing ends to the end walls **34** of the shell **10**.

A first plurality of vertically spaced, apertured elements are disposed in the shell **10** on one side of the inlet means or duct **24**; and a second plurality of vertically spaced, apertured elements are disposed in the shell **10** on the opposing side of the inlet duct **24**. The apertured elements of each plurality cooperate to provide a tortuous steam flow passage which communicates with the inlet duct **24** to receive one of the lateral flows of steam, the apertured elements discharging streams of cooling liquid through the steam flow passages to cause steam therein to be condensed.

The first plurality of apertured elements, as viewed in FIGS. 2 and 4, is positioned on the left-hand side of the inlet duct **24** and comprises a first or lower apertured element in the form of a tray **42**. The tray **42** is welded or otherwise suitably affixed along one of its sides to the adjacent baffle plate **32**, and arranged to project laterally from such baffle plate **32** towards the adjacent sidewall **40** in spaced relation to the bottom of the shell **10** and above the lateral steam flow towards the sidewall **40** provided by the baffle plate **36**. The tray **42** includes a plurality of apertures or spray openings **44** in its bottom, and longitudinally extends the full length of the shell **10** whereby its opposing ends are connected to the end walls **34**. The tray **42** is, however, spaced from the sidewall **40** by a flow space **46** which permits steam flow vertically between the tray **42** and the sidewall **40** throughout the length of the tray **42**.

A second apertured element in the form of a tray **48** is welded or otherwise suitably affixed to the sidewall **40** above, and in vertically spaced relation to, the tray **42**. The tray **48** includes apertures or spray openings **50** in its bottom and, although sufficiently overhanging the tray **42** to cause cooling liquid passing through the apertures **50** to fall into the tray **42**, is spaced throughout its length from the adjacent baffle plate **32** to provide a vertical flow space **52** therebetween. The tray **48**, similarly to the tray **42**, extends the full length of the shell **10** and has its opposing ends connected to the end walls **34** of the latter.

A third apertured element in the form of a plate **54**, having apertures or spray openings **56** therethrough, is positioned above the tray **48** and in vertically spaced relation thereto. The plate **54**, as illustrated in FIGS. 2 and 4, is mounted on the sidewall **40** and affixed by welding or other suitable means to the adjacent baffle plates **30**, **32**. The plate **54** extends the full length of the shell **10** and is mounted at its opposing ends on the end walls **34** of the shell **10**. Hence, as will be seen from FIGS. 2 and 4, cooling liquid flowing through the apertures **56** falls into the tray **48**.

From the preceding description, it will be seen that the apertured elements **42**, **48**, **54** cooperate to provide a tortuous first steam flow passage which, due to the before-described arrangement of such apertured elements, causes steam passing therethrough to successively flow outwardly from the inlet duct **24**, inwardly towards such inlet duct **24**, and then again outwardly from the inlet duct **24**. It will, moreover, be seen that this first steam flow passage directs steam upwardly in the shell **10** and, due to its tortuousness and reversal of steam flow, is adapted to provide maximum condensing action in a minimal space.

The second plurality of apertured elements, as shown in FIG. 2, is positioned on the right-hand side of the inlet duct **24**. This second plurality includes a first or lower apertured

element in the form of a tray **58**, a second apertured element in the form of a tray **60**, and a third apertured element in the form of an apertured plate **62**. The apertured elements **58, 60, 62** are constructed identically to the apertured elements **42, 48**, and **54**, respectively, and are also arranged identically to the latter. Hence, in view of the previous detailed description of the construction and arrangement of the apertured elements **42, 48, 54**, it is believed that the construction and arrangement of the apertured elements **58, 60, 62** is apparent.

Similarly, the second steam flow passage provided by the second plurality of apertured elements **58, 60, 62** is identical to the aforementioned first steam flow passage and directs steam successively outwardly from the inlet duct **24**, inwardly theretowards, and then again outwardly therefrom. Moreover, this second steam flow passage also directs the steam upwardly in the shell **10** and, due to its construction, provides maximum condensing action in minimum space.

Means are provided for supplying cooling liquid to the apertured elements of each plurality whereby the apertured elements discharge streams of cooling liquid through therebelow portions of the steam flow passages. This cooling liquid supply means, as illustrated, comprises chambers **64, 66** formed in the shell **10** above the apertured plates **54, 62**, respectively, and bounded along their lower sides by the respective one of such apertured plates. An inlet **68** communicates with each of the chambers **64, 66** and, during the operation of the condenser, is connected to a conventional source of a cooling liquid, such as cold water, suitable for use as the condensing medium of a direct contact condenser.

In addition, as will be seen from FIGS. **2** and **3**, tortuous passage means are provided for discharging noncondensable gases from the upper ends of the steam flow passages. These tortuous passage means are of identical construction and, as will be seen from FIG. **3** wherein one thereof has been shown for the purposes of illustration, each comprise a plurality of sets of baffle plates **70, 72, 74** which are arranged to provide labyrinth flow passages **75** communicating with the upper end of a respective one of the steam flow passages. The noncondensable gases are discharged from the labyrinth flow passages **75** into a manifold passage or duct **76** from whence they are discharged from the shell **10** through an outlet **78**.

In the operation of the before-described direct contact condenser, cold water or other suitable cooling liquid is supplied to the chambers **64, 66** through the inlets **68**. Colling liquid is discharged in streams from the chamber **64** through the apertures **56** in the plate **54** and falls through the portion of the first steam flow passage therebelow into the tray **48**. The tray **48** discharges cooling liquid streams through the portion of the first steam flow passage therebelow into the tray **42** which, in turn, discharges streams of cooling liquid to the bottom of the shell **10**. In this manner, the apertured elements **54, 48, 42** are successively fed cooling liquid supplied to the chamber **64**; and the first steam flow passage is saturated by streams of falling cooling liquid throughout substantially its entire length.

Moreover, cooling liquid is simultaneously discharged in streams from the chamber **66** through the apertures in the plate **62** and, in a manner identical to that aforedescribed with regard to the first steam flow passage, passes downwardly through the second steam flow passage and the trays **58, 60** to the bottom of the shell **10**. Hence, the apertured elements **62, 60, 58** are successively fed cooling liquid supplied to the chamber **66**; and the second steam flow passage is also saturated by streams of falling cooling liquid throughout substantially its entire length.

Steam from the turbine **22** (or other source) is supplied to the inlet duct **24** which directs the steam downwardly into the shell **10**. The baffle plate **36** divides this steam into a pair of opposing steam flows, one flowing laterally in the shell **10** to the first steam flow passage and the other flowing laterally in the shell **10** to the second steam flow passage. The steam supplied to the first steam flow passage flows successively beneath the apertured elements **42, 48, 54**, and during this flow is substantially entirely condensed due to its contact with the streams of cooling liquid falling through the first steam flow passage. The condensate formed from this steam, of course, falls downwardly with the downwardly falling streams of cooling liquid. The noncondensable gases flowing into the first steam flow passage pass into the labyrinth flow passages **75** from whence they are discharged by the communicating manifold **76** and outlet **78** from the shell **10**.

Similarly, the portion of the steam flowing to the second steam flow passage passes successively beneath the apertured elements **58, 60, 62** and is condensed by direct contact with the streams of cooling liquid provided by such apertured elements. The condensate, thus formed, falls downwardly to the bottom of the shell **10**; and the noncondensable gases in the steam are discharged in a manner identical to that of the aforedescribed discharge of the noncondensable gases from the first steam flow passage.

From the aforegoing it will be seen that we have provided new and improved means for accomplishing all of the objects and advantages of our invention. It will be understood, however, that, although we have illustrated and hereinbefore specifically described only a single embodiment of our invention, the invention is not limited merely to this single embodiment but rather contemplates other embodiments and variations within the scope of the following claims.

We claim:

1. A direct contact condenser comprising a horizontally elongated shell, means defining a generally vertical steam inlet duct having an upper end for receiving steam and a lower end in said shell for discharging steam to said shell, said steam inlet duct being laterally generally centrally of said shell to provide portions of said shell on opposite sides of said steam inlet duct and said steam inlet duct at least adjacent its said lower end extending the length of said shell to discharge steam to such shell portions throughout the length of said shell, a first plurality of apertured elements in one of such shell portions vertically spaced along one side of said steam inlet duct, a second plurality of apertured elements in the other of such shell portions vertically spaced along the other side of said steam inlet duct, the apertured elements of each said plurality being staggered to define a tortuous steam flow passage which at its lower end communicates with said lower end of said steam inlet duct and upwardly extends successively below each apertured element of the plurality, means for supplying cooling liquid to the apertured elements whereby the latter discharge streams of cooling liquid through said tortuous steam flow passages, and means at the upper ends of said tortuous steam flow passages providing labyrinth passages for discharging noncondensable gases from said tortuous steam flow passages, said streams of cooling liquid being the primary condensing medium of the condenser.

2. A direct contact condenser according to claim **1**, wherein said labyrinth passage providing means comprises baffle means disposed below the uppermost apertured element of each plurality.

3. A direct contact condenser according to claim **2**, wherein said apertured elements each extend the length of the shell, said cooling liquid supply means comprises a chamber bounded at its lower end by the uppermost apertured element of each said plurality, and the apertured elements of each said plurality are arranged to cause cooling liquid discharged by the uppermost apertured element of the plurality to pass downwardly through therebelow ones of the apertured elements and then be discharged to the bottom of said shell.

4. A direct contact condenser according to claim **3**, further comprising baffle means extending the length of said shell below said lower end of said steam inlet duct for directing steam from such lower end towards said tortuous steam flow passages.