April 19, 1938. B. P. COULSON, JR 2,114,873

ELASTIC FLUID SURFACE CONDENSER

Filed May 16, 1935

Fig. 1.

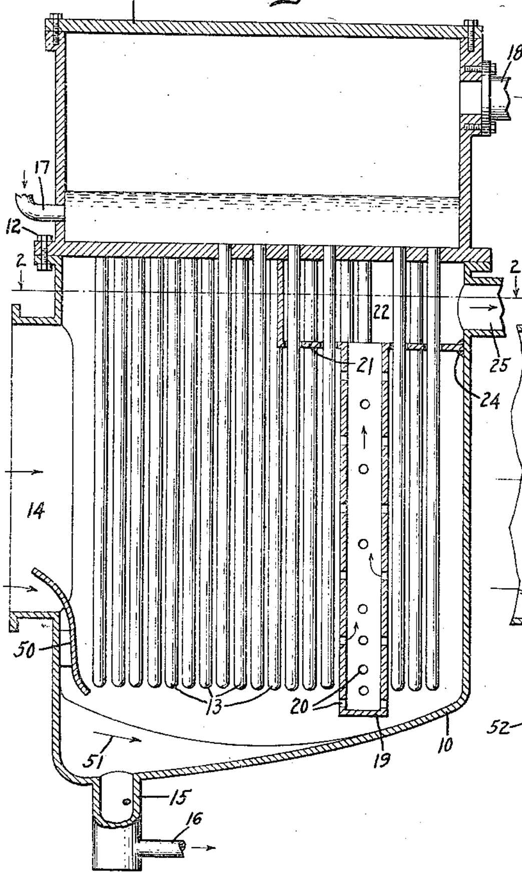


Fig. 3

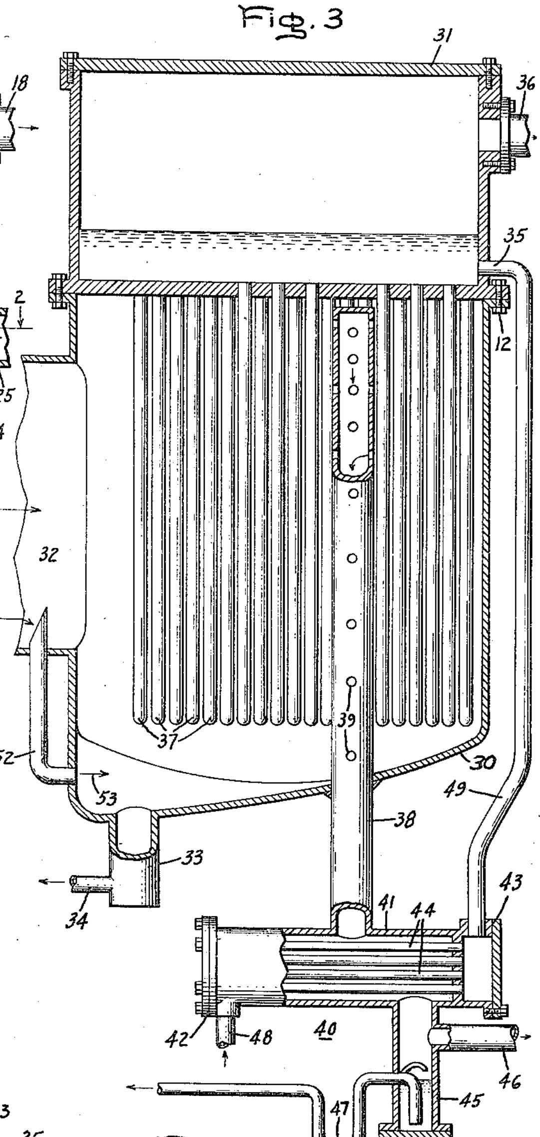


Fig. 2.

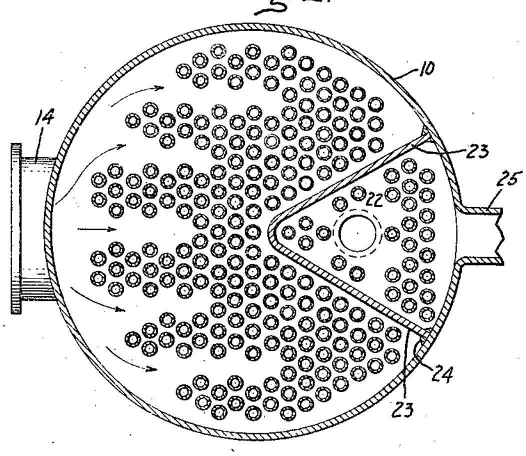
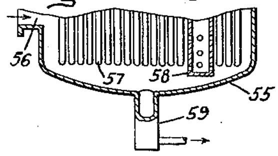


Fig. 4.



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2,114,873

ELASTIC FLUID SURFACE CONDENSER

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Application May 16, 1935, Serial No. 21,891

3 Claims. (Cl. 257—45)

The present application is a continuation in part of my application Serial No. 712,538, filed February 23, 1934, relating to elastic fluid surface condensers, particularly mercury vapor condenser and condenser boilers, although it is not necessarily limited thereto. The invention is of special importance in connection with surface type mercury condenser boilers in which mercury vapor is condensed by a medium such as water which in turn is evaporated.

Vapor exhausted by elastic fluid turbines contains air and other non-condensable gases leaking past packings into the interior of turbines exhausting into condensers. The amount of such gases is often considerably increased due to air leaking from the atmosphere into the condenser. These non-condensable gases in surface condensers reduce the heat transfer from the vapor through the tubes to the cooling medium by forming blankets on the tubes, an effect known as blanketing of the tubes. To overcome this drawback, it is necessary to provide means for removing or extracting non-condensable gases from the condensers.

One object of my invention is to provide an improved construction and arrangement of mercury condensers and the like whereby the air and other non-condensable gases contained in the mercury vapor or like elastic fluid to be condensed are readily removed and the efficiency of the condenser thereby substantially increased.

Another object of my invention is to provide an improved arrangement of condensers in which the flow of non-condensable gases through the conduit for discharging condensate is substantially eliminated.

This is accomplished in accordance with my invention by the provision of means for extracting the non-condensable gases at the region or regions where the final condensation takes place. I have found that the relative amount of air or other non-condensable gases contained in the mercury vapor increases with increasing condensation and reaches a maximum in those regions of the condenser in which the final condensation takes place. Therefore, I provide air-extracting means which may be in the form of a tube or tubes with a plurality of openings located at points of minimum heat concentration due to the blanketing of the condenser tubes by the non-condensable gases.

The second object of my invention is accomplished by the provision of means reducing the flow of non-condensables towards the outlet for the condensate.

For a better understanding of what I believe to be novel and my invention, attention is directed to the following description and the claims appended thereto in connection with the accompanying drawing which forms a part of my specification.

In the drawing, Fig. 1 is a sectional view of a condenser embodying my invention; Fig. 2 is a cross-section along line 2—2 of Fig. 1; Fig. 3 is a sectional view of a modification of my invention; and Fig. 4 is a sectional view, partly broken away of another modification of my invention.

The surface condenser shown by way of example in Fig. 1 is a condenser boiler for condensing mercury vapor and evaporating water of the type in which a single bank of tubes communicating with a header or tank for receiving cooling medium is provided. It comprises a lower tank 10 and an upper tank or header 11 having flanged portions united by bolts 12. Depending from the upper tank 11 are a plurality of dead-end tubes 13 communicating with the upper tank. The lower tank 10 has a flanged opening 14 for receiving mercury vapor to be condensed. A sump 15 having a discharge conduit 16 for mercury liquid is connected to the bottom of the lower tank. The upper tank 11 has an inlet conduit 17 for conducting water to the tank and an outlet conduit 18 for discharging steam. During operation, mercury vapor is passed across the outer surfaces of the depending tubes 13 whereby its heat content is transferred to the water contained in the tubes 13, effecting condensation of the mercury and evaporation of the water. The mercury condensate collects in the sump 15 and is discharged through the conduit 16. The steam generated in the depending tubes 13 flows into the upper tank 11 and is discharged through the conduit 18. The direction of flow of the mercury vapor is indicated by arrows in Fig. 2. The arrangement of the depending tubes is such as to obtain the best cooling effect at a minimum resistance toward the flow of mercury vapor.

From a consideration of Fig. 2, it will be readily seen that the relative amount of non-condensable gases increases along the path of the mercury vapor, reaching a maximum value at points where the final condensation takes place. The increasing content of air and other non-condensables in the mercury vapor causes an increased blanketing of the tubes 13 and thereby reduces considerably the heat transfer through these tubes. To reduce the blanketing of the tubes in order to increase the heat transfer, I provide in accordance with my invention means for extracting non-condensable gases wherever the amount of these gases reaches a certain value. Preferably, I provide an air-extracting tube extending over a substantial area of minimum heat concentration due to blanketing of the tubes by the non-condensable gases. In the type of condenser shown in the drawing the region of minimum heat concentration is considerably spaced from the outer condenser wall. It is located intermediate the center of the cylindrical condenser casing and the wall portion of the casing opposite the inlet opening 14. In the present instance I have shown an extraction tube 19 having a plurality of openings 20 through which the non-condensable gases are withdrawn. The tube 19, as pointed out above, is located in a region of minimum heat concentration and in the type of condenser shown in the drawing is surrounded by or interspaced between cooling tubes. Its upper end is connected to the bottom 21 of an extraction chamber 22 having a V-shaped wall 23 fastened to the lower tank or casing 10 by welds 24. The non-condensable gases are removed from the chamber 22 by any suitable means through an opening 25 in the outer tank or casing 10.

It is desirable to extract air and non-condensable gases at a uniform rate along the entire length of the extraction tube. To this end I provide the tube with a plurality of openings having an opening area per unit tube length decreasing in the direction of the tube outlet, that is, the opening area over a unit length near the bottom of the tube (Fig. 1) is larger than over a unit length near the top or discharge end thereof. The larger opening area near the bottom causes a somewhat higher pressure to exist within the lower portion of the extraction tube than within the upper portion thereof, resulting in flow of gases from the bottom portion of the tube towards the upper portion, that is, towards the discharge end thereof.

Referring now to Fig. 3, where I have shown a modification of my invention, the condenser boiler comprises a lower tank 30 and an upper tank 31 corresponding to tanks 10 and 11 respectively of Fig. 1. The lower tank has an inlet opening 32 for mercury vapor to be condensed and its bottom is connected to a sump 33 having a conduit 34 for discharging condensed mercury. The upper tank 31 has an inlet opening 35 through which water is conducted into the tank and a conduit 36 for discharging steam. A plurality of depending dead-end tubes 37 projecting into the lower tank 30 are connected to the upper tank 31 for receiving water therefrom, the water being at least partly evaporated in the tubes and expelled into the upper tank. A tube or channel 38 corresponding to the tube 19 of Fig. 1 is provided in the lower tank 30, extending over a considerable region of minimum heat concentration, that is, a region in which the content of non-condensable gases in the mercury vapor has reached a maximum value. In the present instance the tube 38 has a closed upper end and projects through the bottom of the lower tank 30. The tube has a plurality of openings 39 which are more closely spaced at the upper end of the tube than near the lower tube portion in order to obtain uniform extraction along the tube. In the present instance I have shown means for removing mercury vapor which may be carried along by the non-condensable gases into the tube 38. This means comprises an auxiliary condenser 40 having an outer casing 41 forming two headers 42 and 43. The headers are connected by a plurality of cooling tubes 44. A lower portion of the tank 41 is connected to a sump 45 having an outlet 46 for non-condensable gases and a discharge conduit 47 for mercury. The headers 42 and 43 are connected to conduits 48 and 49 respectively for receiving and discharging water, the tube 49 being connected to the inlet opening 35 of the upper tank 31. During operation, mercury vapor, as it flows through the inlet 32 of the lower tank across the depending tubes 37, is condensed, the condensate being discharged through the sump 33 and its discharge conduit 34. The non-condensable gases and a certain amount of mercury vapor is withdrawn from the lower tank 30 through the extraction tube 38 and flows into the auxiliary condenser. Water is conducted through the conduit 48 to the header 42 of the auxiliary condenser, whence it flows through the cooling tubes 44 into the right-hand header 43 of the auxiliary condenser. From the header 43 the preheated water is conducted through conduit 49 into the upper tank 31 and its tubes 37 in which it is evaporated to be finally discharged through the conduit 36. The mixture of non-condensable gases and mercury vapor discharged from the extraction conduit or tube 38 flows across the tubes 44 of the auxiliary condenser whereby the mercury condenses and collects in the sump 45 whence it is withdrawn through the conduit 47, the non-condensable gases being removed by any suitable means, such as pumps or the like (not shown), through the conduit 46.

During operation of condensers of the type described above, I have found that the non-condensables have a tendency to flow partly towards the outlet conduit for the condensate, in which case they are discharged partly together with the condensate and in the case of a mercury power plant flow into the boiler. The presence of non-condensables in the form of air in the boiler is undesirable because air causes oxidation of the boiler walls which reduces considerably the heat transfer from these walls and consequently the boiler output, moreover endangers the operation of the boiler in that oxidized boiler surfaces lead to hot spots.

In accordance with my invention I provide two means for reducing the flow of non-condensables into the outlet for the condensate. The first means consists in a particular location of the outlet conduit for condensates and a special relation between the location of this outlet and the location of the air removal means. As shown in Fig. 1 of the drawing, the sump 15 forming an outlet for the condensate is considerably spaced from the air removal conduit 19. More specifically, the sump 15, that is, the outlet conduit for the condensate, is connected to a region of the condenser in which the heat concentration is a maximum, whereas the air removal conduit 19, as explained above, is disposed in a region in which the heat concentration is a minimum. From another viewpoint, the discharge conduit for condensate is connected to a region of the condenser in which the partial pressure of condensables, in the present instance mercury, is a maximum, that is close to the opening 14 for admitting vapor to the condenser, whereas the air removal means is disposed in a region in which the partial pressure of the condensables is a minimum and the partial pressure of the non-condensables a maximum, in the present instance, at a considerable distance away from the inlet 14 for admitting vapor to the condenser. However, it is to be noted that this considerable distance between the inlet 14 and the air removal conduit 19 is less than the diameter of the tank because the location of the region of maximum partial air pressure is not diametrically opposite the inlet 14. The second means for preventing flow of non-condensables into the discharge conduit for condensate comprises the provision of a deflector or like auxiliary means for creating an artificial draft from the region to which the discharge conduit for condensate is connected to the region in which the air removal conduit is disposed. As shown in Fig. 1, this means comprises a deflector 50 suitably fastened to the wall of the condenser for deflecting a portion of the vapor flowing into the inlet 14 towards the bottom of the condenser. The deflected vapor flows across the connection of the casing with the sump 15 towards the air removal conduit 19. The direction of flow is indicated by an arrow 51. Thus the provision of the deflector 50 causes the creation of an artificial draft from the inlet 14 across the connection with the sump 15 towards the air removal conduit 19. This draft reduces or prevents the formation of a draft in opposite direction. The bottom of the casing 10, as shown in the drawing, forms a channel inclined towards the left with the sump 15 connected near the left-hand end or lowest portion of this channel.

The arrangement for preventing the flow of non-condensables from the region of minimum heat concentration into the discharge conduit for condensate is similar in Fig. 3 but instead of a deflector I provide in Fig. 3 means including a conduit 52 for extracting vapor from the condenser inlet 32 and discharging vapor across the inlet sump 33 in the direction of the air removal conduit 38. The direction of flow across the connection of the discharge for condensate is indicated by an arrow 53. As explained before, the discharge conduit for condensate is connected to a region in which the partial pressure of non-condensables is a minimum, whereas the air removal conduit 38 is disposed in a region in which the partial pressure of the non-condensables is a maximum and the partial pressure of the condensables a minimum.

The arrangement shown in Fig. 4 includes a tank 55 corresponding to the tank 10 of Fig. 1. The tank has an inlet 56 and a plurality of cooling tubes 57 corresponding to the tubes 13 of Fig. 1. Means including a perforated conduit 58 corresponding to the conduit 19 of Fig. 1 are provided for extracting non-condensable gases. The conduit 58 is interspaced between the cooling tubes 57 and disposed in a region in which the partial pressure of the non-condensable gases including air reaches a maximum. A sump representing in substance a conduit 59 for discharging condensate mercury is connected to a central portion of the bottom of the tank 55. The arrangement shown in Fig. 4 is provided in accordance with my invention with an air removal conduit disposed in a region of maximum partial pressure of air and other non-condensable gases as is the case in the arrangement of Figs. 1 to 3. In contrast to the latter arrangements the condensate discharge means is not connected to a portion of the tank near the inlet for vapor to be condensed, that is in a region in which the partial pressure of the non-condensable gases is a minimum. Whereas my invention may be used in the form shown in Fig. 4, I prefer the arrangements shown in Figs. 1 to 3.

Having described the method of operation of my invention, together with the apparatus which I now consider to represent the best embodiments thereof, I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An elastic fluid surface condenser including a tank having an inlet for elastic fluid to be condensed and an outlet for condensate, cooling means including a plurality of tubes projecting into the tank, and means for extracting air and other non-condensable gases from the tank, said means comprising a tube with a plurality of openings extending over a substantial portion of the region of minimum heat concentration in the tank, the opening area of said openings per unit tube length being reduced towards the outlet of the tube to cause uniform extraction along the entire length of the tube.

2. An elastic fluid surface condenser including means comprising a perforated conduit disposed within the condenser for extracting air and other non-condensable gases, a conduit connected to the condenser for discharging condensate, and means for creating an artificial draft across the connection of said last named conduit with the condenser towards the perforated conduit of the air removing means.

3. An elastic fluid surface condenser including means for extracting air and other non-condensable gases from the condenser, said means being disposed in a region of minimum heat concentration, a conduit connected to the condenser for discharging condensate, and means including a deflector for causing a draft from the connection of the condenser with said conduit towards the air removal means.

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