Dec. 8, 1959 G. A. WORN ET AL 2,916,260

CONDENSER DEAERATOR

Filed Dec. 9, 1955 2 Sheets-Sheet 1

Fig. 1.

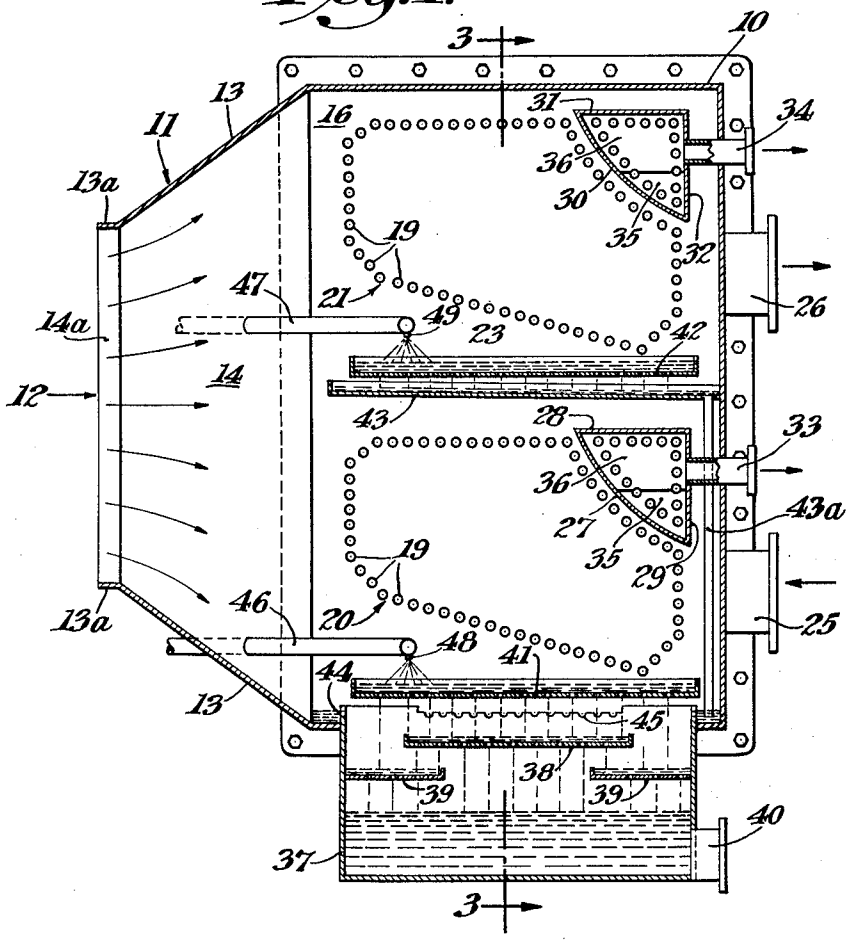
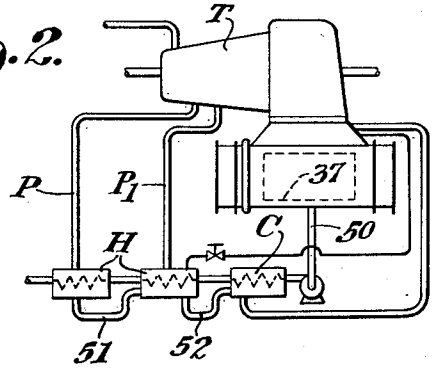


Fig. 2.



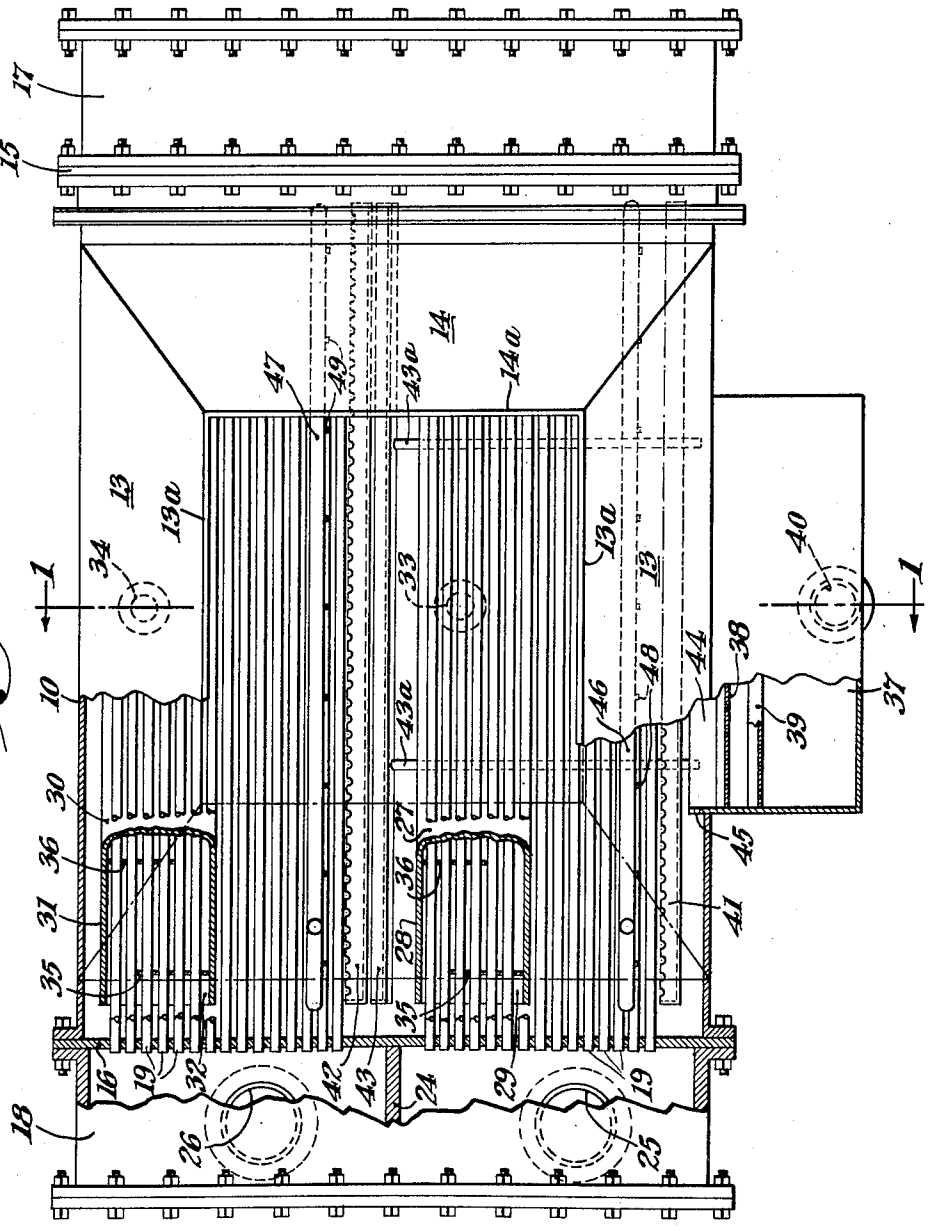
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Fig. 3.



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2,916,260

Patented Dec. 8, 1959

2,916,260

CONDENSER DEAERATOR

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Application December 9, 1955, Serial No. 552,106

1 Claim. (Cl. 257—43)

This invention relates to improvements in steam power plant equipment and more particularly to improved condensing and deaerating apparatus for such a plant and this application is a continuation-in-part of our copending application Serial Number 532,176, filed September 2, 1955, and entitled "Condenser," now Patent No. 2,848,197.

A steam power plant employing a turbine normally includes, in addition to a boiler or steam generator, a series of feed water heaters and a surface condenser for the exhaust steam from the turbine. Steam is condensed in the condenser and the condensate is conducted from the hot well of the condenser through the feed water heaters in series and returns to the boiler. Within the heaters, the condensate is heated by steam which may be bled from one or more stages of the turbine. Such steam is condensed in its pasage through the heaters and the condensate is also returned to the boiler. This condensate, together with make-up water, as required for the boiler, should be deaerated before introduction to the boiler and it is customary to provide a separate deaerator unit for that purpose. The deaerated water is then pumped from such unit through one or more heaters to the boiler.

An object of our invention is to provide a combined steam condensing and deaerating apparatus devised to obtain advantageous cooperation of condenser features with deaerating means.

A further object of our invention is to provide a construction of, high vacuum, surface condenser adapted especially for large sizes in which each condenser tube contributes the maximum area possible to active condensation of steam.

A still further object of our invention is to provide an improved condensing unit wherein exhaust steam from a side exhaust or end exhaust turbine may be conveniently introduced through a side inlet in the unit with a resultant substantial saving in supporting structure and head room and wherein the inlet area of the nest of condensing tubes is at a maximum so that the velocity of the steam entering the nest of tubes is materially reduced and the paths of steam flow converge toward points of complete condensation.

Further objects and advantages of our invention will appear from the following description taken in connection with the accompanying drawings.

In the drawings:

Figure 1 is a vertical sectional view of a condenser unit embodying the invention, the section being on the line 1—1 of Figure 3;

Figure 2 is a diagrammatic top view of a portion of a steam power system embodying a side exhaust turbine and the invention; and

Figure 3 is a vertical section on the line 3—3 of Figure 1, partly broken away.

The structure of the condensing unit shown in Figs. 1 and 3 includes a shell 10 horizontally disposed and formed at one side with a portion 11, which provides

an inlet passage for exhaust steam from the turbine. The steam inlet 12 in portion 11 may be rectangular in vertical section having opposite walls 13, which converge outwardly from the shell to the steam inlet and terminate in horizontal portions 13a. Opposite walls 14 may converge outwardly from the shell to the steam inlet and terminate in vertical portions 14a, similar to portions 13a of the walls 13, and form therewith a frame for connection with the exhaust opening of the turbine.

The opposite ends of the shell are provided with flanges and have secured thereto respectively tube sheets 15 and 16 and water boxes 17 and 18. Tubes 19 connect to the tube sheets and are arranged in a nest comprising two or more equal banks 20 and 21 formed one above the other and spaced to define therebetween a horizontal central lane or lanes 23. Water box 18 has a horizontally, diametrically disposed pass partition 24 and two nozzles 25 and 26. Referring to Fig. 1, the nozzle 25 admits cooling water to the compartment below the pass partition for flow through the tubes of the lower tube bank 20 to the water box 17 and thence in reverse direction through the tubes of the upper bank 21 to the water box compartment above the partition and out through the nozzle 26. Thus, the condenser as illustrated is a two-pass unit but the number of passes may be varied by appropriate arrangements of pass partitions and nozzles.

Each tube bank has an air offtake baffle structure which includes walls 27, 28 and 29 and 30, 31 and 32 respectively; the ends of each baffle structure being open so that non-condensible gases may be withdrawn from both banks through nozzles 33 and 34. Within each baffle structure is a portion of the tubes of the respective bank which act as an air cooler section. Also within each baffle structure are transversely disposed interleaving baffle plates 35 and 36, which are spaced to provide a tortuous path of flow for the non-condensible gases. A steam jet ejector, not shown, may be connected to nozzles 33 and 34 to maintain a desired vacuum. Such an ejector may deliver to the usual inter and after condenser combination, not shown.

Beneath the shell 10 there is a hot well 37, which extends along the major portion of the shell length and is of quite substantial depth and width to give it relatively large storage capacity. Within the upper portion of the hot well, there are deaerating means for the condensate drained from the tube banks. Such means includes perforated shower trays 38 and 39 with upturned outer edges. These trays extend horizontally the full length of the hot well but do not individually span the full width of the hot well. All of the shower trays are welded or otherwise suitably secured to the adjacent walls of the hot well. Air offtake pipes, not shown, may lead from opposite sides of the hot well, at points between trays 38 and 39, to the air offtake baffle structures. The hot well has a condensate discharge nozzle 40 leading from its lower portion.

Incorporated and coacting with the condenser tube banks 20 and 21 are condensate shower trays 41 and 42 for deaerating condensate from the respective tube banks. Tray 42, which is positioned within the horizontal central lane 23, receives most of the condensate from the tube bank 21 and showers such condensate to an underlying imperforate plate 43, which is shaped to direct the condensate to the rear side of the condenser shell where it is led by conduits 43a downwardly to a point below the lower tube bank and is thereafter directed to the hot well. In showering from tray 42 to plate 43, the condensate from the upper tube bank is substantially reheated and deaerated. By passing the reheated and deaerated condensate downward through closed conduits 43a such condensate is isolated from the air being removed from con-

densate of the lower bank and is delivered to the hot well in its deaerated condition. A weir 44 at the top of the hot well 37 and within shell 10 is provided with notched portions 45 whereby condensate from plate 43 is collected in the troughs formed between the weir and shell and discharges in divided streams to tray 38. Final deaeration of the upper tube bank condensate occurs as it showers from trays 38 and 39 to the hot well with condensate from the lower tube bank. Tray 41, which underlies tube bank 20, receives most of the condensate from such lower tube bank and showers such condensate to the trays 38 and 39 in the hot well. In showering from the tray 41 to trays 38 and 39, the condensate from the lower tube bank is substantially reheated and deaerated. Final deaeration of the lower bank condensate occurs as it showers from trays 38 and 39 to the hot well with condensate from the upper tube bank.

All of the shower trays have their free edges turned up so that the condensate will collect sufficiently on the trays for passage through the perforations rather than spill ineffectually from one edge. The upper edge of the upturned tray portion is notched so that in the event of tray flooding, condensate pouring over a tray edge will fall in a plurality of streams.

Integrated and coacting with the condensing apparatus there is apparatus for deaerating a charge of condensate from feed water heaters and/or boiler make-up water. This apparatus may comprise pipes 46 and/or 47 spaced above trays 41 and 42 to deliver the charge to such trays and which extend throughout most of the length of the condenser. These pipes have a row of spray nozzles 48 and 49 which direct the charge toward the trays whereby it is substantially reheated and deaerated. The reheated condensate originating from pipes 46 and/or 47 joins condensate from tube banks 20 and/or 21 in trays 41 and/or 42 for flow to the hot well.

In the operation of the apparatus, exhaust steam passes from the turbine T (Fig. 2) into the condenser, and condensate is withdrawn from the hot well 37 through a pipe 50 and passed in succession through the tube side of a drain cooler C and a plurality of feed water heaters H, en route to the boiler, not shown. Steam is bled from one or more stages of the turbine through pipes P and P_1 and passed to the shell side of heaters H respectively, to heat the water flowing through the tube side of the heaters by indirect heat exchange. Condensate of the steam within the heaters may be passed through pipe 51 from one heater to another, and through a pipe 52 to the drain cooler C and thence through deaerating means as described above before joining the condenser condensate in the hot well 37. Make-up water may be supplied, as needed, to the system and be deaerated and heated at a suitable point as described above.

Usually a vacuum ranging from 26 to 29 inches will be maintained within the condenser and this vacuum will exist within each deaerator.

It is known that in order to obtain the necessary condensing surface without unduly increasing the size of the condenser, the tube spacing adjacent the steam inlet perimeter of the nest of tubes must of necessity be such as to occasion no objectionable loss in vacuum between the point or points of complete condensation within the tube nest and the steam inlet to the condenser. To overcome objectionable losses of vacuum, the cooling tubes 19 are distributed so as to increase the inlet area of the nest of tubes so that the velocity of steam flow entering the nest of tubes is materially reduced below that employed in ordinary condensers. Likewise the condensing surface is so distributed that the paths of steam flow converge toward the air offtake baffle structures.

To accomplish the above and primarily to eliminate the massive structure generally required to support the turbine above the condensing unit, the present invention utilizes a side inlet to the condenser with the tubes divided into separate independent groups having separate primary condensate deaerating means and separate air offtake structures. With such an arrangement the condenser may be positioned adjacent to the turbine affording better maintenance opportunity and substantially less supporting structure. The tubes are arranged for maximum inlet area for the steam with the condenser steam inlet facing directly into the turbine exhaust. The tubes of each group are distributed to obtain the advantage gained by having the condensing surface so distributed that the areas of steam flow diminish from the steam space toward the air offtake in substantially direct proportion to the decrease in condensation taking place along the paths of steam flow, or in direct proportion to the decrease in volume of uncondensed vapor along the path of flow.

While the invention is disclosed as employed in power plant service, it may be employed advantageously in other services requiring surface condenser equipment where it is particularly desirable to support the prime mover on the same level with such condenser. It is, of course, to be understood that the present disclosure of the invention is merely illustrative and in nowise limiting and that the invention comprehends such modifications as will fall within the scope of the following claim.

In the claim, the word "steam," except where identified with a steam power system, is intended to comprehend other vapors also, and the word "air," wherever it occurs, is intended to comprehend also other non-condensible gaseous media.

We claim:

In a surface condenser unit including: a shell; a nest of substantially horizontal condensing tubes within the shell; means for circulating cooling water through said tubes, said shell having therein a side steam inlet passage for conducting steam in a substantially horizontal direction to said tube nest for condensation therein; a hot well positioned below said tube nest to receive partially deaerated steam condensate from said tubes; a substantially horizontal baffle plate located within said shell and dividing said tube nest into separate groups of tubes, one above the other, said baffle plate being so disposed as to collect condensate from the upper group of tubes and direct such condensate in a separate path away from said inlet passage for discharge into said hot well; a horizontally disposed perforated tray located below said upper group of tubes and above said baffle plate to intercept condensate from said upper group of tubes and shower it downwardly in divided streams to said plate whereby said condensate is substantially reheated and partially deaerated by steam passing between said groups of tubes; a second horizontally disposed perforated tray located beneath said lower group of tubes and above said hot well to intercept condensate from said lower group of tubes and shower it in a separate discharge path downwardly in divided streams into said hot well whereby said condensate is substantially reheated and partially deaerated by steam passing under said lower group of tubes; a deaerating device within said hot well to complete deaeration of condensate from said separate discharge paths; and integrated means within said shell and independent of the deaeration device within said hot well for reheating and deaerating condensate from an outside source; an improved integrated means for substantially reheating and partially deaerated condensate from an outside source comprising condensate delivery conduits leading from outside of the condenser unit, said conduits being in condensate delivery communication above said perforated trays to deliver to said trays a plurality of fine streams of condensate from said outside source whereby it is substantially reheated and partially deaerated by steam flowing crosswise of said streams to said tube nest, said reheated and partially deaerated condensate passing with condensate from said groups of tubes to said hot well for final deaeration in the deaeration device therein.

(References on following page)

References Cited in the file of this patent

UNITED STATES PATENTS

1,076,522	Samuelson	Oct. 21, 1913
1,586,234	Bancel	May 25, 1926
1,812,591	Grace	June 30, 1931
2,168,902	Grace	Aug. 8, 1939
2,247,514	Mart	July 1, 1941
2,663,547	Evans et al.	Dec. 22, 1953

FOREIGN PATENTS

271,065	Great Britain	Sept. 22, 1927
417,256	Germany	Aug. 10, 1925