Nov. 19, 1940. D. W. R. MORGAN 2,222,439

CONDENSER

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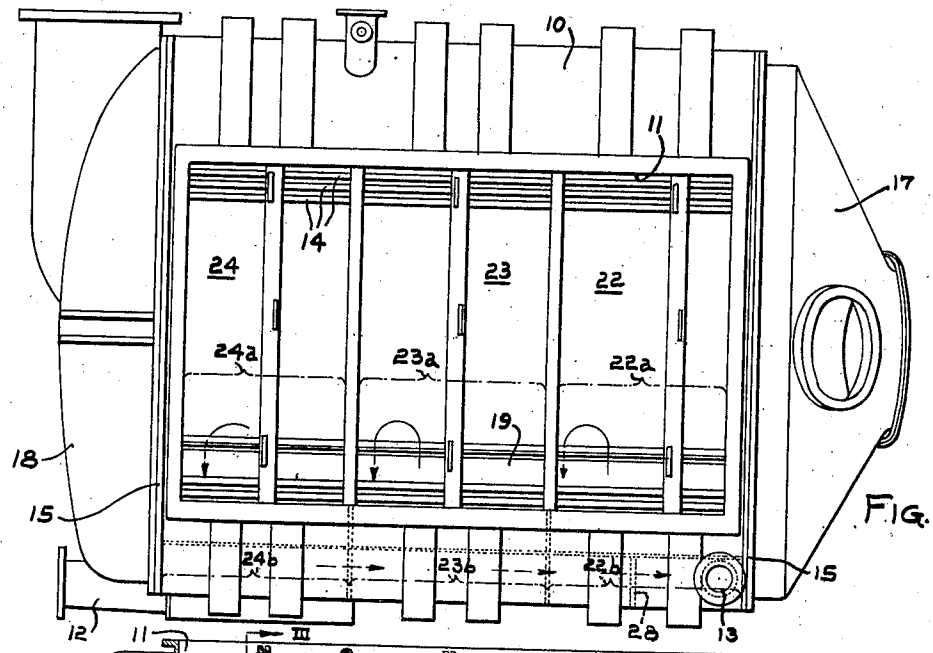


FIG. 1.

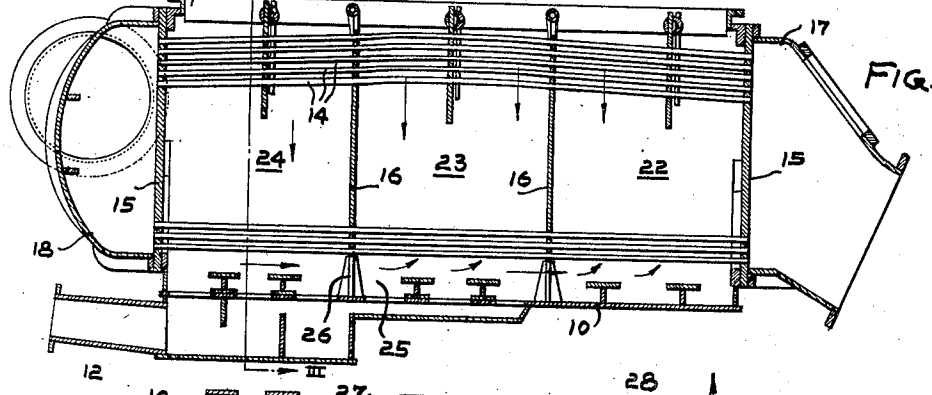


FIG. 2.

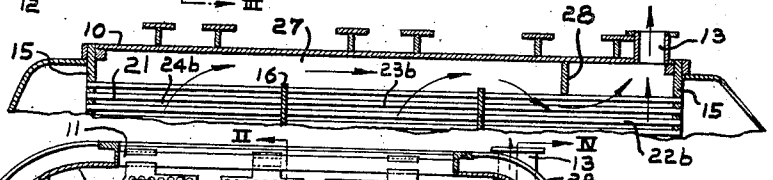


FIG. 4.

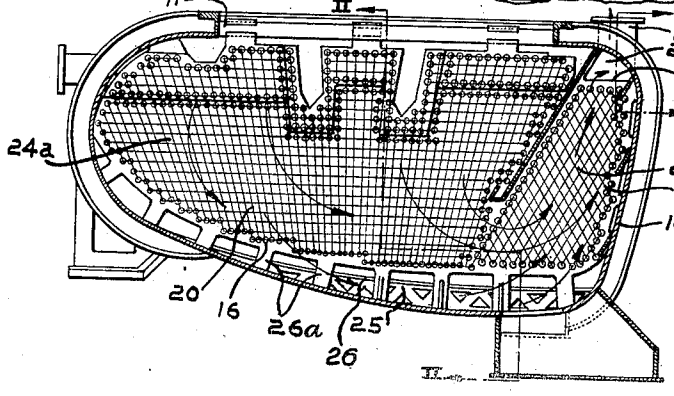


FIG. 3.

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CONDENSER

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2 Claims. (Cl. 257—43)

My invention relates to steam condensers and it has for an object to provide apparatus of this character which shall assure of good steam distribution with a relatively low pressure drop.

In marine power plants of the steam turbine type, the condenser is frequently located below the turbine to minimize the space required for an installation; however, with this arrangement, to preserve a desired turbine location, it is frequently necessary to employ a flat or shallow condenser and at the same time to have as short a connection as possible with the exhaust of the turbine. Due to high velocity of steam entering the condenser tube nest and to the shallowness of the latter, it is necessary to provide for distribution of steam to use the condensing surface effectively and to assure of any steam passing through the nest being condensed.

Accordingly, a further object of my invention is to provide for an arrangement of baffles which assure not only of good distribution of steam throughout the condenser but also of the condensation of any steam passing through the nest with effective devaporization and cooling of the air-vapor mixture before the latter leaves the air outlet.

These and other objects are effected by my invention, as will be apparent from the following description and claims taken in connection with the accompanying drawing, forming a part of this application, in which:

Fig. 1 is a plan view of my improved condenser;

Fig. 2 is a longitudinal sectional view taken on the line II—II of Fig. 3 of the condenser shown in Fig. 1;

Fig. 3 is a transverse sectional view taken along the line III—III of Fig. 2; and

Fig. 4 is a sectional view taken along the line IV—IV of Fig. 3.

Referring now to the drawing more in detail, the condenser shell 10 is provided with an inlet 11 for connection to the exhaust of a turbine, the inlet 11 extending substantially for the full length of the shell and being relatively wide to promote easy entrance and good distribution of steam. The condenser is provided with a condensate outlet 12 and an air outlet 13.

As shown, the shell 10 is relatively wide and shallow and it has therein a relatively wide and shallow nest of tubes 14 whose ends are attached to the tube plates 15. One or more intermediate tube supporting sheets 16 have the tubes passing therethrough. Inlet and outlet water boxes 17 and 18 are attached to opposite ends of the shell.

The tubes 14 of the nest are divided both longitudinally and transversely with provisions for flow so that, not only is the surface used effectively, but this is accomplished with very small pressure drop through the condenser. To this end, the tube nest is divided longitudinally by a baffle 19 into a condensing group 20 and an air cooling and de-vaporizing group 21 and it is divided transversely by the intermediate tube supporting sheets 16 into sections 22, 23, and 24 including condensing sub-sections 22*a*, 23*a*, and 24*a* and cooling and de-vaporizing subsections 22*b*, 23*b*, and 24*b*. Steam entering through the inlet 11 flows through the condensing sub-sections and then through air cooling and de-vaporizing sub-sections, the air-vapor mixture finally being withdrawn from the air outlet 13.

Since the baffle 19 terminates with the tube nest, such that a substantial portion of the nest is arranged below the lower edge thereof and the condensing and air cooling and de-vaporizing tube groups merge together at the bottom of the nest, steam or steam and air mixture may flow within the nest from the condensing group to the de-vaporizing and cooling group, this being particularly true of that portion of steam passing among tubes within the vicinity of the baffle. Also, steam or the mixture of steam and air may pass through the nest and enter the space 25 therebelow. The intermediate tube supporting sheets 16 have tongues 26*a* extending below the tubes for substantially the full width of the bottom of the condenser, such tongues providing support from the shell bottom for the plates and the burden of the tube and water weight sustained thereby. The tongues define copious openings 26 therebetween, and, as the openings are also arranged for the full width of the condenser bottom, the space 25 is free and open from side to side and from end to end of the condenser. Hence, steam or the mixture of steam and air entering the space 25 is free to pass therealong and therefrom not only to the cooling and de-vaporizing sub-sections but also possibly to some of the condensing sub-sections particularly at the regions where the tube groups merge together.

The apparatus described is particularly suitable for single-pass operation in which event, the section 22 is to be at the cold end and the section 24 at the warm end, the air outlet 13 being located at the cold end to assure of de-vaporization and cooling of air to the maximum extent. In a single-pass condenser, the temperature difference between the steam and the

condensing water diminishes from the cold to the warm end with the result that the capacity for condensation of steam per unit of surface diminishes from the cold to the warm end. Since the turbine is located relatively near the top of the nest and since the nest is relatively wide and shallow, not only may steam pass through one or more of the condensing sections due to the high velocity of entrance, but this result may be aided in the warmer sections because of the diminished condensing capacity thereof. Therefore, the particular arrangement of baffle 19 and intermediate tube supporting plates 16 having the openings 26 provide for parallel downflow of steam through the condensing sub-sections 22*a*, 23*a*, and 24*a*, for flow from the condensing sub-sections to the corresponding air cooling and de-vaporizing sub-sections merging therewith, and for flow from the common space 25 through the air cooling and de-vaporizing sub-sections 22*b*, 23*b*, and 24*b* to the space 27 arranged thereabove and extending from end-to-end of the condenser, a baffle 28 being arranged in the space 27 near to the cold end of the condenser and adjacent to the air outlet 13 to assure that the mixture of steam and air shall be forced to pass among the uppermost tubes before being withdrawn from the outlet 13.

Thus, it will be seen that, even though the nest is relatively shallow and steam enters at high velocity, the fact that steam may enter the space below the nest, is a matter of no moment for the reason that the steam or steam and air may shift and be distributed in the latter space and pass through the de-vaporizing and air cooling tube group as determined by the existing flow conditions therethrough and the air-vapor mixture finally leaving the condensing and de-vaporizing sub-sections to the common space 27 thereabove moves longitudinally of such space toward the cold end of the condenser, it being deflected by the baffle 28 to pass among the uppermost tubes before finally leaving through the air outlet 13. In other words, the arrangement of the tube nest and the shell, the baffle 19, and the intermediate tube support sheets with their openings assure of distribution of steam throughout the tube nest with effective use of all the surface thereof and with effective de-vaporization and cooling of the air-vapor mixture before the latter leaves the condenser, these results all being secured with relatively low pressure drop through the condenser.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. In a condenser, a relatively shallow and wide shell increasing in depth from one side to the other, having a steam admission opening in its top wall extending for substantially the full length and for the major portion of the width thereof, having a condensate outlet communicating with its lower portion, and having an air offtake communicating with its upper portion to one side of the admission opening at the deep side of the shell; a relatively shallow and wide nest of tubes in the shell increasing in depth from the shallow side of the shell to the deeper side thereof, spaced from the bottom wall of the latter to provide a steam distribution space extending for the length and width of the shell, and extending contiguously to the sides of the shell to separate the distribution space from the admission space above the nest; means for supporting the tubes of the nest including tube sheets connected to the shell ends and intermediate tube supporting plates; said tube sheets and supporting plates dividing the nest into vertical transverse sections; means for supporting said supporting plates from the shell and providing for the lower edges of such plates defining openings with respect to the bottom wall of the shell for substantially the full width of the latter to afford free and unrestricted flow in said distribution space from side to side and end to end of the condenser; and a baffle depending from the shell top wall between the air offtake and the adjacent side of the admission opening and dividing said transverse sections into down-flow portions underneath the admission opening and up-flow portions substantially to one side of said opening; said baffle terminating intermediately of the depth of the nest so that the flow areas of said down-flow and up-flow portions are joined at the bottom by a flow area within the nest, said baffle and the shell forming, with the uppermost tubes of the up-flow portions, an air and non-condensable gas discharge space in communication with said offtake, and said intermediate tube supporting sheets having their upper edges terminating adjacent to said uppermost tubes to afford continuity of said discharge space to provide for free and uninterrupted flow of media therealong.

2. In a single pass condenser, a relatively shallow and wide shell increasing in depth from one side to the other; inlet and discharge water boxes connected to opposite ends of the shell; said shell having a steam admission opening in its top wall extending for substantially the full length and for the major portion of the width thereof, having a condensate outlet communicating with its lower portion, and having an air offtake communicating with its upper portion to one side of the admission opening at the deep side of the shell and adjacent to the inlet water box; a relatively shallow and wide nest of tubes in the shell increasing in depth from the shallow side of the shell to the deeper side thereof, spaced from the bottom wall of the latter to provide a steam distribution space extending for the length and width of the shell, and extending contiguously to the sides of the shell to separate the distribution space from the admission space above the nest; means for supporting the tubes of the nest including tube sheets connected to the shell ends and intermediate tube supporting plates; said tube sheets and supporting plates dividing the nest into vertical transverse sections; means for supporting said supporting plates from the shell and providing for the lower edges of such plates defining openings with respect to the bottom wall of the shell for substantially the full width of the latter to afford free and unrestricted flow in said distribution space from side to side and end to end of the condenser; a baffle depending from the shell top wall between the air offtake and the adjacent side of the admission opening and dividing said transverse sections into down-flow portions underneath the admission opening and upflow portions substantially to one side of said opening; said baffle terminating intermediately of the depth of the nest so that the flow areas of said down-flow and up-flow portions are joined

at the bottom by a flow area within the nest, said baffle and the shell forming, with the uppermost tubes of the up-flow portions, an air and non-condensable gas discharge space in communication with said offtake, and said intermediate tube supporting sheets having their upper edges terminating adjacent to said uppermost tubes to afford continuity of said discharge space to provide for free and uninterrupted flow of media therealong; and a baffle in said discharge space at the side of the offtake remote from the inlet water box to cause air and non-condensable gases flowing therealong to flow among the tubes before issuing from the offtake.

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