

Feb. 16, 1932.

J. H. SMITH

1,845,541

CONDENSER

Original Filed June 7, 1930 3 Sheets-Sheet 1

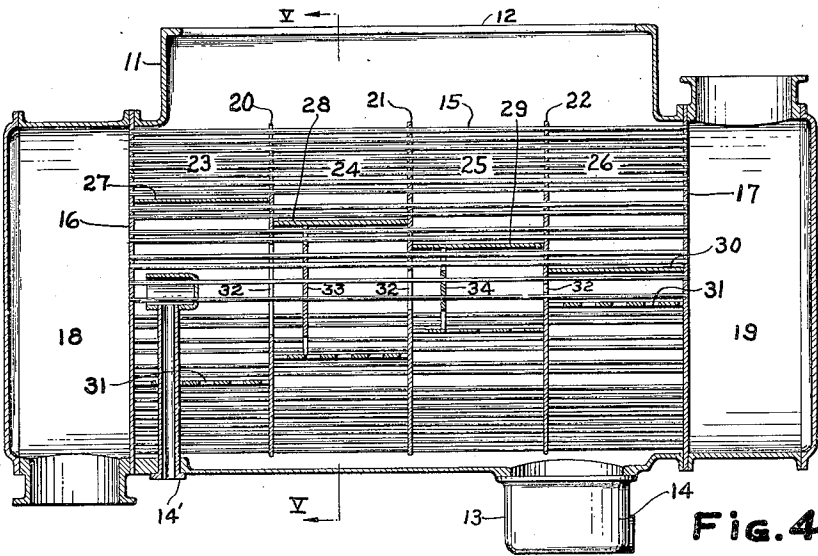


Fig. 4.

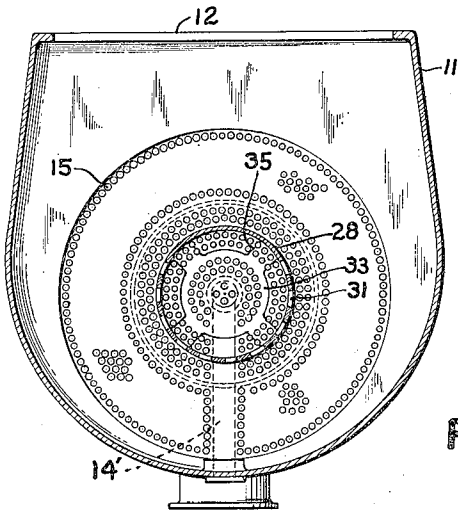


Fig. 5.

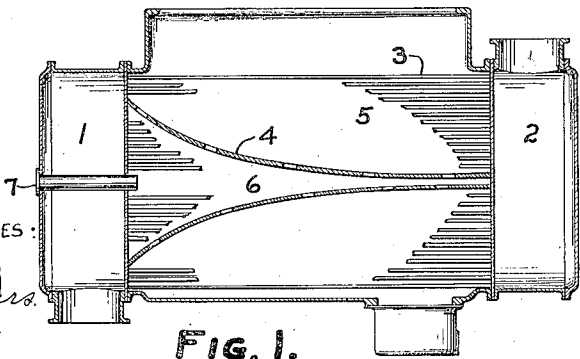


Fig. 1.

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CONDENSER

Original Filed June 7, 1930 3 Sheets-Sheet 2

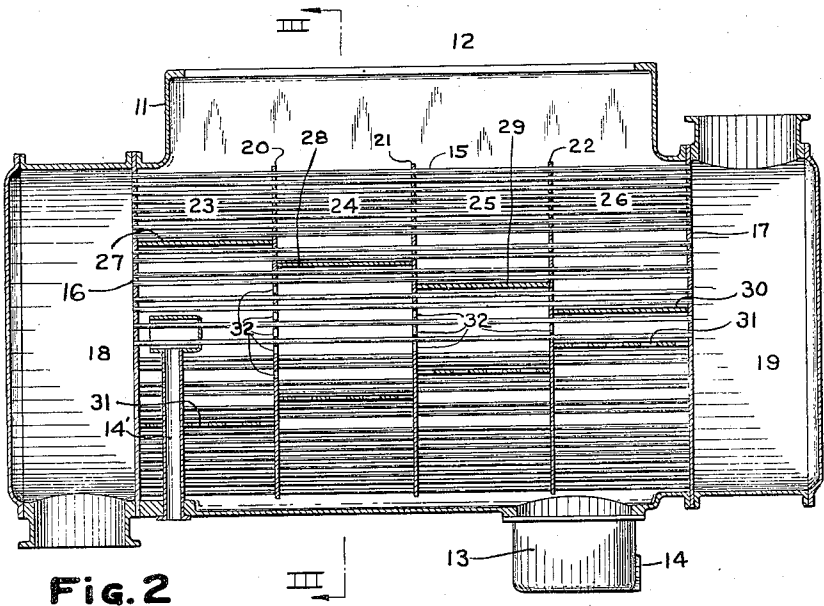


Fig. 2

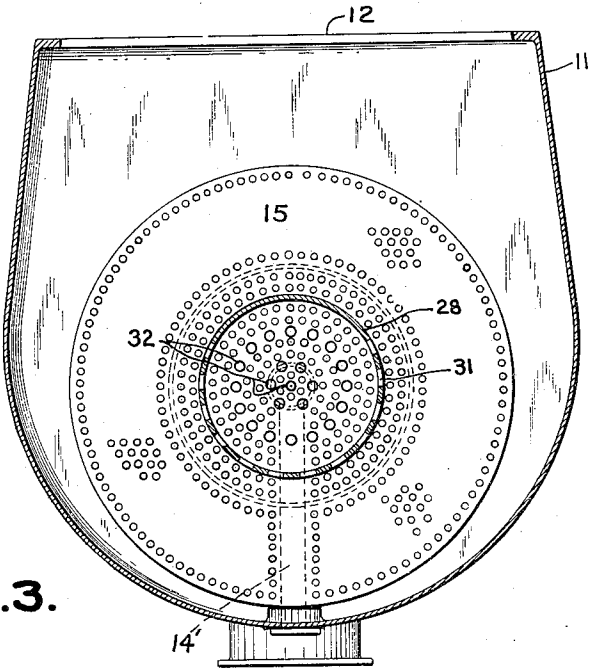


Fig. 3.

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CONDENSER

Original Filed June 7, 1930 3 Sheets-Sheet 3

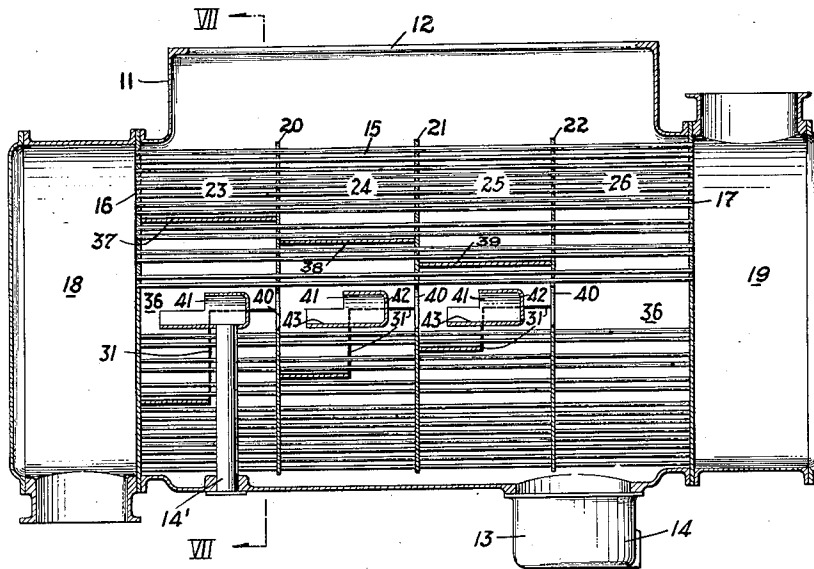


FIG. 6.

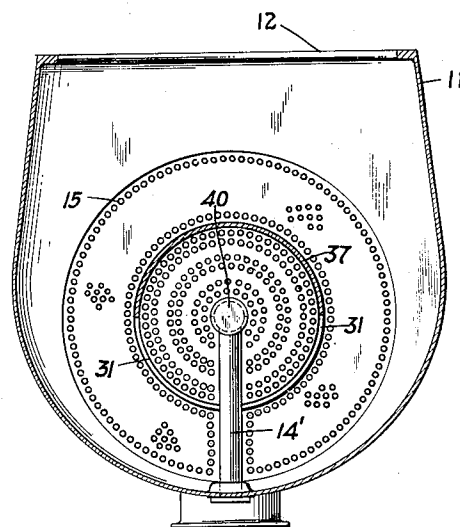


FIG. 7.

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CONDENSER

Application filed June 7, 1930, Serial No. 459,803. Renewed November 13, 1931.

My invention relates to apparatus for condensing gaseous media and particularly to apparatus of the surface type intended primarily for condensing steam, and it has for an object to provide apparatus of this character which shall be so constructed and arranged as to effectively utilize the entire cooling surface of the apparatus in order that it may operate at a high heat transfer rate.

In the operation of surface condensers, the cooling water assumes progressively-increasing temperatures as it flows through the tubes of the nest from the inlet to the discharge water box. In other words, the portion of the condenser adjacent to where cooling water enters may be termed the cold end while the portion adjacent to where the cooling water leaves the tube nest may be termed the relatively warm end. As a result of these differences in the temperature of the tube nest, different heat heads prevail within internal portions of the tube nest, the cold end of the tube nest having a relatively high heat head and the warm end a relatively low heat head. This condition is especially pronounced in condensers of the single-pass type.

As a result of the difference in heat heads at the two ends of the tube nest, more steam will naturally flow to the region of high heat head or the cold end of the condenser and less steam to the region of low heat head or the warm end of the condenser. Assuming, as in the prior art, that the depth of the tube nest is the same throughout the longitudinal length of the condenser, more resistance to flow or, in other words, more pressure drop across the tube nest, will occur at the cold end of the condenser than at the warm end because of the relatively greater amount of steam traversing the cold end than the warm end.

In order that the pressure drop of each particle of fluid traversing the tube nest may be substantially the same, I have conceived of the idea of so forming the tube nest as to embody, essentially, a portion through which the steam travels in a transverse direction and a portion through which the steam travels in a longitudinal or axial direction. In

addition, the air is removed from the cold end of the condenser, the point of air removal serving as the terminus of that portion of the tube nest through which the gaseous media flows in a longitudinal direction. Furthermore, in accordance with my invention, the transverse portion of the tube nest is relatively shallow at the cold end and increases in depth toward the warm end, whereby the other portion of the tube nest, that is, the longitudinal portion, has a transverse flow-area which increases progressively from the warm toward the cold end. As a consequence, steam entering the cold end of the tube nest travels transversely across a relatively shallow nest of tubes, where it is largely condensed, and the residuum of steam and the non-condensable media enter the longitudinal portion of the tube nest at a relatively short distance from the point of air removal, while steam entering the warm end of the tube nest flows transversely through a relatively deep bank of tubes, where it is largely condensed, and the residuum of steam and non-condensable media flowing therefrom enter the longitudinal portion of the tube nest at a point quite remote from the point of air removal. The steam at the cold end, therefore, has a relatively short transverse path of travel as well as a relatively short longitudinal path of travel while the steam at the warm end has a relatively long transverse path of travel as well as a relatively long longitudinal path of travel. Consequently, by means of my arrangement, a relatively large number of particles of steam traverse a relatively short distance from the cold end of the tube nest and a relatively small number of particles traverse a relatively long distance from the warm end of the tube nest with the result that, an equilibrium of pressures is established through the entire tube nest. Steam and non-condensable media entering the longitudinal portion of the nest are caused to circulate to-and-fro across the tubes thereof with the result that such steam is condensed and the non-condensable gaseous media are cooled to a maximum extent prior to removal.

It is, therefore, a more particular object of my invention to provide a condenser having a tube nest so arranged that, not only is the resistance or pressure drop between all points of entry of the tube nest and the point of final air removal substantially identical, but the entire surface of the tube nest is effectively utilized to condense steam, any steam left over and passing longitudinally from warmer or cooler compartments being condensed in the latter.

It has for a further object to provide a condenser of the surface type and of relatively large capacity which shall be provided with intermediate tube-supporting sheets so arranged as to permit an unrestricted circulation of the gaseous media within the condenser shell longitudinally of the tube nest as induced by the difference in heat heads obtaining between the cooling water inlet or cold portion of the condenser and the cooling water outlet or relatively warm portion of the condenser.

It has for still another object to provide a condenser of large capacity which shall be so arranged as to provide for the circulation of steam and non-condensable gaseous media longitudinally of the tube nest from the warm portion of the tube nest toward the cold portion thereof in order that proper distribution of the steam may be obtained and maximum cooling of the non-condensable gaseous media effected.

It has for still another object to provide a condenser of the foregoing character wherein the longitudinal movement of the steam and non-condensable gaseous media from the relatively warm portion of the condenser toward the relatively cold portion thereof shall assume a path or route so arranged as to insure ample transfer of heat to the tube nest in order that the longitudinally moving steam may be condensed and in order that the longitudinally moving non-condensable gaseous media may be cooled.

A further object of my invention is to provide a condenser having intermediate tube supporting plates defining sections together with means associated with the plates and defining a longitudinal portion of the condenser which increases in flow-area from the warm to the cold end of the condenser, the longitudinal portions of each section being in communication with one another and being open radially to permit of the entry of media from the surrounding portions of the tube nest, baffles preferably being disposed in one or more of the longitudinal portions of the sections in order to assure tortuous passage of steam and non-condensable gaseous media about tubes of the nest in flowing in the general longitudinal direction toward the air offtake.

These and other objects are effected by my invention, as will be apparent from the fol-

lowing description and claims taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a view, in sectional elevation, of a condenser showing an embodiment of my invention in a more or less theoretical form;

Fig. 2 is a view, in sectional elevation, of a condenser embodying my invention in a more practical form and wherein the longitudinal section is separated from the transverse section by a series of cylindrical baffles;

Fig. 3 is an enlarged, transverse sectional view taken on the lines III—III of Fig. 2;

Fig. 4 is a view, in sectional elevation, of another form of condenser embodying my invention and having a single opening instead of a plurality of openings in the intermediate tube sheets for providing communication through the longitudinal sections;

Fig. 5 is a transverse, sectional view taken on the line V—V of Fig. 4;

Fig. 6 is a view, in side elevation, of still another form of condenser in which the tube nest is provided with a central cavity for the passage of air; and,

Fig. 7 is a transverse, sectional view taken on the line VII—VII of Fig. 6.

My invention is applicable to various types of condensers and, in Fig. 1, I show a more or less theoretical form of condenser which is of the radial flow type and in which cooling water is admitted through an inlet 1 and discharged through an outlet 2, a tube nest being shown at 3. As stated heretofore, water in flowing through the tube nest from the inlet 1 to the outlet 2, increases progressively in temperature. I, therefore, divide the tube nest by some means, such as the partition 4, into a transverse condensing portion 5 and a longitudinal cooling portion 6 with openings at intervals over its surface to allow the air or gaseous media to enter the cooling space. The transverse portion, as shown in the drawings, increases progressively in depth from the cold end 1 of the tube nest to the warm end 2 while the longitudinal portion increases in flow area or diverges in a direction from the warm end 2 of the tube nest to the cold end 1. Removal of air from the condenser is diagrammatically indicated at 7.

Referring now to a more practical embodiment of my invention shown in Figs. 2 and 3, I show a radial flow type condenser having a shell 11 provided with an exhaust steam inlet 12 and a hotwell 13 having a condensate outlet 14 leading therefrom. A nest of tubes 15 is disposed within the shell and is supported at its ends by tube sheets 16 and 17 disposed at each end of the shell. Cooling water is admitted through an inlet water box 18 at one end of the condenser shell 11, referred to hereinafter as the cold end, passes through the tubes of the tube nest 15 and out

through an outlet water box 19 located at the other end of the shell, referred to hereinafter as the relatively warm end. An air or gaseous media offtake conduit 14' is provided to withdraw the air from the cold end of the tube nest.

In condensers of large capacity, it is necessary to provide for supporting the tubes at points intermediate their ends. The number of such intermediate supports may be varied as desired, but I show, by way of example, in this embodiment, intermediate tube sheets 20, 21 and 22 spaced longitudinally at such positions as to divide the tube nest 15 longitudinally into substantially equal sections 23, 24, 25 and 26; the section 23 adjacent to the inlet water box 18 being referred to as the relatively cold section and the section 26 adjacent to the outlet water box 19 as a relatively warm section.

To properly apportion the condensing and cooling tubes in each of the respective portions, as shown in Fig. 2, I provide cylindrical baffle elements, the diameters of which decrease progressively from the section at the cold end toward the section at the warm end of the condenser, that is, baffle 27 in section 23 is of such size as to include a relatively large number of tubes for the longitudinal cooling portion leaving a relatively small number of tubes in the transverse or outer annular portion. Baffle 28 in section 24, baffle 29 in section 25, and baffle 30 in section 26 are each successively of such proportions as to enclose a progressively decreasing number of tubes in the longitudinal portion and leave a progressively increasing number of tubes in the transverse portion of the tube nest.

To allow the non-condensable air or gaseous media and any vapor not condensed in the transverse portions of the respective sections to enter the longitudinal portion, a series of openings 31, as best shown in Fig. 3, are provided in the baffles 27, 28, 29 and 30. These openings are preferably spaced at intervals about the lower portions thereof and are omitted from the upper portions of the baffles in order to permit the latter to act as a hood for preventing condensate from "raining" down into the longitudinal compartment. To provide for circulation of the air or gaseous media through the longitudinal portion of the tube nest toward the offtake conduit 14' located at the cold end of the nest, I provide a plurality of communicating openings 32 in the intermediate tube sheets 20, 21 and 22. These openings 32 are located between the openings in the intermediate sheets which support the tubes 15.

It will, therefore, be apparent that, by utilizing a series of baffles in the stepped arrangement shown in Figs. 2 and 3, the tube nest is divided into a transverse portion and a longitudinally-extending portion closely

approximating, in form, the ideal arrangement illustrated in Fig. 1.

Referring now to Figs. 4 and 5, I show another form of condenser of the radial flow type embodying my invention which is similar to that shown in Figs. 2 and 3 except that the tube nest 15 is provided with intermediate tube sheets 20, 21 and 22 each having a single, relatively large opening 32 for establishing communication between the respective compartments of the longitudinal portion, such openings having an area increasing in proportion to the increase in flow-area of the adjoining compartments from the warm end toward the cold end of the condenser.

To support the tubes passing through the openings 32, I provide auxiliary tube sheets 33 and 34 longitudinally displaced from the intermediate tube sheets 20 and 21. The auxiliary tube sheets 33 and 34 are supported by radial extensions 35, shown in Fig. 5, reaching out to the interior surface of the baffles 28 and 29 respectively. The openings 32 in the intermediate tube sheets 20, 21 and 22 provide a longitudinal passageway through the compartments of the longitudinal portion and connect them with the gaseous media offtake conduit 14', permitting longitudinal circulation of the gaseous media entering the longitudinal portion through the respective compartments thereof to the offtake. The auxiliary sheets 33 and 34, in addition to supporting a portion of the tubes, effect a somewhat tortuous path of travel for the gaseous media as it approaches the offtake.

Referring now to Figs. 6 and 7, I show a form of condenser of the general arrangement of the forms already described, embodying my invention in its preferred form. I show, in this form, a tube nest arrangement having a longitudinally-extending core space or cavity 36 for the circulation of gaseous media through the longitudinal portion toward the offtake. I provide a baffle 37 of proportions similar to those of the foregoing embodiments for separating the transverse portion of the tube nest section 23 adjacent the cold end of the condenser from the longitudinal portion. The upper portion of this baffle extends between the tube sheets 16 and 20 while the under portion extends only part way, leaving a single opening 31 which provides a communicating passageway between the longitudinal portion and the transverse portion of that section of the tube nest. The upper portion of the baffle 37 comprises a continuous surface so that it may act to deflect any condensate which might otherwise fall into the longitudinal portion of the tube nest section.

Similar baffles 38 and 39, are provided in the tube nest sections 24 and 25, respectively, enclosing a progressively smaller number of the tubes in the longitudinal portion and leaving a progressively larger number of tubes

in the annular transverse portion. The arrangement of these baffles divides the tube nest into an outer portion of progressively increasing transverse area toward the warm end and a longitudinal portion of progressively increasing transverse area toward the cold end of the tube nest. The other characteristics of the baffles are substantially the same as in the other forms of baffles heretofore described.

Openings 40 are provided in each of the intermediate tube sheets as a part of the longitudinally-extending core space or passageway. Disposed within the core space in tube nest sections 23, 24 and 25, are baffles 41 which act to deflect the gaseous media circulating through the respective compartments, out over the cooling tubes located therein. These baffles 41 embody a head portion 42 directed toward the warm end of the condenser and a cylindrical skirt portion 43 extending longitudinally toward the cold end of the condenser. The lower section of the cylindrical skirt portion 43 of each of the deflecting baffles forms an extension which acts to deflect the gases entering through the communicating openings in the cylindrical baffles 37, 38 and 39 over the adjacent cooling tubes. A non-condensable gaseous media offtake conduit 14' is provided to withdraw the gases from the interior portion of the deflecting baffle located in section 23 of the tube nest, that is, the cold section.

Although I have described a tube nest arrangement which is particularly adaptable to condensers of the single-flow type, it will be apparent to those skilled in the art that it may be applied to condensers of the multi-flow type; and, although I have described my invention as applied to condensers of the radial flow type, it can, obviously, be applied to other types of condensers. Furthermore, while I have shown, in each of my embodiments, a condenser having a tube nest embodying a transverse portion increasing in depth in a direction toward the warm end of the condenser, and a longitudinal portion increasing in area from the warm end toward the cold end of the condenser, it will be apparent that the scope of my invention is such as to contemplate a condenser embodying either of these features alone.

While I have shown my invention in four forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other 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, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for con-

densate, a tube nest extending longitudinally through the shell structure, said tube nest embodying a portion for the transverse flow of the gaseous media and a communicating portion for the longitudinal flow of the gaseous media, water chambers associated with the tube nest for circulating cooling water therethrough, and means connecting with the longitudinal portion for removing non-condensable gaseous media from the shell structure, said longitudinal portion having a flow-area which increases in the direction of the removal means.

2. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell structure, said tube nest embodying a portion for the transverse flow of the gaseous media and a communicating portion for the longitudinal flow of the gaseous media, water chambers associated with the tube nest for circulating cooling water therethrough, baffle means disposed within the longitudinal portion for effecting a tortuous path of flow therethrough, and means communicating with the interior of the longitudinal portion for removing non-condensable gaseous media from the shell structure, said longitudinal portion having a flow area which increases in the direction of said removal means.

3. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell structure, said tube nest embodying a portion for the transverse flow of the gaseous media and a communicating portion for the longitudinal flow of the gaseous media, water chambers associated with the tube nest for circulating cooling water therethrough, and means communicating with said longitudinal portion for removing the non-condensable gaseous media from the shell structure, said longitudinal portion embodying a larger portion of the tube nest as it approaches said removal means.

4. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a plurality of longitudinally-extending tubes disposed in the shell structure and providing a transverse gaseous media condensing portion, a plurality of longitudinally-extending tubes disposed in the shell structure and providing a longitudinal condensing and cooling portion, water boxes provided at each end of the shell structure for supplying cooling water to all of the tubes, and means communicating with the longitudinal condensing and cooling portion for removing non-condensable gaseous media from the shell structure, the tubes in said

longitudinal condensing and cooling portion being arranged to provide an increasing amount of cooling area in the direction of said removal means.

5 5. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell structure and spaced therefrom so that a substantial portion of the outermost tubes of the nest define, with the shell structure, an arcuate steam delivery space in communication with said inlet, water boxes provided at each end of the shell structure for conveying cooling water for the tube nest, a longitudinally-extending gaseous media cooling portion embodied in the interior portion of the tube nest, and means communicating with the cooling portion of the tube nest for removing gaseous media from the shell structure, said cooling portion having a cooling area which increases in the direction of said removal means.

6. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest of uniform cross-section extending longitudinally through the shell structure, an inlet water box associated with one end of the tube nest and defining a cold end thereof, an outlet water box associated with the other end of the tube nest and defining a relatively warm end thereof, said water boxes providing for the circulation of cooling water in a single, longitudinal direction through the tube nest and said tube nest being divided into a transverse condensing portion and a longitudinally-extending condensing and cooling portion, said transverse portion having a cross-sectional area which increases progressively from the cold end toward the warm end of the tube nest and said longitudinal portion having a cross-sectional area which decreases progressively from the cold end toward the warm end of the tube nest, and means communicating with said longitudinal portion of the tube nest near the cold end thereof for removing non-condensable gaseous media from the shell structure.

7. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell structure, an inlet water box associated with one end of the tube nest and defining a cold end thereof, an outlet water box associated with the other end of the tube nest and defining a relatively warm end thereof, said water boxes providing for the circulation of cooling water in a single, longitudinal direction through the tube nest, a compartment formed in the tube nest and extending longitudinally through the same for affording longitudinal circulation of gas-

eous media, said compartment being provided with means for affording admission of the gaseous media at a plurality of points distributed longitudinally thereof and said compartment increasing progressively in flow area from the warm end toward the cold end of the tube nest, and means communicating with said longitudinally-extending compartment near the cold end of the tube nest for removing the non-condensable gaseous media from the shell structure.

8. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell structure, an inlet water box associated with one end of the tube nest and defining a cold end thereof and an outlet water box associated with the other end of the tube nest and defining a relatively warm end thereof, said water boxes providing for the circulation of cooling water in a single, longitudinal direction through the tube nest, means for dividing the tube nest into an outer transverse condensing portion and an inner longitudinally-extending condensing and cooling portion, said longitudinally-extending condensing and cooling portion increasing in flow area, progressively, step-by-step, in a direction toward the cold end of the tube nest, and means communicating with the interior of the longitudinally-extending condensing and cooling portion near the cold end thereof for removing the non-condensable gaseous media from the shell structure.

9. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell structure, an inlet water box associated with one end of the tube nest and defining a cold end thereof, an outlet water box associated with the other end of the tube nest and defining a relatively warm end thereof, said water boxes providing for the circulation of cooling water in a single, longitudinal direction through the tube nest and said tube nest being divided, transversely, into an outer, longitudinally-extending circumferential condensing portion and an inner, longitudinally-extending, condensing and cooling portion, said outer condensing portion having a progressively increasing depth from the cold end toward the warm end of the tube nest, and means communicating with the inner condensing and cooling portion of the tube nest near the cold end thereof for removing non-condensable gaseous media from the shell structure.

10. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell structure, an inlet water box associated with one end of the tube nest

- and defining a cold end thereof and an outlet water box associated with the other end of the tube nest and defining a relatively warm end thereof, said water boxes providing for the circulation of cooling water in a single, longitudinal direction through the tube nest and said tube nest being divided into a longitudinally-extending, outer circumferential condensing portion and a longitudinally-extending, inner condensing and cooling portion, said outer condensing portion having a depth increasing progressively, step-by-step, from the cold end toward the warm end of the tube nest, and means communicating with the inner condensing and cooling portion of the tube nest near the cold end thereof for removing non-condensable gaseous media from the shell structure. 70
11. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell structure, an inlet water box associated with one end of the tube nest and defining a cold end thereof, an outlet water box associated with the other end of the tube nest and defining a relatively warm end thereof, said water boxes providing for the circulation of cooling water in a single, longitudinal direction through the tube nest and said tube nest being divided, transversely, into a longitudinally-extending condensing portion arranged for transverse flow of gaseous media therethrough and a longitudinally-extending condensing and cooling portion arranged for longitudinal flow of gaseous media therethrough, said condensing portion having a progressively-increasing depth from the cold end toward the warm end of the tube nest and said condensing and cooling portion having a progressively-decreasing depth from the cold end toward the warm end of the tube nest, and means communicating with said condensing and cooling portion of the tube nest near the cold end thereof for removing the non-condensable gaseous media from the shell structure. 75
12. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest of uniform cross-section extending longitudinally through the shell structure, an inlet water box associated with one end of the tube nest and defining a cold end thereof and an outlet water box associated with the other end of the tube nest and defining a relatively warm end thereof, said water boxes providing for the circulation of cooling water in a single, longitudinal direction through the tube nest and said tube nest embodying two complementary portions, one for the transverse flow of gaseous media therethrough and one for the longitudinal flow of gaseous media therethrough, said transverse portion having a cross-sectional area which increases progressively from the cold end toward the warm end of the tube nest and said longitudinal portion having a cross-sectional area which decreases progressively from the cold end toward the warm end of the tube nest, and means communicating with said longitudinal portion of the tube nest near the cold end thereof for removing non-condensable gaseous media from the shell structure. 80
13. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell structure and spaced therefrom so that a substantial portion of the outermost tubes of the nest define, with the shell structure, an arcuate steam delivery space in connection with said inlet, an inlet water box associated with one end of the tube nest and defining a cold end thereof, an outlet water box associated with the other end of the tube nest and defining a relatively warm end thereof, said water boxes providing for the circulation of cooling water in a single, longitudinal direction through the tube nest, and said tube nest being divided into complementary, longitudinally-extending flow sections arranged, respectively, for transverse and longitudinal flow of gaseous media therethrough, the longitudinal flow section occupying an interior portion of the tube nest and the transverse flow section occupying a circumferential portion of the tube nest, and said transverse flow section progressively increasing in depth from the cold end toward the warm end of the tube nest, and means communicating with the longitudinal flow portion of the tube nest near the cold end thereof for removing the non-condensable gaseous media from the shell structure. 85
14. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell structure and spaced therefrom so that a substantial portion of the outermost tubes of the nest define, with the shell structure, an arcuate steam delivery space in connection with said inlet, an inlet water box associated with one end of the tube nest and defining a cold end thereof, an outlet water box associated with the other end of the tube nest and defining a relatively warm end thereof, said water boxes providing for the circulation of cooling water in a single, longitudinal direction through the tube nest, means formed in an interior portion of the tube nest and extending longitudinally therethrough for affording longitudinal flow of gaseous media in a direction toward the cold end of the tube nest, said longitudinally extending means increasing progressively in flow-area from the warm end toward the cold end of 90
- 95
- 100
- 105
- 110
- 115
- 120
- 125
- 130

the tube nest, and an offtake conduit communicating with said longitudinally extending means near the cold end of the tube nest for removing the non-condensable gaseous media from the shell structure.

15. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell structure, an inlet water box disposed at one end of the tube nest for supplying cooling water thereto, an outlet water box disposed at the other end of the tube nest for receiving cooling water therefrom, tube sheets located at each end and intermediate of the ends of the tube nest and dividing the latter, longitudinally, into a series of sections, means embodied in a plurality of the sections for dividing the tube nest into a plurality of portions for transverse flow and a plurality of portions for longitudinal flow, said longitudinal flow portions having transverse areas which increase, progressively, in a direction toward the inlet water box and said transverse flow portions having transverse areas which increase, progressively, in a direction toward the outlet water box, means embodied in the intermediate tube-supporting sheets for affording communication between adjacent sections of the longitudinal flow portion of the tube nest, and means for withdrawing air from the longitudinal flow portion of the tube nest section adjacent to the inlet water box.

16. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell structure and embodying a longitudinally-extending core space, an inlet water box disposed at one end of the tube nest for supplying cooling water thereto, an outlet water box disposed at the other end of the tube nest for receiving cooling water therefrom, tube sheets located at each end and intermediate of the ends of the tube nest and dividing the latter, longitudinally, into a series of sections, baffles disposed about the core spaces in a plurality of the sections and embracing portions of the tube nest so as to form internal air cooling chambers, said baffles being disposed in stepped relation so as to provide air cooling chambers of progressively-increasing transverse area in the direction of the inlet water box, means embodied in the intermediate tube-supporting sheets for affording communication between the core spaces of adjacent sections, baffles disposed in the core spaces of the respective sections for directing gaseous media from the core spaces to the portions of the tube nest embodied in the air cooling chambers, and means communicating with the core space of the section adjacent the inlet water box for removing air from the condenser.

17. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell structure, an inlet water box associated with one end of the tube nest and an outlet water box associated with the other end of the tube nest, said water boxes providing for circulation of cooling water in a single, longitudinal direction through the tube nest, tube sheets located at the ends and intermediate of the ends of the tube nest and dividing the latter, longitudinally, into a series of sections, the temperatures of the respective tube nest sections increasing progressively in a direction from the inlet water box toward the discharge water box, said intermediate tube sheets being provided with openings for affording circulation of the gaseous media between adjacent sections, compartments of uniform cross sectional area formed separately in each section of the tube nest concentric with the openings in the intermediate tube sheets for condensing and cooling the gaseous media, and means for removing uncondensed gaseous media from the coldest tube nest section.

In testimony whereof, I have hereunto subscribed my name this 4th day of June, 1930.

JOHN H. SMITH.