Feb. 16, 1932. J. H. SMITH 1,845,540

CONDENSER

Filed March 27, 1930 2 Sheets-Sheet 1

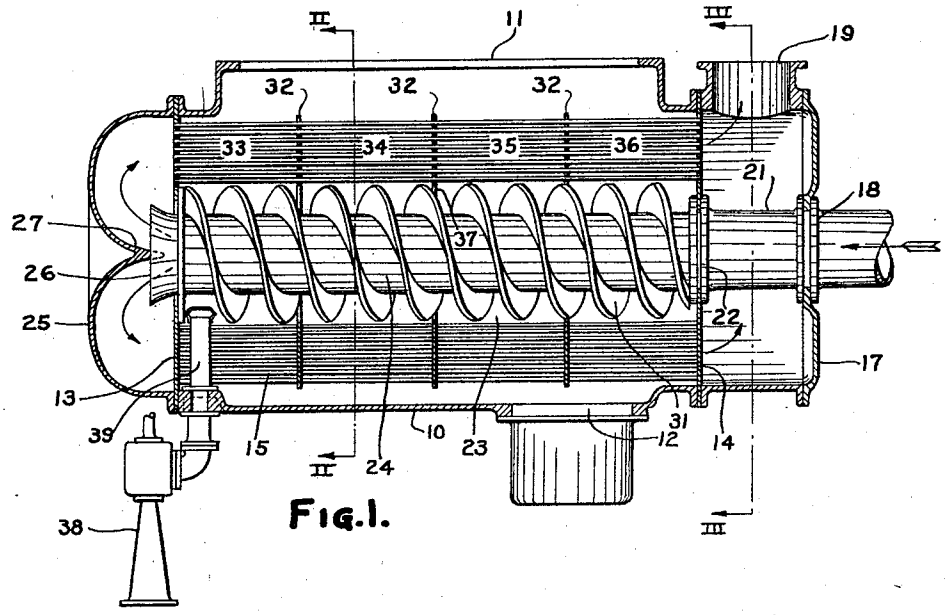


FIG. 1.

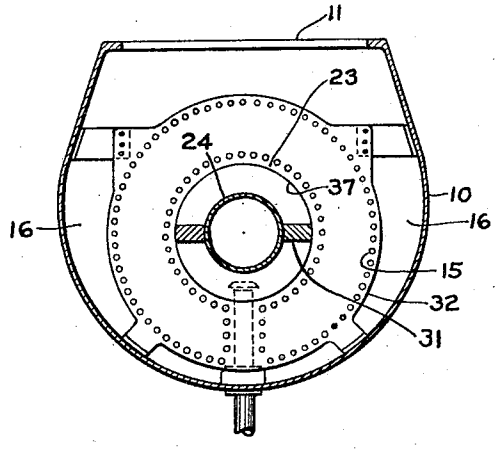


FIG. 2.

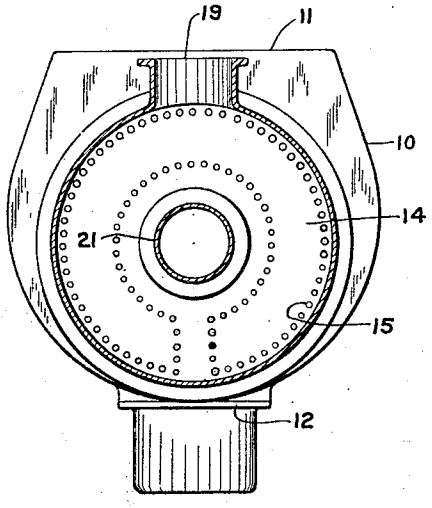


FIG. 3.

WITNESS
C. Lutz.

INVENTOR
J.H.Smith

BY A. B. Rhuvis
ATTORNEY

Feb. 16, 1932. J. H. SMITH 1,845,540

CONDENSER

Filed March 27, 1930 2 Sheets-Sheet 2

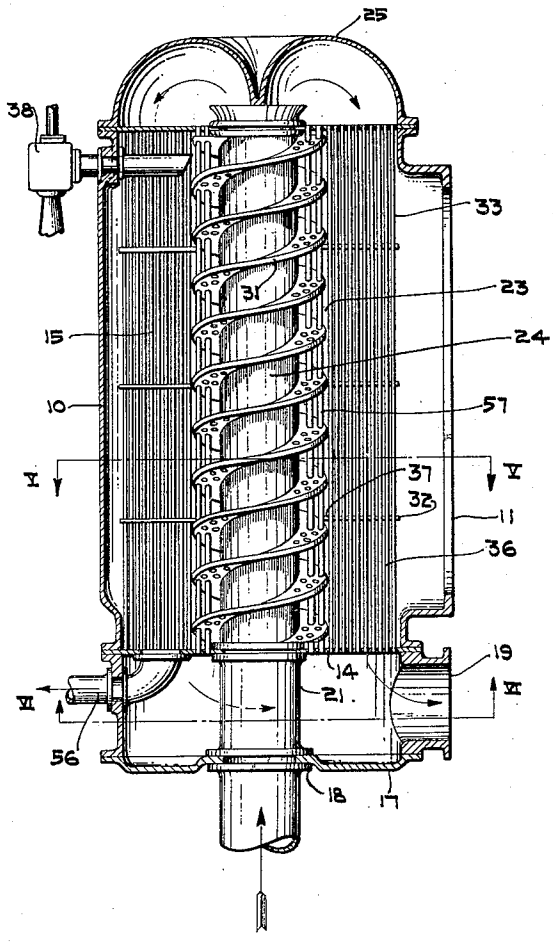


FIG. 4.

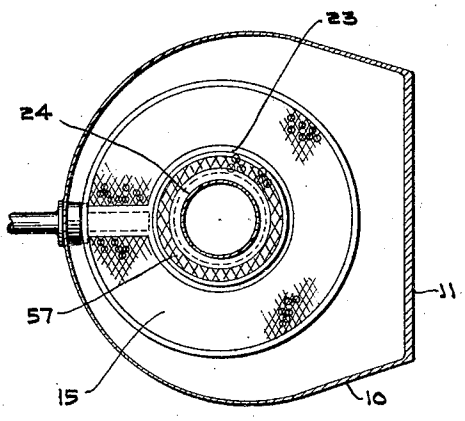


FIG. 5.

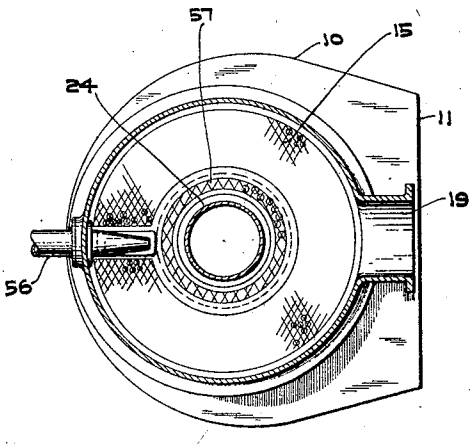


FIG. 6.

WITNESS
E. Lutz

INVENTOR
J. H. Smith.

BY A. B. Rivers
ATTORNEY

Patented Feb. 16, 1932 1,845,540

UNITED STATES PATENT OFFICE

JOHN H. SMITH, OF LANSDOWNE, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

CONDENSER

Application filed March 27, 1930. Serial No. 439,388.

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 the character designated 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 very high heat transfer rate.

In numerous power plant installations, the intake and discharge tunnels for supplying cooling water to and receiving cooling water from the condenser are located at a common end of the condenser. This location of the tunnels relative to the condenser affords a very good arrangement where condensers having an even number of passes for the cooling water such as, for example, two passes, are employed inasmuch as the cooling water inlet and outlet connections on the condenser may be located at the end of the latter which is adjacent to the tunnels. By means of such an arrangement, relatively short connecting pipes between the tunnels and the condenser are required.

However, frequently, it is desired to install condensers having an odd number of passes for the cooling water such as, for example, single-pass condensers, in existing power plants having their intake and discharge tunnels located as heretofore described and, inasmuch as the conventional form of single-pass condenser has its circulating water inlet and outlet connections located at opposite ends thereof, it becomes necessary to extend a pipe longitudinally past the condenser in order that one of the tunnels may be connected to that circulating water connection of the condenser which is disposed at the end of the condenser removed from the tunnels. When it is taken into consideration that pipes of this character may be of the order of 60″ in diameter, it can be appreciated that it is highly desirable that the length of such pipe be reduced as much as possible.

It has heretofore been proposed, as disclosed and claimed in United States Patent No. 1,748,676, issued February 25, 1930 for condenser and assigned to the Westinghouse Electric & Manufacturing Company, to locate, in a single-pass condenser, both the inlet and outlet circulating water connections in a common water box, which common water box may be disposed adjacent to the water tunnels. In such a condenser, there is provided, interiorly of the condenser shell structure, a longitudinally-extending pipe or trunk conduit for connecting one of the circulating water connections to the end of the tube nest removed from the water tunnels. With such a form of condenser, the pipes connecting both the intake and discharge tunnels to the condenser may be made as short as though a two-pass condenser were installed and the extension of relatively large pipes about the exterior of the condenser is entirely avoided. Preferably, the trunk conduit within the condenser shell is so located that at least a portion of the tube nest intervenes between it and the main exhaust steam inlet of the condenser.

More particularly, therefore, my invention has for an object to provide a condenser of the foregoing character, which shall be so constructed and arranged as to utilize, to the fullest extent possible, the heat-absorbing capacity afforded by the relatively large circulating water trunk conduit extending through the condenser shell.

Still more particularly, my invention has for an object to provide a condenser of the foregoing character which shall be so arranged as to provide for the circulation of steam and non-condensable gaseous media longitudinally within the condenser shell in a direction from the outlet or warm end of the tube nest toward the inlet or cold end of the tube nest and, furthermore, to effect such longitudinal circulation in the vicinity of the relatively large circulating water trunk conduit extending longitudinally through the shell structure. In this way, the natural tendency for the gaseous media in the condenser shell structure to flow from the region of relatively low heat head to the region of relatively high heat head, is not interfered with and consequently better distribution of the steam to the tube nest is afforded.

My invention 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 end toward the relatively cold end of the tube nest shall assume a path or route so arranged as to insure as much transfer of heat as possible to the circulating water trunk conduit extending through the shell structure in order that the longitudinally-moving steam may be condensed and in order that the longitudinally-moving non-condensable gaseous media may be cooled.

My invention has for still another object to provide a condenser of the foregoing character which shall utilize the coldest portion of the tube nest as well as the circulating water trunk conduit extending through the shell structure for cooling the non-condensable gaseous media prior to the removal of the same from the shell structure.

My invention has for still another object to provide a condenser of the foregoing character which shall be of the radial flow type in that the steam enters the tube nest from the greater portion of its periphery and the air and non-condensable gaseous media are withdrawn from an interior or central portion of the tube nest and, furthermore, to provide a condenser which shall be of the coreless type in that the tube nest shall embody a longitudinally-extending cavity for the longitudinal circulation of gaseous media within the shell structure, the circulating water trunk conduit provided in the condenser shell preferably being located within this cavity.

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 drawings, forming a part of this application, in which:

Fig. 1 is a view, in longitudinal sectional elevation, of one form of condenser arranged in accordance with my invention and intended for installation in a horizontal position;

Fig. 2 is a transverse, sectional view through the shell structure, and is taken on the line II—II of Fig. 1;

Fig. 3 is a transverse sectional view through the water box and is taken on the line III—III of Fig. 1;

Fig. 4 is a view, in longitudinal sectional elevation, of another embodiment of my invention which is similar to that shown in Fig. 1 with the exception that cooling tubes are associated with the relatively large circulating water conduit extending through the shell structure for augmenting the cooling action of the same and, furthermore, as will be apparent from the drawings, the condenser is intended for installation in a vertical position;

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

Fig. 6 is a transverse, sectional view through the water box and is taken on the line VI—VI of Fig. 4.

Referring now to Figs. 1 to 3, of the drawings, I show a condenser having a shell structure 10 provided with an inlet 11 for steam to be condensed and an outlet 12 for condensate. Secured to one end of the shell structure 10 is a tube sheet 13 and to the other end a tube sheet 14. Extending longitudinally between the tube sheets 13 and 14 is a tube nest 15, which tube nest may have its outer perimeter so formed, as to define, with the interior of the shell structure 10, an intervening steam delivery space 16 surrounding a substantial portion of the tube nest and freely communicating with the inlet 11.

Secured to the end tube sheet 14 is a water box 17 provided with a cooling water inlet connection 18 and a cooling water outlet connection 19, the inlet connection 18 being provided with a conduit 21 extending longitudinally of the water box and joining the tube sheet 14, as at 22.

The tube nest 15 is provided with a longitudinally-extending core space or cavity 23, which core space is preferably of substantial cross-sectional area. Disposed in the core space 23 is a trunk conduit 24 for conveying cooling water admitted through the inlet 18 and conduit 21 directly to a water box 25 located at the other end of the condenser. In the present embodiment, the tube nest is of the single-pass type, that is, the cooling water circulates through the tube nest in a single, longitudinal direction. Hence, the trunk conduit 24 is so formed that its flow-area is several times larger than any of the individual tubes of the nest in order that it may convey adequate cooling water for all of the tubes of the nest. Such an arrangement is very desirable in that it provides a type of condenser having an odd number of passes wherein both the inlet and outlet cooling water connections are located at a common end of the condenser. As pointed out heretofore, such a form of condenser is especially applicable to numerous power plants and is particularly applicable to power plants wherein the condensers are installed in a vertical position and the intake and discharge tunnels are necessarily located below one end of the condenser. In this connection, it is noted that, while in the present embodiment, I show a single trunk conduit 24 for conveying water to all of the tubes of the nest, it will be obvious that it is within the purview of my invention to utilize more than one trunk conduit of this character in which case the number of such trunk conduits would be only a small percentage of the number of condensing tubes and, consequently, the flow-area of

each of such trunk conduits would be equivalent to the total flow-area of a group of condensing tubes.

Preferably, the conduit trunk 24 extends through the centrally-disposed core space inasmuch as this affords the most desirable arrangement in a condenser of the type illustrated, that is, the radial flow type. In a condenser of this character, an internally-disposed core space can be provided without materially increasing the outer dimension of the tube nest due to the fact that the number of tubes omitted from the core space may be distributed about the periphery of the nest with little increase in the diameter of the latter. It also has the additional advantage of providing a relatively thin, annular band of tubes surrounded, on the outside, by the steam to be condensed and forming, on the inside, a housing for the trunk conduit 24 as well as a passageway for the longitudinal circulation of steam and air. It will be understood, however, that it is within the purview of my invention to provide such a form of core space or cavity as will not be entirely surrounded by the tube nest, my invention, contemplating, in its broader aspects, a longitudinally-extending, passageway somewhere in the shell structure for the longitudinal circulation of gaseous media and a trunk conduit, such as 24, extending through said passageway from the water box 17 to the water box 25.

The trunk conduit 24 has a bell-mouthed portion 26 projecting into the water box 25 and the latter has a cuspidated bounding wall 27 having its apex arranged substantially coaxial with the conduit 24. The bell-mouthed portion 26 of the conduit 24, therefore, cooperates with the cuspidated bounding wall 27 to form a smoothly-curved annular passageway through which the water may pass from the trunk conduit 24 to the water box 25 with a minimum amount of turbulence and without eddy or shock losses. Of more importance is the fact that this arrangement avoids erosion of the tube end portions projecting into the water box 25. The water, preferably, first circulates through the trunk conduit 24 and is thence distributed to the tube nest. Such an arrangement maintains the trunk conduit at a relatively low temperature. However, in some cases, the order of circulation may be reversed.

The trunk conduit 24 is preferably provided with lateral or radial projections for augmenting the cooling surface thereof and for directing the passage of the gaseous media longitudinally through the shell structure in a somewhat tortuous path. In the present embodiment, I show a radially-projecting plate 31 which is wound spirally about the trunk conduit 24 and thus forms a helical passageway leading in a direction from the water box 17 toward the water box 25. For supporting the tube nest intermediate of the end tube sheets 13 and 14, suitable intermediate tube-supporting sheet or sheets 32 are provided. As shown in Fig. 2, the outer perimeter of each intermediate tube-supporting sheet is similar and adjacent to that of the tube nest in order that the surrounding steam delivery space 16 may communicate freely and uninterruptedly with the entire tube nest.

The intermediate tube-supporting sheets 32 divide the condenser, longitudinally, into a series of sections, 33, 34, 35 and 36 of progressively increasing temperatures, the section 33 adjacent the end of the tube nest where the cooling water enters being a relatively cold section and the section 36 located at the end of the tube nest from which the cooling water is discharged being a relatively warm section. In order to accommodate the trunk conduit 24 and in order that they may not interfere with the free longitudinal flow of the gaseous media through the core space 23, the intermediate tube-supporting sheets 32 are provided with substantial openings 37, which openings are preferably arranged in alignment with the core space.

For removing air and non-condensable gaseous media from the shell structure, some means such as, for example, an ejector 38 is provided, which ejector connects through a conduit 39, with the interior of the shell structure. Preferably, the ejector 38 is so arranged that it withdraws the air and non-condensable gaseous media from the core space 23, which space is adjacent to the trunk conduit 24, and from the cold end of the tube nest, that is, the section 33 or that end through which the cooling water enters the tube nest.

From the foregoing description, the operation of my invention will be apparent. Steam to be condensed enters the shell structure 10 through the inlet 11 and surrounds the tube nest in the steam delivery space 16. The steam is drawn radially inward in each of the sections from the perimeter of the tube nest toward the core space 23 and, in its passage across the tube nest, a considerable portion of the steam is condensed and falls to the bottom of the shell structure from whence it drains to the hotwell or outlet 12.

Cooling water enters through the inlet 18 and passes by way of the conduits 21 and 24 to the water box 25 in which it is distributed to the tubes of the nest. The water then flows, longitudinally, through the tube nest in a single direction back to the water box 17 from which it is discharged through the outlet 19. Owing to the very large flow-area of the trunk conduit 24, the water assumes only a slight increase in temperature in passing therethrough and hence there is very little difference in temperature between the inlet end of

the conduit 24 and its outlet end. However, when this water enters the numerous tubes of the tube nest, it is divided into many relatively small streams and, hence, it absorbs heat quite rapidly. As a result, the temperature of the cooling tube nest section 33 is substantially lower than that of the tube nest section 36 and the tube nest sections 33 to 36, inclusive, therefore assume progressively increasing temperatures in the direction of the flow of cooling water through the tube nest.

The tube nest section 33, being a relatively colder section than the tube nest section 36, a higher heat head prevails in the vicinity of the section 33 than in the section 36 and hence, there is a natural tendency for the uncondensed steam and air entering the core space 23 to flow in a longitudinal direction toward the tube sheet 13. This tendency is further induced by the withdrawal action of the ejector 38 and, in order to utilize the relatively large cooling surface of the trunk conduit 24 as much as possible, the helical plate 31 is provided so that the uncondensed steam and air entering the core space 23 assume a helical path of travel toward the tube sheet 13. In this way, the steam component of the longitudinally moving gaseous media is condensed while the air and other non-condensable gaseous media are withdrawn by the ejector from the coldest end of the tube nest and, hence, its temperature is reduced as much as possible.

As the capacity of the section 33 for condensing steam is greater than the section 36, any excess steam supplied to the relatively warm sections 36, 35, etc., enters the core space 23 and, in circulating longitudinally therethrough, is condensed by the effective cooling action of the trunk conduit 24 and its spiral plate 31. In this way, not only is the entire tube nest of the condenser utilized to both condense steam and to cool the air, but the trunk conduit is utilized to augment the heat-absorbing action of the tube nest besides joining the water connection to a common end of a single-pass condenser.

Referring now to Figs. 4 to 6, I show a form of condenser which is similar to that shown in Figs. 1 to 3. However, in this latter embodiment, I show the condenser in a vertical position inasmuch as condensers arranged in accordance with my invention are particularly adapted for installations of this character. Like the previous embodiment, the tube nest sections increase progressively in temperature in the direction from the water box 17 toward the water box 25, the section 33 being the coldest section and the section 36 the warmest section. The ejector 38 therefore preferably withdraws the air and non-condensable gaseous media from the section 33. Inasmuch as this condenser is of the vertical type, condensate is removed through an outlet 56 extending through the water box 17 and the tube sheet 14.

In order to provide cooling facilities in the core space 23 in addition to that afforded by the trunk conduit 24, I provide a plurality of additional cooling tubes 57, which additional cooling tubes are spaced about the conduit 24 and extend through and are carried by the spiral plate 31 provided on the conduit. Like the previous embodiment, the intermediate tube-supporting sheets 32 are provided with openings 37 which afford free longitudinal circulation of gaseous media through the core space and about the trunk conduit and the additional cooling tubes 57. Preferably, as shown in Fig. 5, the cooling tubes 57 are disposed in less closely spaced relation than the tubes of the tube nest 15.

It will be apparent that this latter embodiment of my invention operates in a manner similar to the previously described embodiment, the additional cooling tubes 57 augmenting the action of the trunk conduit in condensing the steam and cooling the air entering the core space 23 from the tube nest sections. It will be further apparent that both embodiments of my invention provide condensers wherein gaseous media entering the warmer sections is permitted to flow through the colder sections. In other words, the natural tendency for the gaseous media to flow to the region of relatively high heat head is not interfered with and hence the coldest sections of the tube nest are fully utilized. Furthermore, by arranging the trunk conduit in the manner disclosed, the capacity of the condenser, as a whole, is materially increased. In addition, the gaseous media traveling through the core space may be subjected to the relatively low temperature of the vast body of water circulating through the trunk conduit and, as it is finally removed through the coldest section of the tube nest, removal of air and non-condensable gaseous media at a minimum temperature is assured. It is submitted that a condenser so arranged provides a condenser having an odd number of passes, having both its water connections located at a common end and having a maximum condensing capacity consistent with the space occupied.

While I have shown my invention in two 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 the admission of gaseous media to be condensed and an outlet for condensate, a tube nest ex-

tending longitudinally through the shell structure, cooling water inlet and outlet connections located at one end of the tube nest, a trunk conduit extending longitudinally through the shell structure and connecting one of said cooling water connections to the remote end of the tube nest, said trunk conduit having a flow-area several times larger than the individual tubes of the nest in order to convey adequate cooling water for several tubes of the nest, and means for circulating non-condensable gaseous media over the exterior surface of the trunk conduit prior to the removal of the same from the condenser.

2. In a condenser, the combination of a shell structure having an inlet for the admission of gaseous media to be condensed and an outlet for condensate, a nest of tubes extending longitudinally through the shell structure, said nest of tubes embodying a longitudinally-extending cavity, cooling water inlet and outlet connections located at one end of the tube nest, a trunk conduit extending longitudinally through the cavity of the tube nest and connecting one of the cooling water connections with the far end of the tube nest, said trunk conduit having a flow-area several times larger than the individual tubes of the nest in order to convey adequate cooling water for several tubes of the nest, and means for circulating air longitudinally through the cavity of the tube nest and over the exterior surface of the trunk conduit prior to the removal of the same from the condenser.

3. In a condenser, the combination of a shell structure having an inlet for the admission of gaseous media to be condensed and an outlet for condensate, a nest of tubes extending longitudinally through the shell structure and spaced from the side walls thereof so as to form an intervening steam delivery space surrounding a substantial portion of the tube nest, said tube nest embodying an internal, longitudinally-extending core space, cooling water inlet and outlet connections located at one end of the tube nest, a trunk conduit extending longitudinally through the core space of the tube nest and connecting one of the cooling water connections with the distant end of the tube nest, said trunk conduit having a flow-area several times larger than the individual tubes of the nest in order to convey adequate cooling water for several tubes of the nest, and means for circulating non-condensable gaseous media longitudinally through the portion of the core space unoccupied by said trunk conduit and for removing the non-condensable gaseous media at the cooling water entrant end of the tube nest.

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 tube nest extending longitudinally through the shell structure, cooling water inlet and outlet connections located at a common end of he tube nest, a conduit extending longitudinally through the shell structure and connecting one of said cooling water connections to the remote end of the tube nest, said conduit having a flow-area several times larger than the individual tubes of the nest in order to convey adequate cooling water for several tubes of the nest, passageway means disposed in the shell structure for affording longitudinal circulation of gaseous media over the exterior surface of said conduit, and means for withdrawing non-condensable gaseous media from said passageway.

5. In a condenser, the combination of a tube nest, a trunk conduit for supplying water for passage through the tubes of the nest, the tubes of the nest and the trunk conduit wall being constructed and arranged to provide a gaseous media space, means provided on the conduit wall to increase the heat-conductive area in contact with gaseous media, and means for withdrawing gaseous media from said space.

6. In a condenser, the combination of a tube nest, a trunk conduit having its outlet end communicating with one end of the nest, the tubes of the nest and the trunk conduit wall defining a gaseous media space, means projecting from the conduit wall and in heat-conductive relation with respect to the latter to provide for increased area in contact with gaseous media, and air withdrawal means communicating with said gaseous media space adjacent to the entrant end of said nest.

7. In a condenser, the combination of a tube nest, a trunk conduit for supplying water for passage through the tubes of the nest, the tubes and the trunk conduit wall defining a gaseous media space, means providing for the tortuous passage of gaseous media adjacent to said conduit wall, and means for withdrawing gaseous media from said space.

8. In a condenser, the combination of a tube nest, a trunk conduit for supplying water for passage through the tubes of the nest, the tubes and the trunk conduit wall defining a gaseous media space, heat-conductive means connected to said conduit wall and providing for tortuous passage of gaseous media adjacent to said conduit wall, and air withdrawal means communicating with said gaseous media space adjacent to the entrant end of said nest.

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, cooling water inlet and outlet connections located at a common end of the tube nest, a conduit extending longitudinally through the shell structure and connecting one of said cooling water connec-

tions to the remote end of the tube nest, said conduit having a flow-area several times larger than the individual tubes of the nest in order to convey adequate cooling water for several tubes of the nest, passageway means embodied in the shell structure for affording longitudinal circulation of gaseous media exteriorly of said conduit and in a direction from the cooling water exit end of the tube nest toward the cooling water entrant end of the tube nest, and means for withdrawing non-condensable gaseous media from said passageway means and near the cooling water entrant end of the tube nest.

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, transversely-extending tube sheets located at each end and intermediate of the ends of the tube nest for supporting the latter, cooling water inlet and outlet connections disposed adjacent to one of the end tube sheets, a trunk conduit extending longitudinally through the shell structure and connecting one of said cooling water connections with the far end of the tube nest, passageway means embodied in said intermediate tube-supporting sheets for affording longitudinal circulation of gaseous media in the vicinity of said trunk conduit and in a direction from the cooling water exit end of the tube nest toward the cooling water entrant end of the tube nest, and means for withdrawing non-condensable gaseous media from the cooling water entrant end of the tube nest.

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, said tube nest embodying a longitudinally-extending cavity, tube sheets located at each end and intermediate the ends of the tube nest for supporting the latter, said intermediate tube-supporting sheets being provided with openings aligned with the cavity of the tube nest, cooling water inlet and outlet connections both located adjacent to one of the end tube sheets, a trunk conduit extending longitudinally through the cavity and through said openings in the intermediate tube-supporting sheets and connecting one of said cooling water connections with the far end of the tube nest, and means for withdrawing non-condensable gaseous media from the cavity near the cooling water entrant end of the tube nest, said cavity and said openings in the intermediate tube-supporting sheets being relatively larger than the trunk conduit in order to provide a passage for the longitudinal circulation of gaseous media through the shell structure in a direction from the cooling water exit end of the tube nest toward the cooling water entrant end of the tube nest.

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 extending longitudinally through the shell structure and spaced from the side walls thereof in order to form an intervening steam delivery space surrounding a substantial portion of the outer periphery of the tube nest, said tube nest embodying an internal, longitudinally-extending core space, tube sheets located at each end and intermediate the ends of the tube nest for supporting the latter, said intermediate tube-supporting sheet or sheets being provided with an opening or openings registering with the core space of the tube nest, cooling water inlet and outlet connections both located adjacent to one of the end tube sheets, a trunk conduit extending longitudinally through the core space and through said openings in the intermediate tube-supporting sheets and connecting one of said cooling water connections with the far end of the tube nest, and means for withdrawing non-condensable gaseous media from the core space and at the cooling water entrant end of the tube nest, said core space and said openings in the intermediate tube-supporting sheets being relatively larger than the trunk conduit in order to provide an annular passage surrounding the trunk conduit for affording longitudinal circulation of gaseous media through the shell structure.

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, cooling water inlet and outlet connections located at a common end of the tube nest, a trunk conduit extending longitudinally through the shell structure and connecting one of said cooling water connections to the remote end of the tube nest, said trunk conduit having a flow-area several times larger than the individual tubes of the nest in order to convey adequate cooling water for several of the tubes of the nest, passageway means disposed in the shell structure for affording longitudinal circulation of gaseous media in contact with said trunk conduit, projections provided on said trunk conduit for augmenting the cooling surface thereof, and means for withdrawing non-condensable gaseous media from said passageway.

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, cooling water inlet and outlet connections located at a common end of the tube nest, a trunk conduit extending longitudinally through the shell structure and connecting one of said

cooling water connections to the remote end of the tube nest, said trunk conduit having a flow-area several times larger than the individual tubes of the nest in order to convey adequate cooling water for several of the tubes of the nest, passageway means disposed in the shell structure for affording longitudinal circulation of gaseous media exteriorly of said trunk conduit, means associated with the exterior of said trunk conduit for directing the passage of gaseous media in a tortuous direction thereabout, and means for withdrawing non-condensable gaseous media from said passageway.

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, cooling water inlet and outlet connections located at a common end of the tube nest, a conduit extending longitudinally through the shell structure and connecting one of said cooling water connections to the remote end of the tube nest, said conduit having a flow-area several times larger than the individual tubes of the nest in order to convey adequate cooling water for several of the tubes of the nest, passageway means disposed within the shell structure for affording longitudinal circulation of gaseous media exteriorly of said conduit, projections provided on said conduit for directing the gaseous media around said conduit and in a direction from the cooling water exit end of the tube nest toward the cooling water entrant end of the tube nest, and means for withdrawing non-condensable gaseous media from said passageway near the cooling water entrant end of the tube nest.

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, cooling water inlet and outlet connections located at a common end of the tube nest, a conduit extending longitudinally through the shell structure and connecting one of said cooling water connections to the remote end of the tube nest, said conduit having a flow-area several times larger than the individual tubes of the nest in order to convey adequate cooling water for several of the tubes of the nest, passageway means disposed in the shell structure for affording longitudinal circulation of gaseous media exteriorly of said conduit, a baffle wound about the exterior of said conduit and forming a helical passageway for the circulation of gaseous media in a direction from the cooling water exit end of the tube nest toward the cooling water entrant end of the tube nest, and means for withdrawing non-condensable gaseous media from near the cooling water entrant end of the tube nest.

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, cooling water inlet and outlet connections located at a common end of the tube nest, a trunk conduit extending longitudinally through the shell structure and connecting one of said cooling water connections to the remote end of the tube nest, said trunk conduit having a flow-area several times larger than the individual tubes of the nest in order to convey adequate cooling water for several of the tubes of the nest, passageway means disposed in the shell structure for affording longitudinal circulation of gaseous media exteriorly of said trunk conduit, radial projections provided on said trunk conduit, additional longitudinally-extending cooling tubes spaced about said trunk conduit and communicating at one of their ends with an end of said trunk conduit for the circulation of cooling water, said additional cooling tubes extending through the radial projections, and means for withdrawing air from the vicinity of the cooling tubes spaced about said trunk conduit.

18. 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, cooling water inlet and outlet connections located at a common end of the tube nest, a trunk conduit extending longitudinally through the shell structure and connecting one of said cooling water connections to the remote end of the tube nest, said trunk conduit having a flow-area several times larger than the individual tubes of the nest in order to convey adequate cooling water for several of the tubes of the nest, passageway means disposed in the shell structure for affording longitudinal circulation of gaseous media exteriorly of said trunk conduit, additional longitudinally-extending cooling tubes spaced about said trunk conduit and communicating at one of their ends with one end of said trunk conduit for the circulation of cooling water, said additional cooling tubes being disposed in less closely spaced relation than the tubes of the nest.

19. 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, cooling water inlet and outlet connections located at a common end of the tube nest, a trunk conduit extending longitudinally through the shell structure and disposed adjacent to the tube nest for conveying cooling water from one of said cooling water connections to the remote end of the tube nest, said tube nest and trunk conduit defining an intervening passageway for the longitudinal circulation of gaseous media from the cooling water exit end

of the tube nest to the cooling water entrant end of the tube nest, and means communicating with said passageway means at the cooling water entrant end of the tube nest for removing gaseous media from the shell structure.

In testimony whereof, I have hereunto subscribed my name, this 21st day of March, 1930.

JOHN H. SMITH.