

Feb. 16, 1932.

F. A. MEYER

1,845,549

CONDENSER

Filed June 26, 1931

2 Sheets-Sheet 1

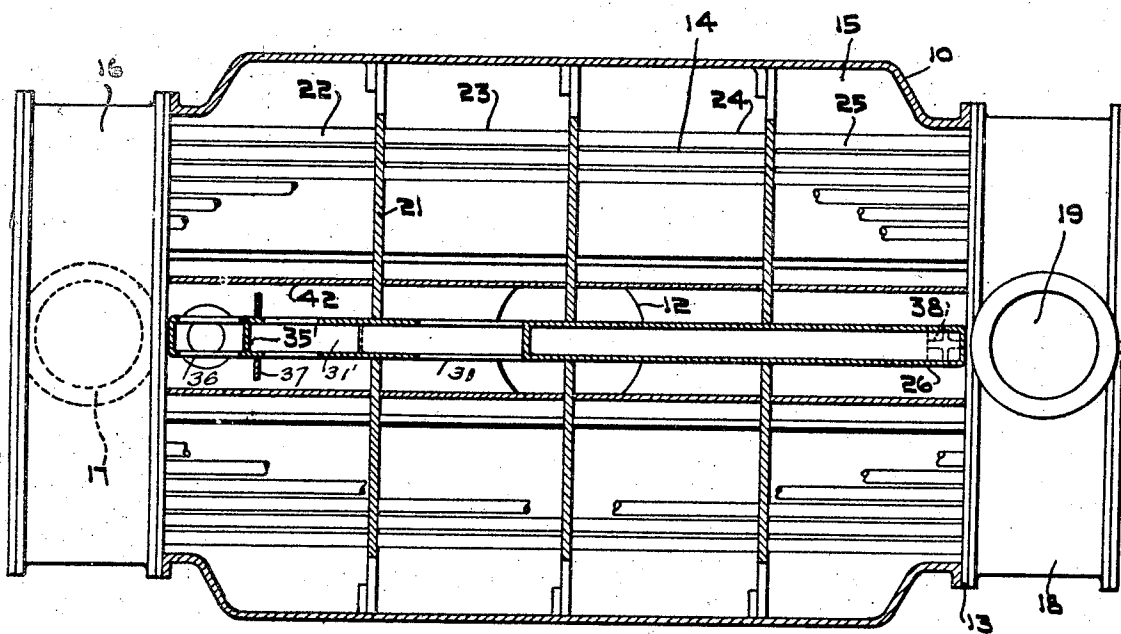


FIG. 1.

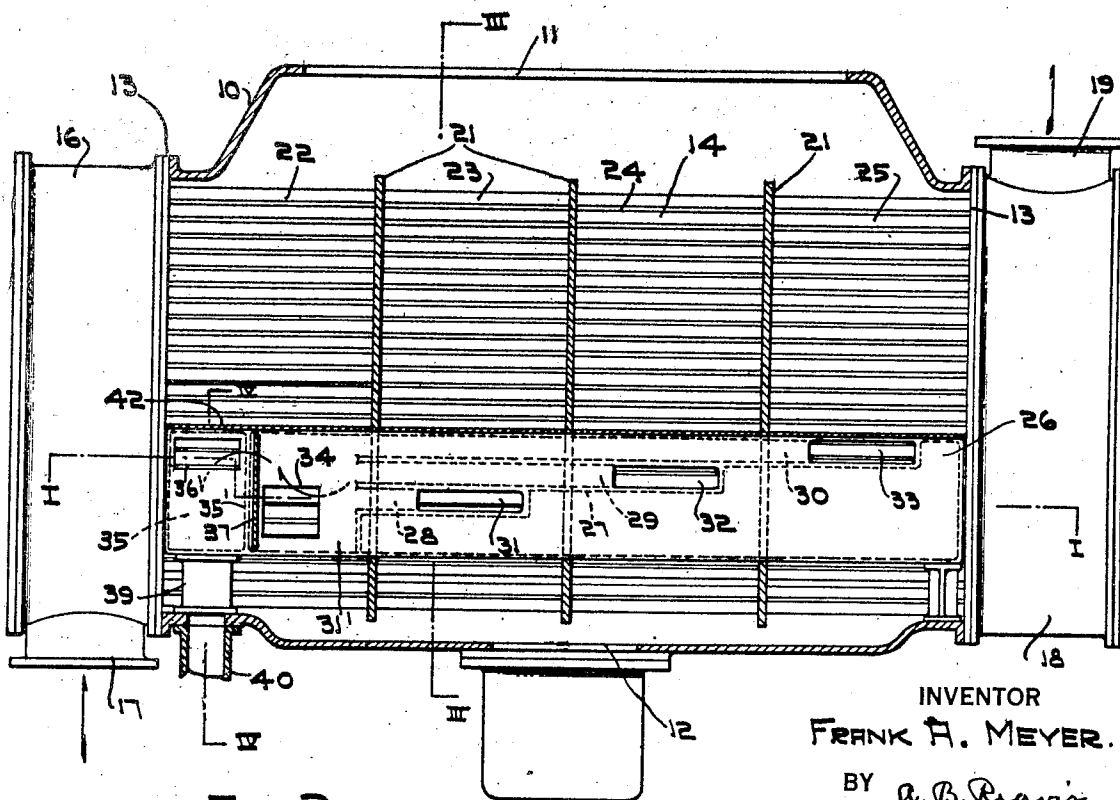


FIG. 2.

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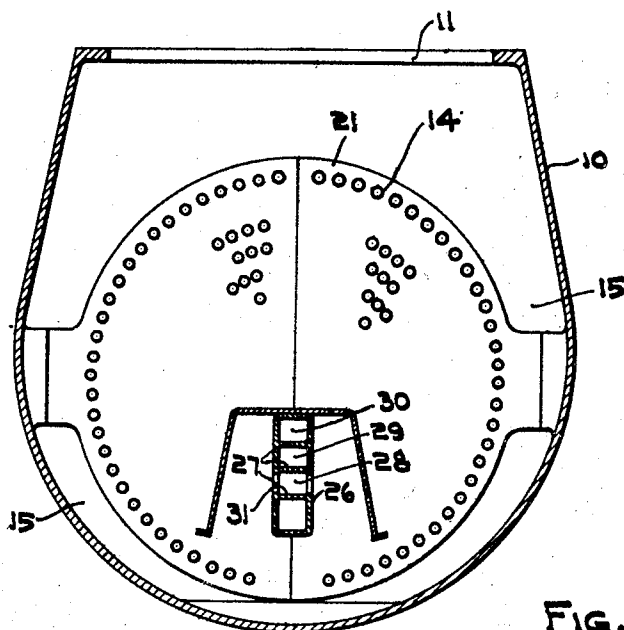
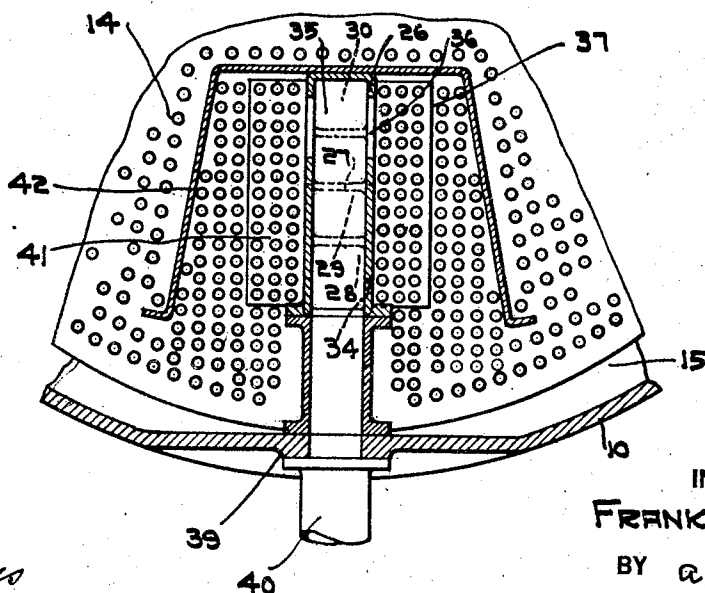


FIG. 3.

FIG. 4.



WITNESSES:

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CONDENSER

Application filed June 26, 1931. Serial No. 547,105.

My invention relates to apparatus for condensing gaseous media and particularly to condensers of the surface type, intended primarily for condensing exhaust steam, and it has for an object to provide apparatus of this character which shall be so constructed and arranged as to effectively condense the steam without cooling of the condensate, and which will properly reduce the temperature of the non-condensable gases before they reach the intake of the air withdrawing mechanism.

It has been common practice on larger condensers of this character to provide a tube nest having intermediate tube supporting sheets which divide the tube nest into a plurality of sections, longitudinally spaced in the shell. It has also been proposed to provide a passage in the tube nest for conducting gaseous media from the warmer sections of the tube nest to the coldest section, that is, the section adjacent to the tube nest cooling water inlet, and to finally remove the air and the saturated vapor contained therein from the coldest section of the tube nest. This assures removal of the air at a relatively low temperature.

Usually, such condensers are provided with an air box structure which extends longitudinally of the condenser, the air removal apparatus connecting with the air box structure at the cold or cooling water entrant end of the tube nest. In such condensers, once the non-condensable gases reach the interior of the air box, no further cooling action of any material extent is effected inasmuch as the gases in the air box pass directly through to the air withdrawal apparatus.

In accordance with the present invention, I so arrange the air box structure that, in the coldest portion of the tube nest, that is, the portion where the cooling water enters, the gases are discharged out of the air box into the tube nest wherein they are subjected to further cooling action after which they are returned to the air box and are finally removed from the condenser.

It is, therefore, an object of my invention to provide, in condensers wherein the air is removed at one end of the tube nest, an improved air box structure which shall be so

constructed and arranged that the coldest portion of the tube nest is effectively utilized to reduce these gases to minimum temperature before their final removal from the condenser.

Furthermore, in the condensers heretofore constructed, the gaseous media from the warmer portion of the tube nest, during its longitudinal passage to the coldest portion, commingles with the gaseous media from the intermediate or slightly cooler portion adjacent to the first-mentioned warmer portion while these commingled gases communicate, in turn, with the gaseous media from the next cooler portion, etc. This condition results in impairing the natural tendency for the gaseous media to flow from the warmer portions or regions of relatively low heat heads, to the coldest portion, or region of relatively high heat head. In other words, the longitudinal draft through the condenser is impaired.

My invention has, therefore, a still further object to provide, for condenser of the foregoing character, a form of conduit or gas box structure extending longitudinally of the condenser for conveying the gaseous media from the respective warmer portions of the tube nest to the coldest portion, which conduit shall be so constructed and arranged that the gases passing from the respective portions do not commingle with each other.

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 plan view in section, taken along line I—I of Fig. 2;

Fig. 2 is a view in sectional elevation 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 fragmentary view, in section, taken along line IV—IV of Fig. 2.

Referring now to 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 the discharge of condensed media. Secured to each end of

the shell structure 10 is a tube sheet 13 and, extending longitudinally through the shell structure between the tube sheets 13, is a nest of cooling tubes 14. Preferably, the tube nest 14 is so formed in relation to the inner contour of the shell structure 10, as to define an intervening steam delivery space 15 entirely surrounding, or surrounding the greater portion of, the tube nest 14.

Secured to one of the tube sheets 13 is an inlet water box 16 provided with an inlet connection 17 while, secured to the other tube sheet 13, is an outlet water box 18 provided with a circulating water outlet 19. In the present embodiment, the condenser is of the single-pass type and hence the water boxes 16 and 18 are so constructed and arranged that the cooling water passes longitudinally through the tubes of the nest 14 in a single direction. Such a condenser is generally referred to as a condenser of the single-pass type. However, it is to be understood that my invention is equally applicable to condensers of other than the single-pass type.

As stated heretofore, in condensers of the larger capacities, it is essential that some means be provided for supporting the tubes of the nest at points located intermediate of the end tube sheets 13 and, hence, in the present embodiment, I show a plurality of longitudinally-spaced tube-supporting sheets 21 extending transversely of the shell structure and having an outer contour generally similar to the outer contour of the tube nest 14. Preferably, the intermediate tube-supporting sheets 21 have their peripheral edges spaced from the side walls of the shell structure or from both the bottom wall as well as the side walls of the shell structure in order that the entire longitudinal length of the tube nest may freely communicate, through the intervening steam delivery space 15, with the steam inlet 11.

The intermediate tube-supporting sheets 21 may be said to divide the tube nest into a plurality of sections 22, 23, 24, and 25, the section 22 adjacent the inlet water box being referred to as a relatively cold section and the section 25 adjacent the outlet water box 18 as a relatively warm section. Disposed within the tube nest 14 and extending through the intermediate tube-supporting sheets for substantially the entire length of the shell is a box structure 26 having partition walls 27 defining passageways 28, 29 and 30 which terminate at one end in a common chamber 31'. The passageways 28, 29, and 30 communicate, respectively at their other ends with the sections 23, 24, and 25 through longitudinally-spaced openings 31, 32, and 33 in the side walls of the box structure 26. The chamber 31' is located in the portion of the box structure 26 that is within the relatively cold section 22 and has openings 34 communicating with this section. The box structure

further includes a compartment 35 adjacent the cold end of the tube nest, which compartment is formed by a transversely-extending partition wall 35'. The compartment 35 is provided with inlets 36 for the admission of gaseous media from the cold section 22. A shroud or rain plate 42 is supported upon the box structure 26, the shroud 42 embracing a group of tubes 41 which act primarily to cool the air and condense some of the saturated vapor therein.

From the foregoing description, the operation of my condenser 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 15. Steam is drawn inwardly in each of the sections 22 to 25, inclusive, from the perimeter of the tube nest 14 in the direction of the shroud 42. The tube nest 14 has the heat exchange capacity necessary to condense the steam; the condensate thus created falling to the bottom of the shell structure 10 and being discharged through the condensate outlet 12. Gaseous media which has not been condensed passes beneath the shroud 42 and flows upwardly through the group 41 of the tube nest toward the respective inlet openings 31 to 33. During the passage across the group 41 of the tube nest, some of the vapor in the gaseous media is condensed while the non-condensable gases are cooled.

The gases in sections 23, 24, and 25, after entering the openings 31, 32, and 33, pass through the box structure 26 to the relatively cold section 22. During this longitudinal circulation, the gases from the respective sections 23, 24 and 25 are isolated in the passages 28, 29, and 30, there being no commingling of these gases during this circulation. In this way, the temperature differences existing between the coldest section 22 and the respective sections 24 and 25 are utilized to the fullest extent to facilitate longitudinal circulation.

Within the chamber 31' of the box structure, the gases from the respective sections commingle and, because of the partition 35', are discharged outwardly through the openings 34 back into the tube nest. The laterally-extending baffles 37 serve to compel the gases to travel outwardly from the box structure a sufficient distance to assure intimate contact with that portion of the tube nest in the coldest section which is located beneath the rain plate 42. In this way, more of the saturated vapor circulating with the air is condensed while the temperature of the air is further reduced. The gases are returned to the box structure through the inlet openings 36 after which they are finally removed from the condenser through the outlet 40.

By means of the foregoing arrangement, the difference in heat heads prevailing between the cold and warm ends of the tube

nest is utilized to the fullest extent to facilitate longitudinal circulation of the gases to the coldest section of the tube nest. In addition, the condenser is so arranged that the
 5 gases are brought into intimate contact with the coldest portion of the tube nest, so that, before being finally removed from the condenser, the vapor content and the temperature of the air are reduced to the smallest
 10 figure consistent with the temperature of the circulating water.

Although in the present embodiment, I show a type of radial flow condenser wherein the steam delivery space 15 surrounds the entire periphery of the tube nest, nevertheless, it is to be understood that I may construct radial flow condensers in accordance with my invention wherein the steam delivery space does not extend entirely or completely
 20 around the tube nest. Furthermore, it will be obvious that my invention, in its broader aspects, is not confined to condensers of the radial flow type, but that it may be applied to various other types of condensers. In addition, while I have shown a condenser of the
 25 single-pass type, the broad inventive ideas which I have suggested may also be applied to condensers of the multi-pass type.

While I have shown my invention in but
 30 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
 35 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
 40 shell having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell, an inlet for cooling water disposed at one end of the tube nest, tube sheets disposed intermediate of the ends of the tube
 45 nest and dividing the latter, longitudinally, into a series of sections, a closed gas conduit structure extending substantially throughout the length of the shell, said gas conduit structure having longitudinally spaced inlet openings located in the respective sections of the tube nest except the section where the cooling water enters the latter and said gas conduit structure having an additional inlet and outlet opening disposed in the section of the
 50 tube nest where the cooling water enters, a partition extending transversely of the gas conduit structure between said last-mentioned inlet and outlet openings for deflecting gaseous media from the sections of the tube nest, other than the section where the cooling water enters, outwardly into the tube nest, and means communicating with the inlet opening in the section adjacent to where
 55 cooling water enters for finally removing

non-condensable gaseous media from the condenser.

2. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, an inlet water box disposed at one end of the shell structure, an outlet water box disposed at the other end of the shell structure, a single-pass tube nest extending between the water boxes and exposed throughout its entire length to the gaseous media admitted through said inlet, a plurality of tube sheets disposed intermediate of the ends of the tube nest and dividing the latter, longitudinally, into a series of sections of progressively increasing temperatures from the inlet water box toward the outlet water box, means for removing non-condensable gaseous media from the coldest section of the tube nest, and independent passageways for conveying gaseous media from the respective warmer sections of the tube nest to the warmest end of the coldest section of the tube nest.

3. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, an inlet water box disposed at one end of the shell structure, an outlet water box disposed at the other end of the shell structure, a single-pass tube nest extending between the water boxes and exposed throughout its entire length to the gaseous media admitted through said inlet, a plurality of tube sheets disposed intermediate of the ends of the tube nest and dividing the latter, longitudinally, into a series of sections of progressively increasing temperatures from the inlet water box toward the outlet water box, means for removing non-condensable gaseous media from the coldest end of the coldest section of the tube nest, independent passageways for conveying gaseous media from the respective warmer sections of the tube nest to the warmest end of the coldest section of the tube nest, and a wall structure interposed between the discharge ends of said passageways and said removal means for deflecting gaseous media from the passageways over a portion of the tube nest in the coldest section.

4. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and an outlet for condensate, an inlet water box disposed at one end of the shell structure, an outlet water box disposed at the other end of the shell structure, a single pass tube nest extending throughout in its entire length to the gaseous media admitted through said inlet, said tube nest being spaced from the side walls of the shell structure so as to form an intervening gaseous media delivery space surrounding a substantial portion of the tube nest, a plurality of tube sheets disposed intermediate

of the ends of the tube nest and dividing the latter, longitudinally, into a series of sections of progressively increasing temperatures from the inlet water box toward the outlet water box, means for removing air from the coldest end of the coldest section of the tube nest, and independent passageways disposed interiorly of the tube nest for conveying gaseous media from the respective warmer sections of the tube nest to the warmest end of the coldest section of the tube nest.

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 exposed throughout its entire length to gaseous media admitted through said inlet, an inlet for cooling water disposed at one end of the tube nest, tube sheets disposed intermediate of the ends of said tube nest and dividing the latter, longitudinally, into a series of sections, independent passageways for conveying to the section of the tube nest adjacent the cooling water inlet, gaseous media from the remaining, respective sections, said passageways discharging into said first-mentioned section remote from the cooling water inlet, means adjacent to the cooling water inlet for withdrawing air from said first-mentioned section, and means interposed between said air withdrawal means and the discharge ends of said passageways for deflecting gaseous media from the passageways over a portion of the tube nest section adjacent to the cooling water inlet.

6. In a condenser, the combination of a shell structure having an inlet for gaseous media to be condensed and a condensate outlet, a tube nest exposed throughout its entire length to gaseous media admitted through said inlet and extending longitudinally through the shell structure; said tube nest being spaced from the side walls of the shell structure so as to form an intervening gaseous media delivery space surrounding a substantial portion of the tube nest; an inlet for cooling water disposed at one end of the tube nest, tube sheets disposed intermediate of the ends of said tube nest, and dividing the latter, longitudinally, into a series of sections, independent passageways disposed interiorly of the tube nest for conveying, to the section of the tube nest adjacent the cooling water inlet, gaseous media from the remaining section, said passageways discharging into said first-mentioned section remote from the cooling water inlet, means adjacent to the cooling water inlet for withdrawing air from said first-mentioned section, and means interposed between said air withdrawal means and the discharge ends of said passageways for deflecting gaseous media from the passageways over a portion

of the tube nest section adjacent to the cooling water inlet.

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 for cooling water disposed at one end of the tube nest, tube sheets disposed intermediate of the ends of the tube nest and dividing the latter, longitudinally, into a series of sections, a gas box structure extending longitudinally of the shell structure and embodying independent passageways for conveying, to the section of the tube nest adjacent the cooling water inlet, gaseous media from the remaining, respective sections, said passageways communicating, at their discharge ends, with a portion of the first-mentioned section remote from said cooling water inlet, means adjacent to said cooling water inlet for withdrawing gases from the condenser, and a baffle structure projecting laterally from the gas box structure between said passageway discharge ends and said gas withdrawal means for directing the gases over a portion of the tube nest for cooling the same.

8. In a surface condenser, the combination with a shell having an inlet for gaseous media to be condensed and a condensate outlet, a tube nest extending through said shell and exposed throughout its length to gaseous media admitted through said inlet; said tube nest being spaced from the side walls of said shell so as to form an intervening gaseous media delivery space surrounding a substantial portion of the tube nest, an inlet for cooling water disposed at one end of the tube nest, tube sheets disposed intermediate of the ends of said tube nest and dividing the latter, longitudinally, into a series of sections, a box structure disposed interiorly of said tube nest and extending substantially throughout the length of the latter, said box structure including a compartment having an opening adjacent the cooling water inlet and communicating with the tube nest section adjacent thereto, a chamber having an opening, communicating with said section remote from the first-mentioned opening, transversely extending baffles disposed intermediate of said openings; passageways in said box structure having their discharge ends communicating with said chamber and their inlet ends communicating with the respective remaining sections of said tube nest, and means for withdrawing air from said compartment.

9. In a condenser, the combination of a shell having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell, an inlet for cooling water disposed at one end of the tube nest, tube sheets disposed intermediate of the ends of the tube nest and dividing the latter, longitudinally,

into a series of sections, a gas box structure extending substantially throughout the length of the shell structure, said gas box structure having longitudinally spaced inlet openings located in the respective sections of the tube nest except the section where the cooling water enters the latter and said gas box structure having an additional inlet opening and an outlet opening disposed in the section of the tube nest where the cooling water enters, a partition extending transversely of the air box between said last-mentioned inlet and outlet openings for deflecting through the outlet opening gaseous media from the sections of the tube nest, other than the section where cooling water enters, outwardly into the tube nest, and means communicating with the inlet opening in the section adjacent to where cooling water enters for finally removing non-condensable gaseous media from the condenser.

10. In a condenser, the combination of a shell having an inlet for gaseous media to be condensed and an outlet for condensate, a tube nest extending longitudinally through the shell, an inlet for cooling water disposed at one end of the tube nest, tube sheets disposed intermediate of the ends of the tube nest for dividing the latter, longitudinally, into a series of sections, a gas box structure extending substantially throughout the length of the shell structure, a transversely extending partition disposed within the gas box structure and forming, at the end thereof adjacent to where cooling water enters the tube nest, a compartment, said compartment having a gaseous media final inlet opening and a gaseous media final outlet opening, said gas box structure having an initial outlet opening disposed adjacent to and on the opposite side of the transverse partition wall, said gas box structure also having longitudinally spaced, branch, initial inlet openings communicating, respectively, with the sections of the tube nest except the section located at the cooling water entrant end of the tube nest, longitudinally extending partitions provided in the gas box structure and forming non-communicating passageways between the respective branch initial inlet openings and the initial outlet opening, and conduit means connecting with the final outlet opening of the compartment of the gas box structure for the final removal of non-condensable gaseous media from the condenser.

In testimony whereof, I have hereunto subscribed my name this 25th day of June, 1931.

FRANK A. MEYER.