

July 29, 1958

J. F. SEBALD
MULTI-STAGE DEAERATOR WITH CONTROLLED COUNTERCURRENT
STEAM FLOW PATH

2,845,137

Filed Feb. 27, 1956

3 Sheets-Sheet 1

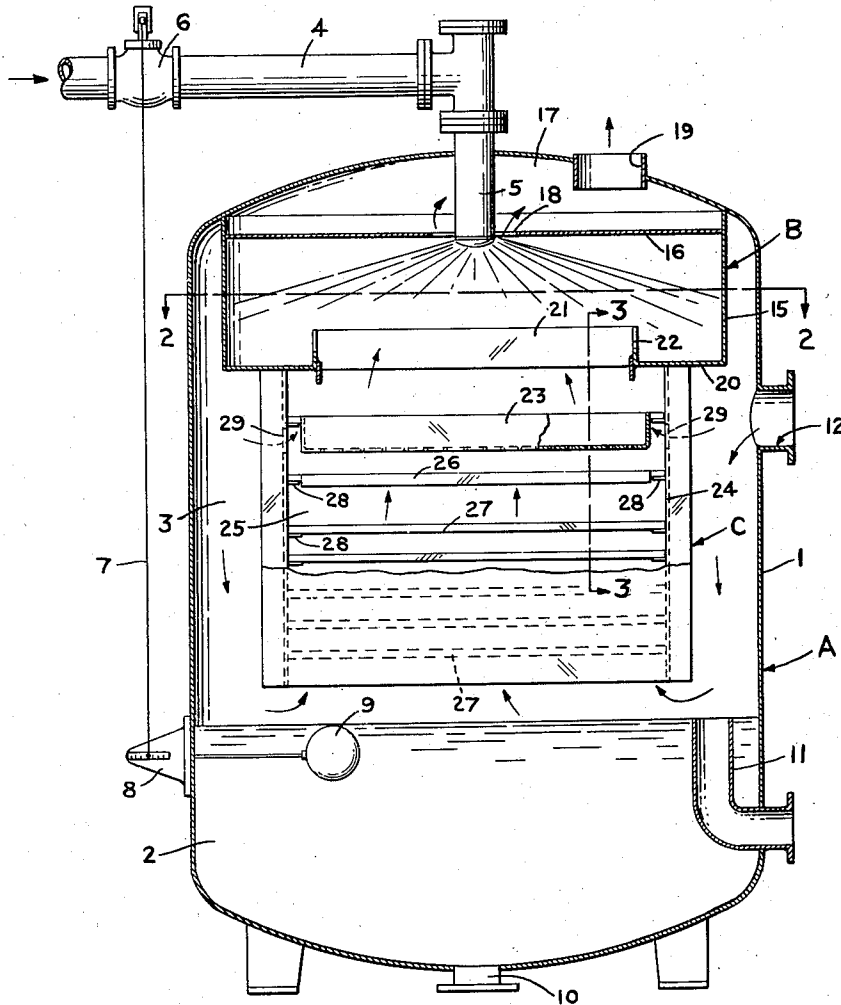


FIG. 1

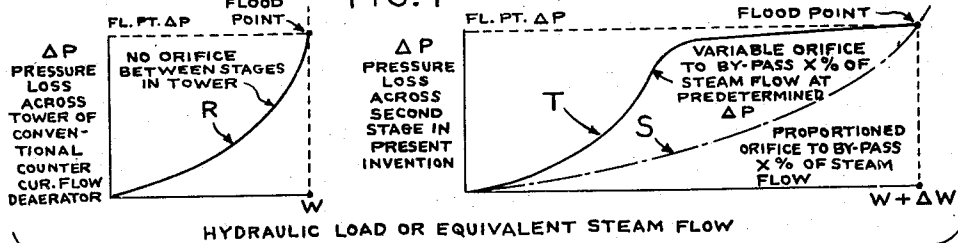


FIG. 6

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3 Sheets-Sheet 2

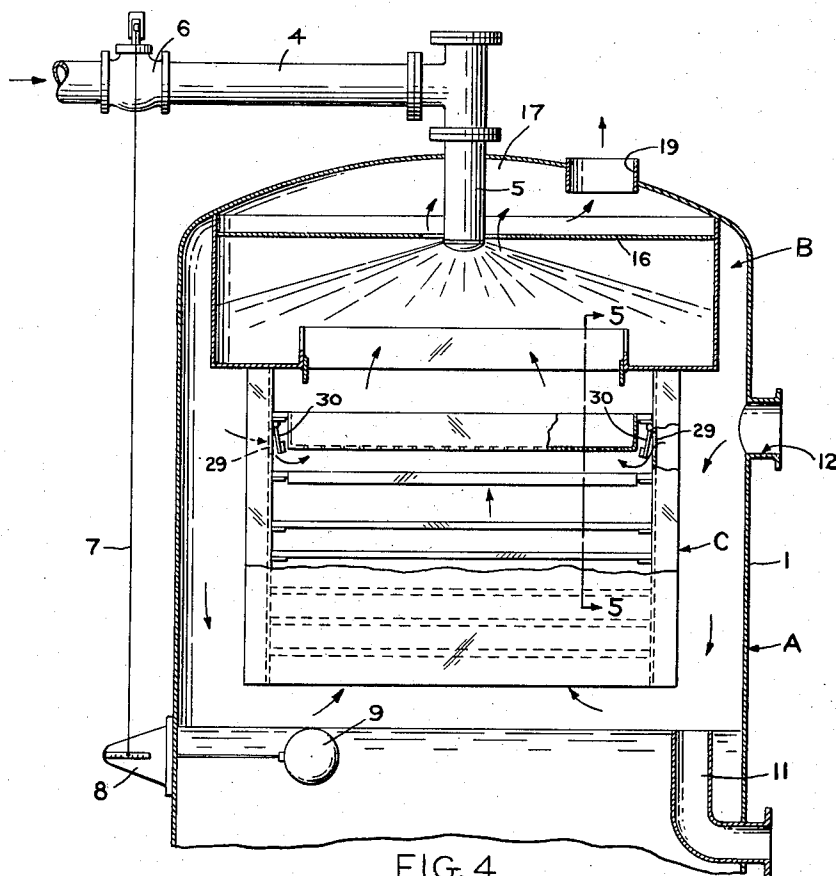


FIG. 4

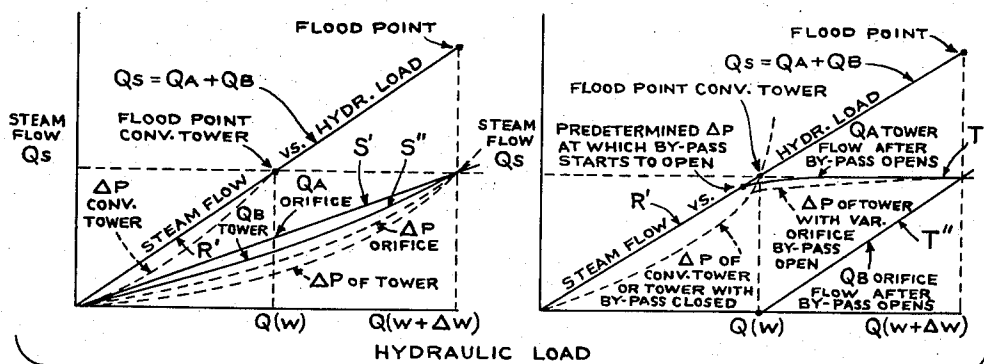


FIG. 7

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3 Sheets-Sheet 3

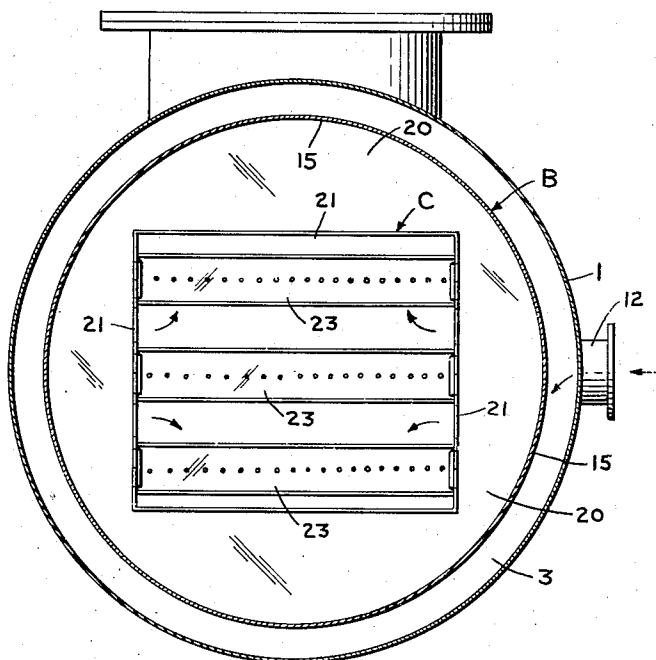


FIG. 2

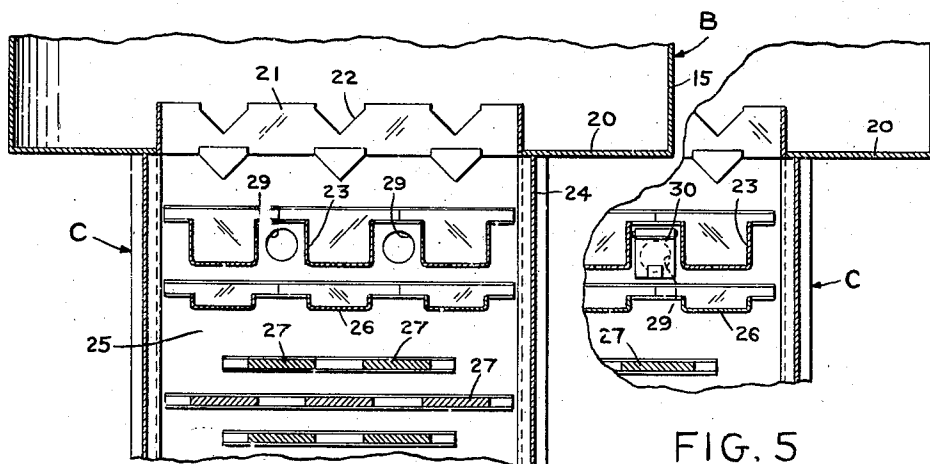


FIG. 3

FIG. 5

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MULTI-STAGE DEAERATOR WITH CONTROLLED COUNTERCURRENT STEAM FLOW PATH

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14 Claims. (Cl. 183—2.5)

This invention relates generally to the deaeration of liquid where heat is added to the medium to be degasified and more particularly to a multistage deaerator having a first heating and deaeration stage and at least one or more second and subsequent heating and deaerating stages and wherein the steam flow is proportioned at a predetermined ratio between the respective stages to adjust and control the thermal characteristics of the apparatus whereby a relatively higher hydraulic loading is effected thereon than heretofore obtainable.

The normal thermal characteristics of the conventional type of counterflow tray type heating and deaerating apparatus which are now available on the open market while superior to the cross flow or parallel flow type of heating and deaeration apparatus from the standpoint of securing effective deaeration are significantly restricted from the capacity viewpoint because there is an inherent hydraulic limitation in the design of each counterflow tray or packed type of heating and deaerating apparatus, which limitation is less than crossflow or parallel flow types of deaerators of the same relative size.

The present invention overcomes this problem by combining in countercurrent flow relationship a first heating and deaerating stage and at least one or more second and subsequent heating and deaerating stages, and providing between the respective first and subsequent stages an orifice either fixed in size or variable so that the steam flow path is controlled to deliver to each of the stages a predetermined proportion of the steam entering the deaerator whereby the velocity of the flow through the second and subsequent stages will be controlled, to allow an increase in the hydraulic loading on a deaerator of the same size than has been heretofore obtainable without flooding.

Accordingly, it is an object of the present invention to provide a multi-stage deaerator including at least one or more countercurrent steam flow paths therein wherein the thermal characteristics will permit carrying relatively larger hydraulic loads without sacrificing efficient deaeration.

Further objects and advantages of the invention will become evident from the following description with reference to the accompanying drawings in which:

Figure 1 is a side elevation partly in section showing one form of the present invention.

Figure 2 is a view taken on line 2—2 of Figure 1.

Figure 3 is a view taken on line 3—3 of Figure 1.

Figure 4 is a side view partly in section of another form of the present invention.

Figure 5 is a view taken on line 5—5 of Figure 4.

Figure 6 is a graph showing a comparative relationship between the pressure loss across the tower and the steam load on known types of heating and deaerating apparatus as against those shown in the present invention.

Figure 7 is a graph showing a comparative relationship between steam flow and load between known types of heating and deaerating apparatus as against those shown in the present invention.

Referring more particularly to the drawings, Figure 1

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shows one form of a multi-stage deaerator generally designated A comprising an elongated fully enclosed tower 1 having formed therein a water storage section 2 and a steam space 3. Raw water or other fluid is delivered to the tower 1 through a raw water inlet pipe 4 from a source, not shown. The raw water inlet pipe 4 is connected to a spring loaded or orifice type inlet valve 5 disposed at the upper end of the tower 1 so that water delivered to the tower from the inlet valve 5 will descend by gravity flow to the water storage section as is herein-after described.

The raw water inlet has a regulating and control valve 6 which is operated through a lever arm 7 connected at one end to the valve and at the other end to a float control mechanism 8, the position of the float 9 of the float control being regulated by the level of the fluid in the water storage section 2 of the tower 1. Signals will be delivered by the float control mechanism 8 and lever arm 7 to the valve 6 to deliver water in accordance with the level of the water in the water storage section 2.

The deaerated water in the water storage section 2 is removed from the tower 1 through a water discharge outlet 10. An overflow pipe 11 is also provided to prevent the amount of water from rising beyond a predetermined level in the tower 1.

The steam from any suitable source is admitted to the steam space 3 through a steam inlet 12 which is disposed medially of the upper portion of the steam space 3. It will be understood that the position of the steam inlet is merely illustrative and that position of the inlet will be such that the desired ratio of steam delivery can be obtained during operation of the deaerator.

Formed in the steam space 3 are a primary heating and deaerating stage generally designated B which is of the spray or jet type and at least one secondary heating and deaerating stage generally designated C of the counterflow tray or packed type deaerator. The primary stage and secondary stage will be disposed in countercurrent flow relationship so that fluid will be delivered from the primary stage to the secondary stage by gravity flow and steam will pass from the secondary stage upwardly through the primary stage in countercurrent flow. It will be understood that while only one additional stage is illustrated in the present embodiment of the invention that more than two stages could be utilized without departing from the spirit of the present invention.

The types of primary heating and deaerating stages and secondary heating and deaerating stages shown in the present preferred embodiment of the invention are only for the purpose of illustration. Hence any combination of primary and secondary heat and deaerating stages of the countercurrent flow type may be utilized without departing from the present invention. In any combination of deaerating stages chosen the primary stage or the next preceding stage of any successive stages beyond the primary stage should generally have a greater hydraulic capacity per unit cross-section area than the next stage. In the present preferred embodiment this is inherent in the types of deaerating stages utilized for illustration.

Primary heating and deaerating stage

Connected to and supported by the upper end of the tower 1 is a box-like container or cylinder 15 which has an upper header or cover 16. The box-like container 15 and upper header 16 form a collection chamber 17 at the upper end of the steam space which collection chamber is in communication with the respective primary stage B through an opening 18 in the header elements 16 through which the inlet valve 5 projects into the primary heating and deaerating stage. At the uppermost end of the tower 1, a vent opening 19 is provided in communication with collection chamber 17 for venting non-condensed steam,

oxygen, and non-condensable gases to atmosphere, as is well known in the art. A vent condenser or other mechanism may be connected to the vent opening 19 to remove non-condensed steam, oxygen, and non-condensable gases from the collection chamber positively. However, these are not illustrated as they are well known in the art and form no part of the present invention.

The inlet valve 5 extends a sufficient distance into the container 15 so that water sprayed therefrom will be retained or collected inside the container on a shelf formed by the lower head 20 and an upwardly extending flange 21 formed about the periphery of a relatively large opening in the lower head 20. Thus, water sprayed outwardly from the inlet valve 5 will hit against the inner walls of the container 15 and collect on the shelf formed by the lower head and flange 20 and 21, respectively, to a depth determined by V-shaped notches 22 formed in the upwardly extending flange 21 which allow the water to fall onto the uppermost trays 23 of the secondary stage C, all of which is clearly shown in Figures 1 and 3 of the drawings. As can be readily seen in Figures 1 and 3 of the drawings, the opening formed in the lower header 20 is almost as large as the cross-sectional area of the secondary heating and deaerating stage C. Hence, the upward steam flow path from the secondary heating and deaerating stage C to the primary heating and deaerating stage B will be relatively unobstructed except for the countercurrent flow relationship between the water dropping by gravity flow and the upwardly flowing steam, oxygen, and non-condensable gas mixture.

Similarly, the opening 18 is indicated as being larger than the outer diameter of the valve 5 so that non-condensed steam, oxygen, and other non-condensable gases released during the operation of the deaerator will be able to pass from the container 15 to the collection chamber 17 and thence through the vent opening 19 to any suitable means of disposal as provided on the particular system in which the deaerator will be utilized.

Secondary heating and deaerating stage

Connected to the bottom header 20 of the primary heating and deaerating stage B outwardly of the opening formed in the header 20 is an elongated hollow member 24 which forms a secondary heating and deaerating chamber 25. The chamber 25 thus formed communicates at its upper end through the opening formed in the header 20 with the primary heating and deaerating stage B and at its lower end directly with the steam space 3 so that the entire area covered by the lowermost end of the chamber 25 is free to receive steam from the steam space at the pressure of the steam in the steam space.

Disposed in the secondary heating and deaerating chamber 25 below the upper tray 23 which receives the fluid from the primary heating and deaerating stage B are the tray 26 and the packing elements 27. The trays 25 and 26 and packing elements 27 will be mounted by any suitable means such as brackets 28 to the inner wall of the member 24 so that they are disposed transversely of the heating and deaerating chamber 25 as is illustrated in Figure 2 of the invention. This type construction is well known in the art, hence is not more fully described herein.

The heating and deaerating chamber 25 further communicates with the steam space 3 through orifices 29 formed in the sides of the cylinder 24 as is shown in Figures 1 and 3 of the drawings. The area of the orifices 29 will be so proportioned relative to the area of the lower end of the heating and deaerating chamber 25 in communication with the steam space 3 that a predetermined amount of the steam will be by-passed through these orifices directly to the primary heating and deaerating stage B without completely passing through the heating and deaerating chamber 25.

The effect of this arrangement, that is, proportioning the size of the orifice relative to the area in the lowermost

end of the heating and deaerating chamber 25, is to control the steam delivered to the primary stage and secondary stage at a relatively constant ratio on the basis of this area relationship, as a result of which the vapor velocity through the second stage of heating and deaeration will be limited. This will avoid flooding and permit the apparatus to carry very much higher hydraulic loads than would normally be possible with the conventional counterflow displacement flow path, as is more fully described herein-after with reference to Figures 6 and 7.

Operation

In operation, raw water is delivered through the raw water supply pipe 4 to the inlet valve 5 and is sprayed into the primary heating and deaerating stage B. Simultaneously therewith, steam enters through the steam inlet 12 and is uniformly distributed through the steam space 3 flowing upwardly through the secondary heating and deaerating chamber 25 and through the orifices 29 so that it will pass in countercurrent flow relationship with the water sprayed from the inlet valve 5 into the container 15 of the primary heating and deaerating stage B. The relative amount of steam by-passed directly to the primary heating and deaerating stage B will depend on the size of the orifices 29 as above described.

The deaerated water in the primary heating and deaerating stage B is collected on the shelf formed by the head 20 and will when it reaches the proper level pass through the notches 22 in the upwardly extending flange 21 where it will flow onto the trays 23 and 26 and packing means 27 of the secondary heating and deaerating stage C. By gravity flow in the secondary heating and deaerating stage C it will pass in countercurrent flow relationship with the steam passing from the steam space through the heating and deaerating chamber 25 where the descending fluid will be secondarily deaerated.

The freed oxygen and non-condensable gases pass upwardly with the non-condensed steam into the primary heating and deaerating stage B and thence the completely collected mixture passes out through the opening 18 into the collection chamber 17 where the mixed vapor and gases are removed through the vent opening 19 provided in the tower 1.

Figure 4 structure

In the form of the invention shown in Figure 4, the structure up to a certain point is identical with that above described for the form of the invention shown in Figures 1 to 3. Hence, the same numerals refer to the same parts described. However, the structure differs from that shown in Figures 1 to 3 by the addition of weight loaded valves 30 connected to the inner wall of the elongated hollow member 24 which covers the orifices 29. These valves are set to open at a predetermined pressure differential in the tower at which time the effect of by-passing the predetermined ratio of the steam from the steam space through the respective primary and secondary stages will occur thereby obtaining the desired results as in the form of the invention shown in Figure 1. It will be understood that while weight loaded valves are shown at 30 that any suitable type valve may be utilized for opening the orifices at the predetermined pressure differential without departing from the spirit of the present invention.

The operation of the structure shown in Figure 4 differs from the form of the invention shown in Figure 1 in that the structure operates initially as if it were a conventional tower, i. e., water flowing downwardly by gravity flow in countercurrent relation with steam which enters at the lower or open end of the secondary or succeeding stages. However, in this form of the invention after the predetermined differential pressure is reached, the valve 30 will start to open thereby imposing a relatively constant steam pressure loss by-passing a portion of the steam through the primary heating and deaerating

stage, and thus maintains the predetermined differential pressure substantially constant until flooding occurs.

Graphic representation

The effect of the forms of the invention shown in Figures 1 and 4 above described and their respective operation can be more readily understood by reference to the graphic illustration shown in Figures 6 and 7 of the drawings. Thus, referring to Figure 6, the line designated R illustrates in a conventional tower that as the hydraulic load increases the pressure loss across the tower also increases and hence the hydraulic load will be limited to some finite quantity W at a differential pressure corresponding to the flood point. Line S shows that with a fixed proportioned orifice by-passing a predetermined portion of the steam flow the hydraulic load can be materially increased by an amount W before the flood point and coincident differential pressure is reached. Line T shows that with a variable proportioned orifice until a predetermined differential pressure is reached the tower operates as a conventional tower, i. e., as if it did not have a proportioned orifice. At the predetermined differential pressure the valves controlling the orifices begin to open to by-pass a portion of the stem flow and will continue to do so allowing an increasing percentage of total steam flow to be by-passed. These valves permit a substantial increase in by-passed steam flow at only a slight change in differential pressure, providing means for increasing the total steam flow and hence hydraulic flow before the differential pressure reaches the value coincident with flooding.

Figure 7 illustrates the actual steam flow as related to hydraulic load and also depicts the relative relation of the differential pressure in the tower relative to these flow conditions.

Line R' represents the steam flow through the conventional tower and clearly shows that the flood point occurs at a much lower hydraulic load than in the present structure disclosed.

Lines S' and S'' represent the respective steam flows through a structure having fixed proportioned orifices. The relative flow through the tower and through the fixed proportioned orifice differs because the pressure drop through the tower varies approximately as the cube of the load while the pressure drop through the orifices varies approximately as the square of the load.

Similarly, T' and T'' represent the respective steam flow characteristics through a structure having a variable proportioned orifice. Since the valve controlling the proportioned orifice does not open until a predetermined differential pressure is reached the tower operates as a conventional tower up to this point and thereafter a relatively constant steam pressure loss is effected by the valve operating to by-pass the necessary portion of the steam to the primary heating and deaerating stage to maintain the pressure differential substantially constant at the predetermined pressure differential at which the valves opened. The respective steam flow lines T' and T'' represent the steam flow after the valve controlling the proportioned orifice opens and once again the flows through the respective proportioned orifice and the tower differ because of their respective variations relative to the load as above set forth relative to the lines S' and S''.

In either a conventional degasifier or a degasifier embodying the features of the present invention the steam flow designated Q_s will be proportional to the hydraulic load where the inlet temperature and the pressure is substantially constant.

In the conventional degasifier we have:

$$Q_s:W$$

In the present invention however when a certain portion of the steam is by-passed through the orifice to control the velocity of the steam flowing in countercurrent

flow to obtain the higher hydraulic loading then the steam flow through the tower is the sum of these two flows or:

$$Q_s = Q_a + Q_b$$

and the hydraulic loading

$$W + W$$

However, since the steam flow is substantially proportional to the hydraulic loading where the inlet temperature and the pressure is relatively constant we have:

$$Q_a + Q_b:W + W$$

Thus, it is believed clear that whether a fixed or variable orifice is utilized that the relationship between the two flows is controlled by the relative area of the orifice and the area of the point of entrance for the steam at the lower end of the second and successive stages of heating and deaeration and that this structure provides a means of limiting the vapor velocity through the second stage of heating and deaeration to avoid hydraulic flooding and to permit the apparatus to carry very much higher loads than would be normally possible with the conventional counterflow displacement flow path types of heating and deaerating apparatus presently on the market.

It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown but that they may be widely modified within the invention defined by the claims.

What is claimed is:

1. In a multi-stage deaerator including a tower having a fluid storage space at the lower end thereof and a steam space formed above the fluid storage space, the combination of a first heating and deaerating stage including a cylindrical member connected at one end to the upper end of said tower, an annular member transversely mounted on said cylinder at the end thereof remote from the connected end, means for delivering fluid to be deaerated to said first stage, means for delivering steam to said steam space, at least one other heating and deaerating stage of a lesser hydraulic capacity than said first stage including a second cylindrical member connected to the annular member of said first stage about the opening therein to allow fluid to pass from said first stage to said second stage and non-condensed steam and non-condensable gases from said second stage to said first stage, said second cylindrical member open at its lower end to communicate with said steam space and to deliver deaerated fluid to said water storage space, said cylindrical member having orifices therein proportioned in accordance with the area of the open end of said cylindrical member to by-pass a pro rata portion of the steam delivered to said steam space to said first stage whereby the velocity of the steam flowing through said second mentioned stage will be controlled, and vent means on said tower communicating with said first stage to pass residual non-condensed steam and non-condensable gases from said tower.

2. In the combination as claimed in claim 1 wherein valve means are provided for each of said orifices adapted to open at a predetermined pressure differential in said tower to provide a constant steam pressure loss through said second mentioned stage for maintaining said predetermined maximum differential pressure constant until flooding occurs during operation.

3. In a multistage deaerator including a tower having a fluid storage space and a steam space above said fluid storage space, the combination of a first heating and deaerating stage disposed at the upper end of said tower including, means for redistributing deaerated fluid from said first heating and deaerating stage, and means forming an outlet in said redistributing means, at least one other heating and deaerating stage disposed in the steam space adjacent said redistributing means and its outlet means to receive fluid therefrom and to pass non-condensed steam and non-condensable gases thereto in coun-

tercurrent flow relationship, said other heating and deaerating stage having an opening at its lower end in communication with said steam space to pass deaerated fluid to said fluid storage space and to receive steam from said steam space for countercurrent flow through said respective heating and deaerating stages, means to bypass a portion of said steam from said steam space to said first stage in predetermined ratio to the quantity flowing through the open end of said other mentioned stage whereby the velocity of the steam flowing through said other mentioned stage will be controlled, and a vent means on said tower communicating with said first stage to pass residual non-condensed steam and non-condensable gases from said tower, all of said heating and deaerating stages being structurally separate and distinct from the steam space within which they are disposed.

4. In the combination as claimed in claim 3 wherein adjustable means is provided for said bypass means to provide a constant steam pressure loss through said other mentioned stage above a predetermined differential pressure thereacross.

5. In a multistage deaerator as claimed in claim 3 wherein the outlet means in said redistributing means has a greater free cross-sectional flow area than the free cross-sectional flow area at any section transverse to the flow area in said other heating and deaerating stage.

6. In a multistage deaerator including a tower having a fluid storage space and a steam space above said fluid storage space, the combination of a first countercurrent flow heating and deaerating stage disposed at the upper end of said tower including means for redistributing deaerated fluid, and means forming an outlet in said redistributing means, at least one other countercurrent flow heating and deaerating stage of a generally lesser hydraulic capacity per unit cross-sectional flow area than said first stage connected to said first stage about the outlet formed in said redistributing means, said first stage and said other stage communicating through said means forming the outlet in said redistributing means in countercurrent flow relationship whereby said other heating and deaerating stage receives fluid from said first stage and passes non-condensed steam and non-condensable gases to said first stage, said other countercurrent flow heating and deaerating stage having means forming an opening at its lower end for communication with said steam space and to pass fluid from said respective stages to said fluid storage space, means coacting with said first heating and deaerating stage to bypass a portion of said steam from said steam space to said first stage in a predetermined ratio to the quantity flowing through the open end of said other mentioned stage whereby the velocity of the steam flowing through said other mentioned stage will be controlled, and vent means on said tower communicating with said first stage to pass residual non-condensed steam and non-condensable gases from said tower.

7. In a multistage deaerator as claimed in claim 6 wherein valve means are provided to adjustably control the opening of said bypass means when the differential pressure across said other heating and deaerating stage reaches a predetermined differential pressure.

8. In a multistage deaerator including a tower having a fluid storage space and a steam space above said fluid storage space, a plurality of independent substantially countercurrent flow heating and deaerating stages disposed in said tower to pass fluid in series from the initial stage through to the final stage, means forming an opening in said final stage communicating with the steam space to receive steam therefrom and to pass deaerated fluid to said fluid storage space from said plurality of independent countercurrent flow heating and deaerating stages, said plurality of stages to receive the steam in countercurrent flow relationship with the fluid passing therethrough from said opening in the final stage, means

coacting with at least one of said stages other than said final stage to bypass a portion of said steam from said steam space to said other stages in a predetermined ratio to the quantity flowing through the opening in said final stage whereby the velocity of the steam flowing through said stages will be controlled, and a vent means on said tower communicating with the initial of said plurality of stages to pass residual non-condensed steam and non-condensable gases from said tower, all of said heating and deaerating stages being structurally separate and distinct from the steam space within which they are disposed.

9. In a multistage deaerator as claimed in claim 8 wherein adjustable means are provided for said bypass means to provide a constant steam pressure loss through the successive stages when the differential pressure across said tower reaches a predetermined maximum.

10. In a multistage deaerator including a tower having a fluid storage space and a steam space above said fluid storage space the combination of a first substantially countercurrent flow type heating and deaerating stage disposed at the upper end of said tower including, means about the lower section thereof for redistributing deaerated fluid, and means forming an outlet in said redistributing means, at least one other countercurrent flow type heating and deaerating stage of a generally lesser hydraulic capacity than said first countercurrent flow type heating and deaerating stage disposed in the tower and connected to said redistributing means about the outlet formed therein for series flow with respect to the fluid passed from said first heating and deaerating stage through said outlet, said other heating and deaerating stage having means forming an opening at the lower end thereof in communication with said steam space and to pass deaerated fluid to said fluid storage space, said outlet means in said redistributing means having a greater cross-sectional flow area than the available cross-sectional flow area in said other heating and deaerating means, and means coacting with said first countercurrent flow type heating and deaerating stage for bypassing a portion of said steam from the steam space to said first stage at a predetermined ratio to the quantity of steam flowing through the open end of said other mentioned stage whereby the velocity of the steam flowing through said other stage will be controlled, and a vent means on said tower communicating with said first stage to pass residual non-condensed steam and non-condensable gases from said tower.

11. In a multistage deaerator as claimed in claim 10 wherein the means coacting with said first stage to form a bypass is disposed in said other heating and deaerating stage adjacent the point of connection with the opening in said connecting means.

12. In a multistage deaerator as claimed in claim 10 wherein adjustable means are provided for said bypass means to provide a constant steam pressure loss through said second mentioned stage when the differential pressure across said tower reaches a predetermined maximum.

13. The method of increasing the hydraulic load in a multistage deaerator which includes the steps of spraying fluid to be deaerated into a primary heating and deaerating stage, simultaneously delivering steam to the deaerator and passing it through at least one other countercurrent flow heating and deaerating stage in said deaerator, collecting and redistributing the fluid from said primary stage and passing it directly to said other heating and deaerating stage in countercurrent flow relationship with steam from said other heating and deaerating stage, and simultaneously bypassing a portion of said steam directly to the primary stage to control the velocity of the steam passing through said secondary stage, and venting residual steam and non-condensable gases from the deaerator, and adjusting the bypassing of steam to maintain a constant pressure loss through said other heating and deaerating stage when the predetermined differ-

ential pressure in said tower exceeds a predetermined maximum.

14. The method of increasing the hydraulic load in a multistage deaerator which includes the steps of spraying fluid to be deaerated into a primary heating and deaerating stage, simultaneously delivering steam to the deaerator and passing it through at least one other countercurrent flow heating and deaerating stage in said deaerator, collecting and redistributing the fluid from said primary stage and passing it directly to said other heating and deaerating stage in countercurrent flow relationship with non-condensed steam from said other heating and deaerating stage through an outlet of relatively greater free cross-sectional flow area than the free cross-sectional flow area at any section transverse to the flow area of said other heating and deaerating stage, simul-

taneously bypassing a portion of said steam directly to said primary stage to control the velocity of steam passing through said secondary stage, and venting residual steam and non-condensable gases from the deaerator and adjusting the bypassing of steam to maintain a constant pressure loss through said second mentioned stage when the differential pressure across said deaerator reaches a predetermined maximum.

References Cited in the file of this patent

UNITED STATES PATENTS

1,879,930	Gibson	Sept. 27, 1932
2,689,018	Kittredge	Sept. 14, 1954

FOREIGN PATENTS

151,313	Sweden	Aug. 30, 1955
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