Feb. 14, 1933. W. J. HUGHES ET AL 1,897,727

VAPOR PURIFIER

Filed May 2, 1927 3 Sheets-Sheet 1

Fig. 1.

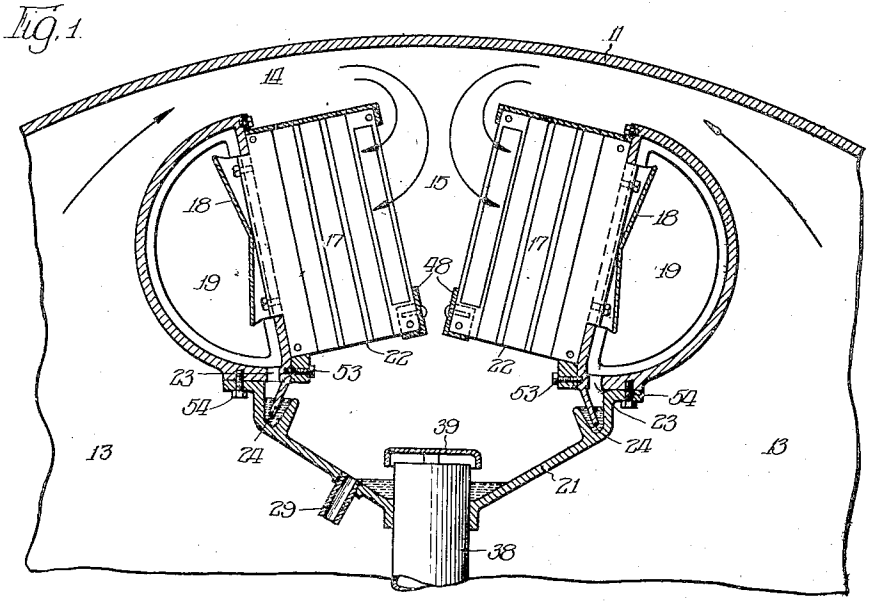

Fig. 2.

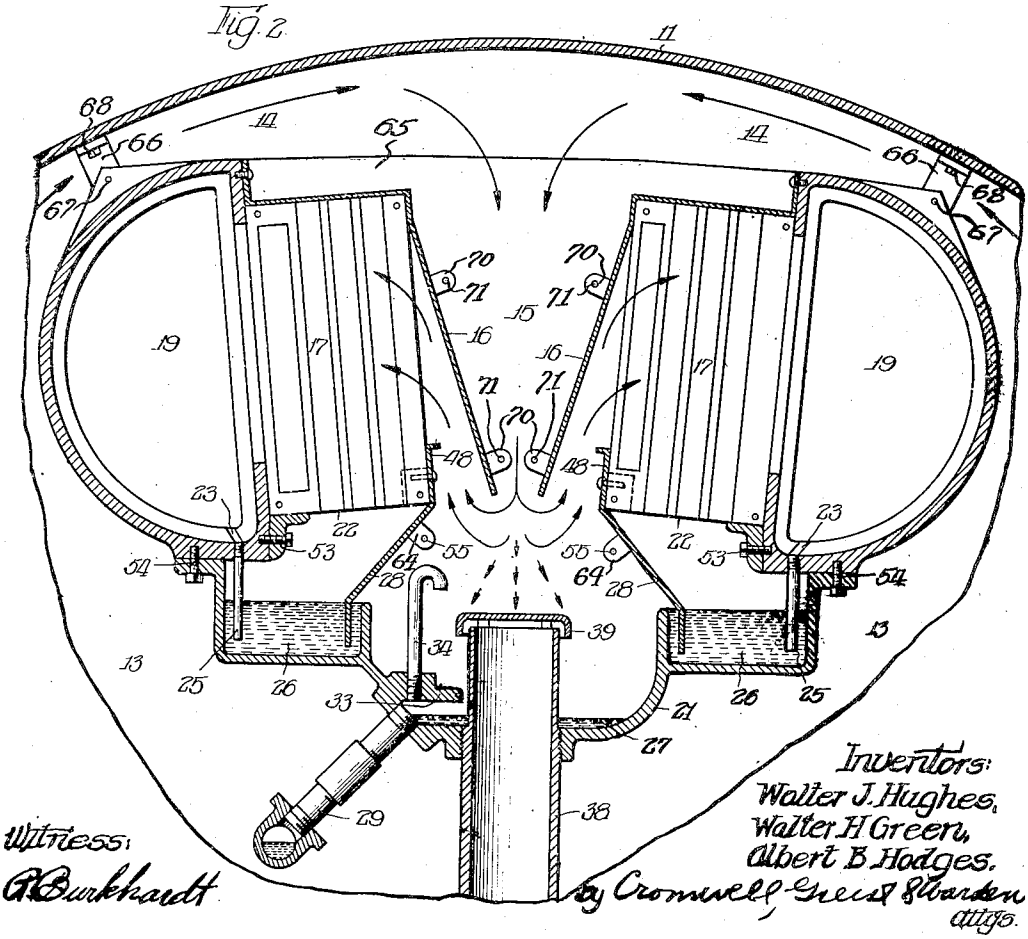

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Fig. 3.

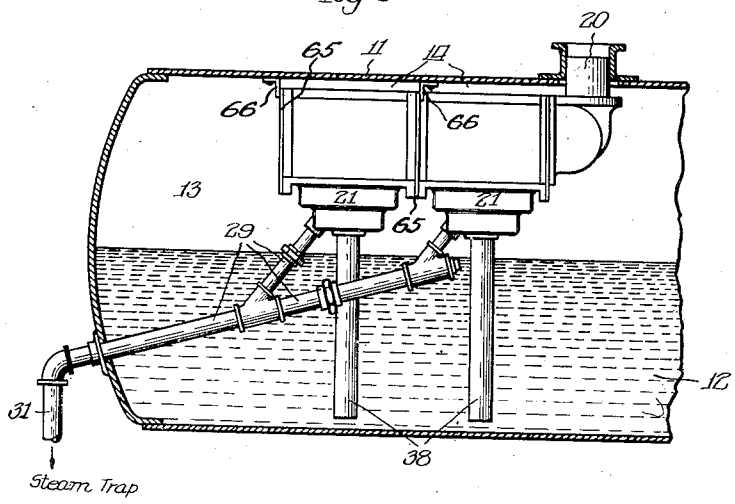
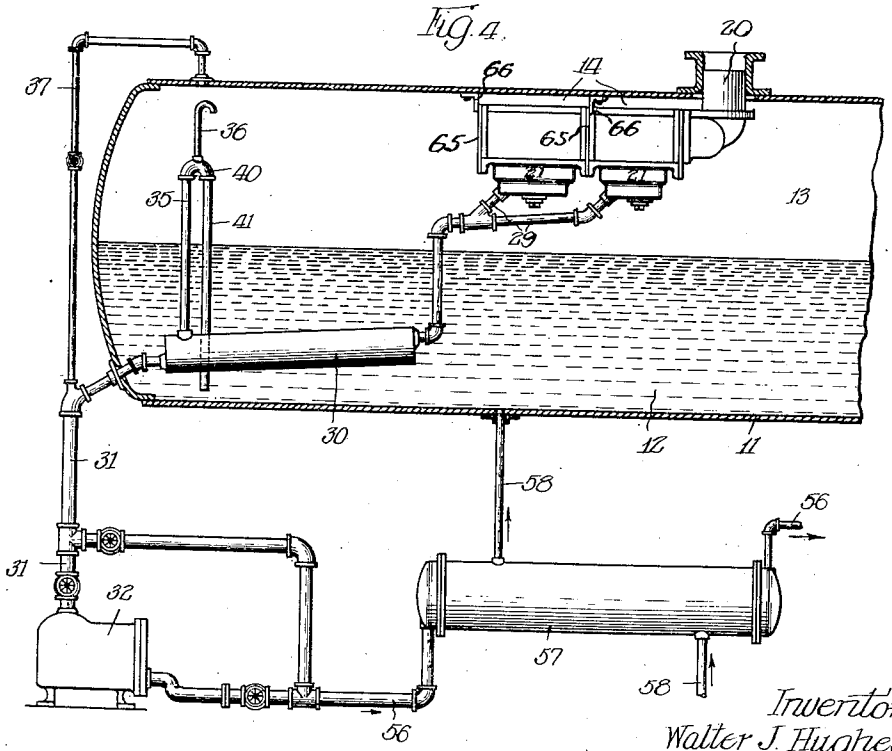


Fig. 4.



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VAPOR PURIFIER

Filed May 2, 1927 3 Sheets-Sheet 3

Fig. 5.

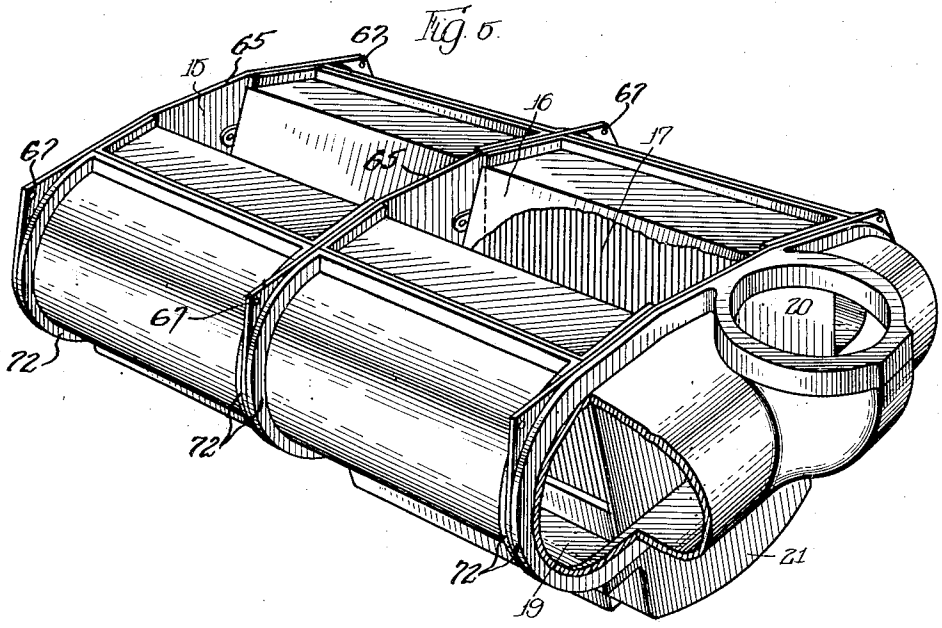
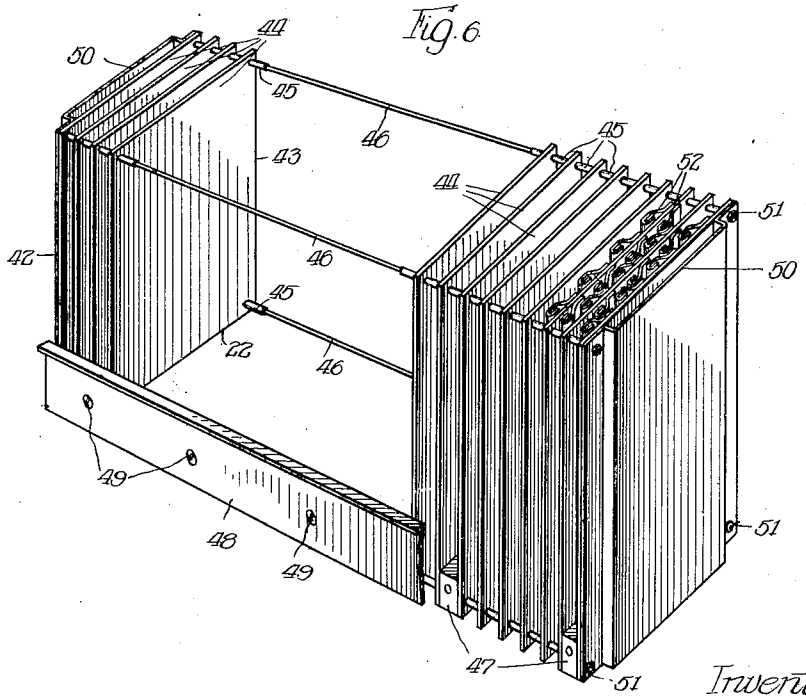


Fig. 6.



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1,897,727

UNITED STATES PATENT OFFICE

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VAPOR PURIFIER

Application filed May 2, 1927. Serial No. 188,104.

This invention relates to means for the purification of vapors and especially relates to menas for the purification of steam generated by boilers and evaporators.

Although many features of the present invention may be utilized in vapor purifiers broadly, the preferred embodiment of the invention, in which the purifier is used to purify steam and is positioned within a boiler shell, will be particularly described.

Boilers of present design, especially water tube types, have proportionately much greater heating surfaces than steam liberating surfaces. Usually the steam is liberated from the water in a comparatively small drum which is kept about half full of water, the top half of the drum providing the steam space. Because of the horizontal position of the cylindrical drum, the distance from the water surface to the steam outlet connection is considerably restricted. The heating surface of such boilers is principally in the tubes and other drums which are so arranged that when steam is generated, a violent circulation results.

At the normally high steaming rates in practice there is considerable turbulence of the water in the steam outlet drum due to the circulation and steam liberation. Even under steady load and other favorable steaming conditions some boiler water is entrained by the steam as fine droplets and is carried to the steam outlet.

The load on a boiler, however, usually varies and other favorable steaming conditions are difficult to maintain with the result that very considerable quantities of entrained boiler water are carried to the outlet. If there are sudden changes in demand for steam, each change will be accompanied by a greater turbulence in the upper drum due to the lag in adjustment of boiler steaming to the changed demand for steam. Again if the firing of the boiler is improper, certain portions of the heating surface may be subjected to a very intense heat causing very violent turbulence in the upper drum adjacent to the connections from the overheated tubes.

The condition of the feed water also has a bearing on the turbulence of the water in the boiler. Even when the feed water contains only a few grains per gallon of soluble or suspended impurities, these remain in the boiler water due to evaporation and concentrate therein until the water in the boiler may contain several hundred grains of solids per gallon depending upon the amount and frequency of blowdown. Concentration of said impurities may reach an amount that will cause an over turbulent condition even though the steaming conditions are otherwise favorable.

In view of the above factors, the moisture content of the steam which normally may be as low as a fraction of a percent may suddenly increase to several percent or actual surging of the water in the boiler may take place, such as when priming occurs, during which slugs of water may leave the drum with the steam.

It obviously is necessary to remove such large quantities of boiler water from the steam, but it also is very important to remove the normally low moisture content.

Since the moisture content of the steam is actual boiler water in more or less finely divided form, this moisture is highly impure and contains the same solid content as does the boiler water. The surprising fact is the enormous weight of dry foreign matter that can be carried by steam of normally high quality and with very usual boiler water concentrations. For instance, steam containing only one half of a percent of moisture from a boiler water at but 200 grains per gallon concentration, carries 120 grains of foreign matter per 1000 pounds of steam. A boiler developing 500 horse power generates over 400,000 pounds per twenty four hours of steam carrying 48,000 grains of foreign matter. This is equal to 6.8 pounds per day or in the short space of ninety days amounts to 612 pounds of solid matter.

To remove such entrained moisture and impurities and to secure steam of supposedly unobjectionable moisture content, the steam is usually taken from the drum at a point where there is the least commotion

due to circulation. The steam generally is delivered to the nozzle or steam outlet by a so-called "dry pipe", the duty of which is to collect the steam from the upper space in the drum over a larger area or throughout a greater length of the drum. Since, as has been pointed out previously, modern boiler design permits of but relatively small steam space above the water line, the fine particles of water sprayed upward into this space do not always have a chance to fall back, but are whisked along with the steam currents which must necessarily approach the "dry" or collecting pipe with considerable velocity. As a result, the steam leaving the boiler nozzle after passing the dry pipe often carries more or less actual boiler water.

Steam purifiers also are used, through which the steam is passed, before it leaves the boiler drum. In many of these purifiers the steam is caused to impinge violently upon deflecting surfaces a number of times in its passage therethrough and as the steam is so treated, its contained moisture is thrown into gutters. In most of these constructions the steam current with its entrained moisture is deflected by surfaces substantially at right angles to its direction of flow with a result that the particles of boiler water are broken up into a fine mist and made very difficult to remove. These violent impingements also cause a very considerable eddying and frictional loss with an appreciable pressure drop. No adequate provision is made for preventing the expelled water and dirt particles from getting back into the vapor stream. The steam moving at a considerable velocity tends to tear loose and carry along anything held to an exposed surface merely by adhesion, due to its scouring action, and therefore frequently entrains again the separated water particles.

When due to priming abnormally large quantities of water are carried to such purifiers, no means are provided to prevent such water from entering and overloading the purifying elements. Furthermore adequate drainage for the water reaching the purifying elements is not provided.

The object of this invention is to prevent overloading of the purifier elements under any boiler conditions.

A further object is to remove abnormally large quantities of water from the steam before it enters the purifying elements.

Another object is to provide adequate and efficient drainage from each steam passage.

A still further object is to prevent bypassing of the steam around the purifying elements.

Other objects will appear during the course of the following description.

A preferred form of apparatus embodying the invention is illustrated in the accompanying drawings.

In the drawings:

Figures 1 and 2 are sectional end views of purifiers within the boiler drum;

Figures 3 and 4 are side views of the boiler with the purifiers arranged therein showing the means of draining the collecting chambers under said purifiers;

Figure 5 is a top view of two purifier sections; and

Figure 6 is a detail view showing one type of a purifying element which can be used.

The boiler shell 11 is about equally divided into a water space 12 and a steam space 13 (see Figures 3 and 4). The steam leaving the steam space 13 (see Figures 1 and 2) moves through the passage 14 and enters the steam purifier through the central admission space 15. It then passes through the vertically sloping purifying elements 17 and then into the steam conduits 19 from whence it is taken to the steam nozzle 20 (see Figures 3 and 4). A sloped distributing plate 18 (in Figure 1) causes the steam to pass from the purifying elements 17 tangentially into the outer edges of the main current in conduit 19 with a minimum of disturbance and eddying. In Figure 2 a baffle 16 causes the steam to pass down through the purifier casing until it reaches the lower part of the central admission space 15 from whence it then passes into the purifying elements 17.

Below the purifying elements 17 there is attached to the purifier casing a collecting chamber 21. This collecting chamber empties into the continuously slanting drain line 29 which conducts the collected impurities to the exterior of the boiler. Any moisture separated from the steam in the purifying elements 17 drains into the collecting chamber 21 through their open bottoms 22. Any moisture which may collect in the steam conduit 19 drains down through the openings 23 in the bottom of the steam conduit passage 19, past the seals 24 (Figure 1) or 25 (Figure 2) into the collecting chamber 21.

Figure 2 shows a collecting chamber 21 which is divided into several compartments 26 and 27. The compartments 26 collect the moisture from the purifying elements 17 and from the purified steam conduit 19 and are sealed from the compartment 27 by the depending plate 28 which prevents any bypassing of the steam from the central admission chamber 15.

The water collected in the bottom of compartment 27 flows out through the continuously downwardly sloping pipes 29 (see Figures 3 and 4) to the pipe 31 which conducts it to a steam trap 32 or any other discharge means. This continuously downwardly sloping pipe may have an enlarged section 30 (see Figure 4) which is of sufficient capacity to hold any large quantities

of water which might be carried into the purifier casing. The steam which flows back from the trap 32 and connecting lines as it is displaced by the downwardly flowing water from the collecting chamber, is vented into the steam purifying chamber 21 (see Figure 2) by means of the baffle 33 and the vent 34. In the case of the enlarged section 30 (see Figure 4) two other methods of venting the drainage system are shown. The steam can be caused to pass up through the pipe 35 and the vent 36 to the steam space 13 or the steam can be caused to pass from the trap 32 through the pipe 37 which leads to the steam space of the boiler exteriorly.

To prevent any flooding of the purifier shown in Figure 1, the overflow pipe 38 which is covered by the plate 39 is provided. Any flooding of the enlarged portion 30 in Figure 4 is prevented by the overflow system, 35, 40 and 41 which will carry off any large quantities of water from 30 when they collect in such great amounts that the steam trap 32 is unable to receive the excess of water expeditiously.

When the collected moisture discharged from the purifier amounts to a substantial quantity it is economical to recover the heat therein by passing it through a heat interchanger. In Figure 4 the discharge from the steam trap passes through the line 56 through a closed type heater 57 where it transfers its heat to the incoming feed water in the line 58.

Figure 6 is a detailed showing of a preferred purifying element. These elements consist of a series of parallel rectangular plates 44 which are spaced apart by collars 45 which ride upon the tie-rods 46. The element has an open bottom 22, an inlet side 42 and an exit side 43. On the lower inside corner of the purifying elements at regular intervals the spacing collars are replaced by blocks 47 to which the plate 48 is attached by the retaining screws 49. It will be noted that the plate 48 cooperates with the lower residual portion of the internal wall of the purified steam conduit to prevent direct passage of the steam through the lower part of the purifying element so that the separated liquid will drain smoothly and easily therefrom into the collecting chamber. The steam being purified will be directed into the upper part of the purifying element. The ends of the purifier sections are provided with the spacing plates 50, which may be slightly bulged, which make a tight fit against the ends of the purifier casing, and which also provide a space for the nuts 51 which hold the tie-rods 46 in position. The plates 44 are provided on either side with staggered semi-tubular lipped deflecting vanes 52 or other deflecting members which will provide pockets or gutters for the drainage of the impurities. It will be noted that both the pockets and sinuous passageways formed by the semi-tubular members are altogether free of horizontal partitions so that any liquid separated in the pocket or in the sinuous passageway may flow directly downwardly. Other forms of purifying elements containing suitably shaped and positioned deflecting members or baffles and gutters or pockets can be used in place of those shown in Figure 6 and described above.

The purifying elements are held within the casing by means of the bolted lugs 53. Upon removal of the collecting chamber casing after taking out bolts 54 it is very easy to remove the lugs 53, and then remove the vertically sloping elements 17 through the bottom of the casing. In the modified construction shown in Figure 2 it is also necessary to remove the retaining screws 55 which assist in holding the purifying sections in place through the sealing plate 28.

The purifier is held in position in the steam space of the boiler shell by means of the plates 65 which are suspended from the brackets 66 by the bolts 67. The brackets 67 are attached to the boiler shell by means of the bolts 68. The casings for the purified steam conduits are attached to these plates by means of the flanges 72 (preferably by bolts not shown). In the embodiment of the invention shown in Figures 2 and 5 the baffle plates 16 and the sealing plates 28 are also attached to the plate 65 by means of the ears 70 and 64 and the bolts or screws 71 and 55 respectively.

In Figure 1 the steam entering the purifying sections through the passages 14 and the space 15 makes substantially a 180° turn. It then passes through the purifying elements 17 and, after being purified, is admitted to the current of steam passing through the conduits 19 at the outer edges of the steam current with a minimum of eddying and frictional loss. The initial turn of substantially 180° before admission to the elements 17 causes the current of steam to discharge the excess moisture which will be thrown into the collecting chamber 21 and will pass off through the continuously sloping drain 29. This excess moisture may fall or pass into the collecting chamber 21 either through the central steam admission space or through the inner edges of the steam purifying elements, which as stated above are altogether free of horizontal partitions. Any moisture which might collect in the purified steam conduits 19 is readily drained into the chamber 21 through the seals 24. In case excessive quantities of water are carried into the purifier due to priming, such quantities are readily conducted into the chamber 21 without over-

loading any of the purifying elements and from this chamber they are drained back into the boiler through the overflow 38.

In Figure 2 the steam is caused to pass through a turn of substantially 180° at a point near the bottom of the central admission space 15 by the baffles 16. This will cause the excess moisture and impurities to be expelled. The moisture collected in the purifying elements 17 will drip down through the open bottoms 22 into the compartment 26 which is sealed from the admission space 15 by the plates 28 so that no by-passing of the steam will take place. The seals 24 (Figure 1) and 25 (Figure 2) will prevent any by-passing of steam from the collecting chamber 21 to the conduits 19.

The collected water in the bottom of the chamber 21 will flow out through the sloping drain pipes 29 along the lower part of said sloping pipes while the displaced steam will flow up along the upper portion of the sloping drain pipe under the baffle plate 33 and up through the vent 34 (see Figure 2). This will prevent any stoppage or clogging of the pipe due to the inlet end thereof being covered by water. The drain pipe system 29 is made continuously sloping so that there will be no vertical or horizontal portions which might fill up with the descending water and retard the return flow of steam.

In Figure 4 any excessive amounts of water which may be carried into the steam purifier casing are collected in the enlarged portion 30 of the sloping pipe 29 and will be held there until they are discharged through the steam trap 32. In case very large quantities of water beyond the capacity of the trap should collect in the enlarged portion 30 as soon as the level of such water reaches the return bend 40, the water will overflow through pipe 41 back to the water space of the boiler. In Figure 4 the steam from the trap may be vented directly back into the steam space by the exterior pipe 37 or it may be conducted into the enlarged portion 30 and vented by the pipe 36 which also will vent the enlargement 30. The steam can be vented back into the steam space only when there is no material drop in pressure through the steam purifier.

In Figure 6, the steam is forced through a wavy, undulating motion past the deflecting vanes 52 and in so doing expels the finely divided moisture, the larger particles having already been separated, into the pockets or gutters formed by said vanes, which pockets or gutters conduct the moisture down into the collecting chamber 21. The pockets or gutters are sloped at an angle of more than 45° to the horizontal so that they will drain very readily and so that there will be very little possibility of their flooding. The steam enters through the inlet side 42 of the element and passes out through 43 and the collected moisture readily drains out through the open bottom 22. It will be noticed that the purifier elements 17 are so arranged that the flow of vapor through the purifier will be as smooth as possible with very little loss due to friction or eddying. The deflecting members offer impinging surfaces at small angles to the direction of the vapor current, which reduces the eddying and frictional loss to a minimum. It will also be noted that a means is provided for first separating excessive quantities or slugs of water from the steam before it is admitted to the purifying elements 17, which carry on the finer separation, by causing it to change its direction abruptly in the central admission space 15.

By changing the width of the opening between the baffles 16 at the bottom of the central admission spaces 15, it is possible to equalize or distribute the flow of steam through the different purifier sections, which may be more or less removed from the steam nozzle.

In Figures 1 and 2 the upper part of the boiler shell 11 forms with the upper part of the purifier casing, a steam passage 14 which will cause the steam to enter the central admission space 15 at a point farthest removed from the water line.

By the expression "vertically slanting" used in the claims it is meant that the purifying elements slant more to the horizontal than to the vertical, the angle to the horizontal being preferably more than 45°. This positioning of the purifying elements prevents flooding and provides a ready drainage of the elements, and this arrangement also enables a relatively horizontal passage of the steam through such purifier.

Furthermore, this relatively vertical position of the purifying elements facilitates their removal as previously described.

What is claimed is:

1. In a steam purifier-boiler combination, purifiying elements within said purifier, means for admitting steam to said elements from the steam space of the boiler, a conduit for the purified steam from the said elements, a drain conduit from said purified to a point exterior to the boiler and a vent to the drain conduit extending upwardly into the vapor spaces within the boiler until it is substantially above the highest liquid levels to permit of ready liberation of the displaced vapor from said drain conduit.

2. In a steam purifier-boiler combination, purifying elements within said purifier, means for admitting steam to said elements from the steam space of the boiler, a conduit for the purified steam from the said elements, a drain conduit from said purifier to a steam trap, a vent to the drain conduit

extending upwardly into the casing a substantial distance above the bottom thereof until its opening will be above the highest liquid level therein.

3. In a steam purifier-boiler combination, purifying elements within said purifier, means for admitting steam to said elements from the steam space of the boiler, a conduit for the purified steam from the said elements, a drain conduit from said purifier to a steam trap, said conduit having an enlarged portion within the boiler shell and being vented to the steam spaces of the boiler and being of sufficient capacity to hold abnormal quantities of water separated by said purifier.

4. In a steam purifier-boiler combination, purifying elements within said purifier, means for admitting steam to said elements from the steam space of the boiler, a conduit for the purified steam from the said elements, a steam trap, a drain conduit from said purifier to said steam trap, and a vent for said drain conduit being vented to the steam space of the boiler, said vent being connected to an enlarged portion of the drain conduit where the vapors and gases will collect.

5. In a steam purifier-boiler combination, purifying elements within said purifier, means for admitting steam to said elements from the steam space of the boiler, a conduit for the purified steam from the said elements, a drain conduit from said purifier to the exterior of the boiler having an enlarged portion within the boiler shell, an overflow means for returning abnormal quantities of water to the boiler from said enlarged portion and a vent from said enlarged portion to the steam space of the boiler.

6. In a steam purifier-boiler combination, opposed purifying elements within said purifier, a central steam admission space communicating with the steam space of the boiler, a conduit for the purified steam from the said elements, a collecting chamber for the separated impurities, the steam admission space, the purifying elements and the purified steam conduit all draining directly into said collecting chamber.

7. In a steam purifier-boiler combination, opposed purifying elements within said purifier, a central admission space for admitting steam to said elements from the steam space of the boiler, a conduit for the purified steam from the said elements, a collecting chamber for the separated impurities, said collecting chamber being placed at a lower level than said purified steam conduit and means for drainage of said conduit into said collecting chamber.

8. In a steam purifier-boiler combination, opposed purifying elements within said purifier, a central admission space between said elements communicating with the steam space of the boiler, a conduit for the purified steam from the said elements, the central steam admission chamber, the purifying elements and the purified steam conduit being substantially on the same level so as to cause a substantially horizontal passage of the steam therethrough.

9. In a steam purifier-boiler combination, purifying elements within said purifier, a steam admission space communicating with the steam space of the boiler, a conduit for the purified steam from the said elements, a collecting chamber for the separated impurities, rapid drainage means into said collecting chamber from the steam admission space, purifying elements and purified steam conduit, and means for preventing bypassing of steam in said collecting chamber around said purifying elements.

10. In a steam purifier, a pair of oppositely vertically sloping purifying elements with a central steam admission space therebetween, and means for causing the entering steam to change its direction through substantially 180° upon passing through said admission space before admission to said purifying elements.

11. In combination with a boiler, a steam purifier comprising opposed purifying elements, a central space between said elements for admitting impure steam from the steam space of the boiler to such elements, a conduit for removing the purified steam from the elements, and downwardly extending baffles in said admission space over the entrance of said elements.

12. In combination with a boiler, a steam purifier comprising opposed purifying elements, a central steam admission space communicating with the steam space of the boiler between such elements, a conduit for removing the purified steam from the elements, downwardly extending baffles in said steam admission space so as to cause the steam to pass through abrupt changes of direction before admission to said purifying elements, said baffles being arranged so as to distribute the steam evenly through the elements.

13. In combination with a boiler, a steam purifier comprising purifying elements, a means for admitting impure steam from the steam space of the boiler to such elements, a conduit for removing the purified steam from the elements, and a sloping distributing plate at the exit side of said elements positioned over the central portion of the outlet side of the purifying elements so as to prevent direct passage of steam from said central portion into said conduit and uncovering the upper and lower portions of said outlet side so as to permit the direct passage of steam from said upper and lower portions into the purified steam conduit.

14. In a steam purifier-boiler combination, a steam purifier, opposite purifying elements within said purifier, a central space between said elements for admitting steam to said elements from the steam space of the boiler, a conduit for the purified steam from the said elements, a collecting chamber for receiving the separating moisture, said collecting chamber being removable and said elements being at an angle of more than 45° to the horizontal and the inlet sides being less than an angle of 90° to each other so as to permit of ready removal downwardly for cleaning.

15. In a horizontal flow purifier adapted to fit in the steam space of a boiler, purified fluid conduits, an admission space, a collecting chamber, and purifying elements comprising a series of parallel vertical rectangular plates positioned in the purifier so that the plates will be perpendicular to the center line of the boiler shell, the top edges of the plates being enclosed, the inside edges of the plates being in the sides of the admission space, the outside edges of the plates fitting in an opening in the purified fluid conduits and the lower edges being unenclosed and in the top wall of the collecting chamber.

16. A fluid purifier comprising symmetrically positioned purified fluid conduits, purifying elements attached to the inner sides of said conduits and an admission space between the adjacent faces of said purifying elements and a collecting chamber below said purifying elements, admission space and purified fluid conduits adapted to receive separated moisture therefrom.

17. In a steam purifier-boiler combination, purifying elements within said purifier, means for admitting steam to said elements from the steam space of the boiler, a conduit for the purified steam from the said elements, a drain conduit from said purifier to a steam trap, said conduit having enlarged portions both within and without the boiler, a trap mechanism placed within the enlarged portion without the boiler and a vent from the enlarged portion within the boiler to the steam space of the boiler.

18. In a horizontal flow vapor purifier, an admission space, a purified vapor conduit, a collecting chamber, and a purifying element comprising a series of parallel, vertical, rectangular plates positioned in the purifying element so that the plates will be parallel to the direction of vapor passage and perpendicular to the horizontal, the top edges of the plates being enclosed, the entrance edges of the plates being in the sides of the admission space, the exit edges of the plates fitting over an opening in the purified vapor conduit and the drainage edges being unenclosed in the top wall of the collecting chamber, the element being free of all horizontal baffles and partitions.

19. In a horizontal flow vapor purifier, an admission space, a purified vapor conduit, a collecting chamber, and a purifying element comprising a series of parallel and vertical partitions positioned in the purifying element so that the partitions will be parallel to the direction of vapor passage and perpendicular to the horizontal, the top edges of the partitions being enclosed, the entrance edges of the partitions being in the sides of the admission space, the exit edges of the partitions fitting over an opening in the purified vapor conduit and the drainage edges being unenclosed in the top wall of a collecting chamber, the elements being free of all horizontal baffles and partitions, and the admission space, the purified vapor conduit and the purifying element being all positioned so as to cause a substantially horizontal passage of vapor therethrough.

20. In a horizontal flow vapor purifier, an admission space, a purified vapor conduit, a collecting chamber and a purifying element comprising a series of rows of deflecting elements positioned in the purifying element so that the rows will be parallel to the direction of steam passage and perpendicular to the horizontal, the top edges of the series of rows being enclosed, the entrance edges of the series being in the sides of the admission space, the exit edges of the plates fitting over an opening in the purified vapor conduit and the drainage edges being unenclosed in the collecting chamber, the elements being free of all horizontal baffles and partitions, and said admission space, purifying element and purified vapor conduit being positioned above said collecting chamber and being adapted to drain into said collecting chamber.

21. In a vapor purifying element, a plurality of parallel partitions adapted to form a series of narrow passageways, a plurality of vertical semi-tubular members attached to said partitions forming vertical pockets adapted to entrap the moisture contained in said vapor, a chamber adjacent to and below the ends of said pockets for receiving the moisture collected and discharged thereby, and means comprising a vertically disposed baffle for preventing the direct horizontal flow of vapor through the lower portion of said narrow passageways.

22. In a vapor purifying element, a plurality of parallel partitions adapted to form a series of narrow passageways, a plurality of vertical semi-tubular members attached to said partitions forming vertical pockets adapted to entrap the moisture contained in said vapor, a chamber adjacent and below the ends of said pockets for receiving the moisture collected and discharged thereby, and plates over the lower portions of the

entrance and exit sides of said purifying element for preventing the direct flow of vapor through the lower portion of said narrow passageways.

23. In a vapor purifying element, the combination of a conduit for a flowing vapor, a plurality of parallel partitions vertically arranged within said element, members mounted on said partitions forming sinuous passageways and pockets adapted to entrap moisture, said pockets and sinuous passageways being closed at their upper ends and open at their lower ends to permit liquids to be discharged freely downwardly, and a collecting chamber below the discharge ends of said pockets and sinuous passageways for collecting the separated liquids directly from and below the sinuous passageways and pockets.

24. In a vapor purifying element construction, a series of parallel, rectangular plates, tie rods passing through the corners of said plates, spacers upon said tie rods for separating said plates, and a series of tubular elements attached to the opposite sides of said plates in staggered relationship so as to form a series of moisture collecting pockets and sinuous passageways therebetween.

25. In a steam purifier-boiler combination, purifying elements within said purifier, means for admitting steam to said elements from the steam space of the boiler, a conduit for the purified steam from said elements, a trap exterior of said boiler, a drain conduit between the purifier and the trap, and a vent opening at one end into the drain conduit intermediate the purifier and trap and at the other end into the steam space of the boiler.

In testimony whereof we have hereunto subscribed our names.

WALTER J. HUGHES.
WALTER H. GREEN.
ALBERT B. HODGES.