United States Patent

Smith

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[54] DISTILLATION APPARATUS HAVING CONCENTRIC RISER, EXPANSION AND CONDENSING CHAMBERS

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[52] **U.S. Cl.**.....**202/187,** 202/189, 202/196, 202/200, 203/10

[51] **Int. Cl.**.....**B01d 3/00**

[58] **Field of Search**.....202/189, 190, 192, 193, 194, 202/195, 196, 200, 185, 187, 197, 182; 203/10, 11, 88

[56] **References Cited**

UNITED STATES PATENTS

1,369,438	2/1921	Jewell	202/194
87,029	2/1869	Dayton	202/189 X
748,564	12/1903	Stocker	202/196 X
806,450	12/1905	Barnstead	202/193
1,043,305	11/1912	Dvensing	202/189
2,254,538	9/1941	Newman	202/193
2,475,482	7/1949	Clemens	202/194 X
3,318,784	5/1967	Murphy	203/11 X
3,362,891	1/1968	Meyers	202/189 X
3,522,149	7/1970	Arvan	203/11 X

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[57] **ABSTRACT**

An apparatus and process for purifying water by distillation and subsequent condensation. The impure water is heated to form a distillate which is moved in a rotational path, expanded condensed and recovered. The recovered condensate contacts only materials not imparting impurities thereto and does not contact the outer shell of the purifying apparatus. Rotational movement is imparted by means of a riser having baffled openings from which the steam exits into an expansion zone.

2 Claims, 3 Drawing Figures

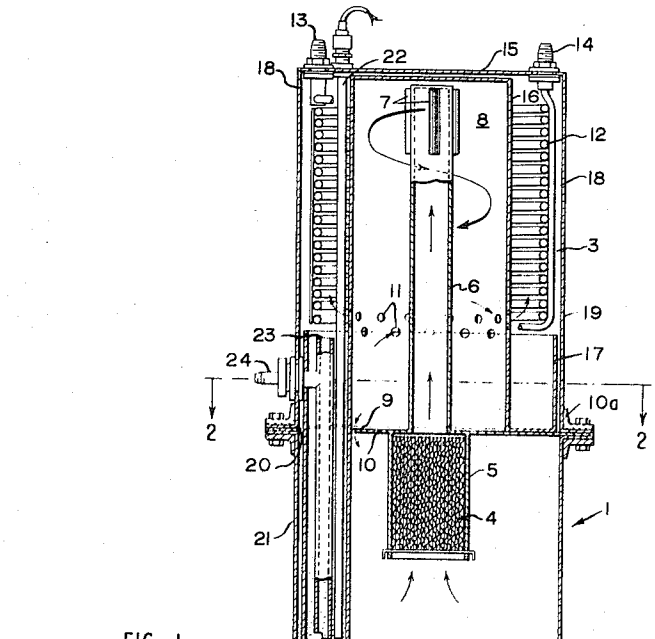
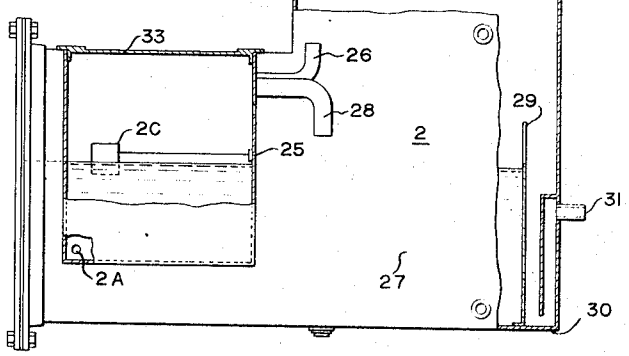


FIG. 1



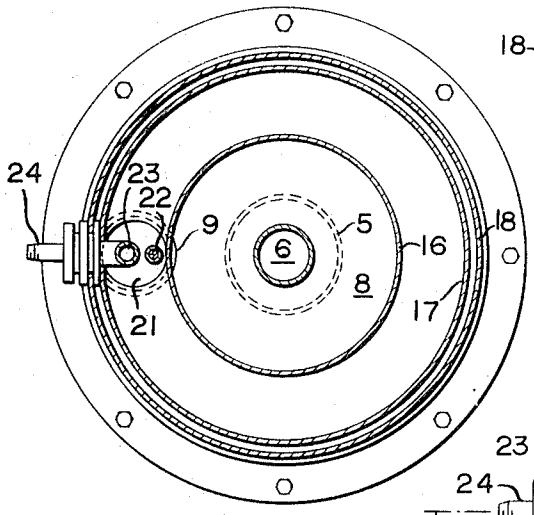


FIG. 2

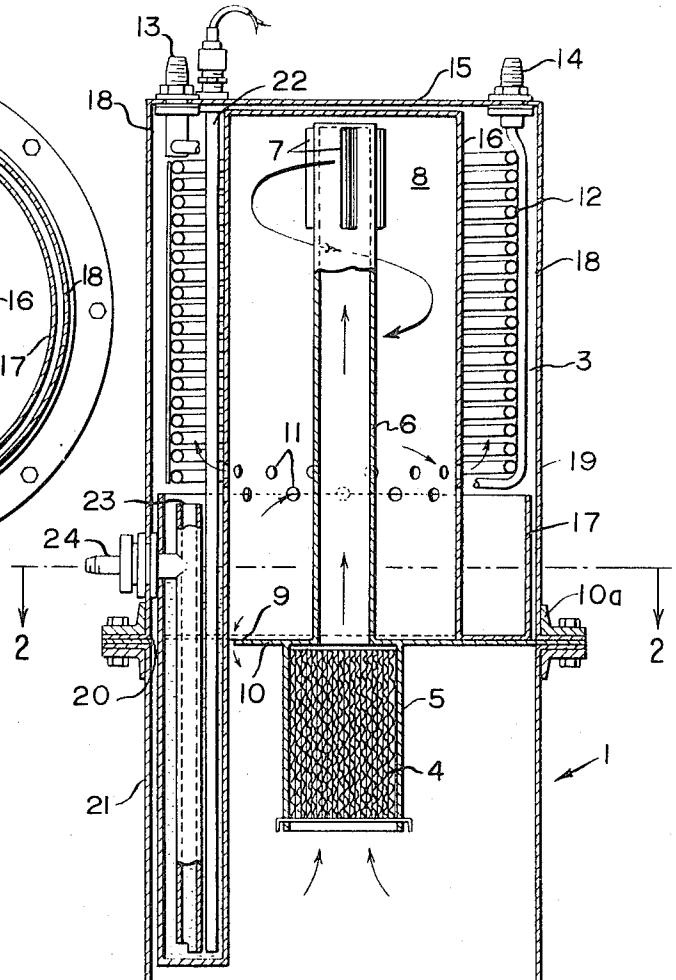
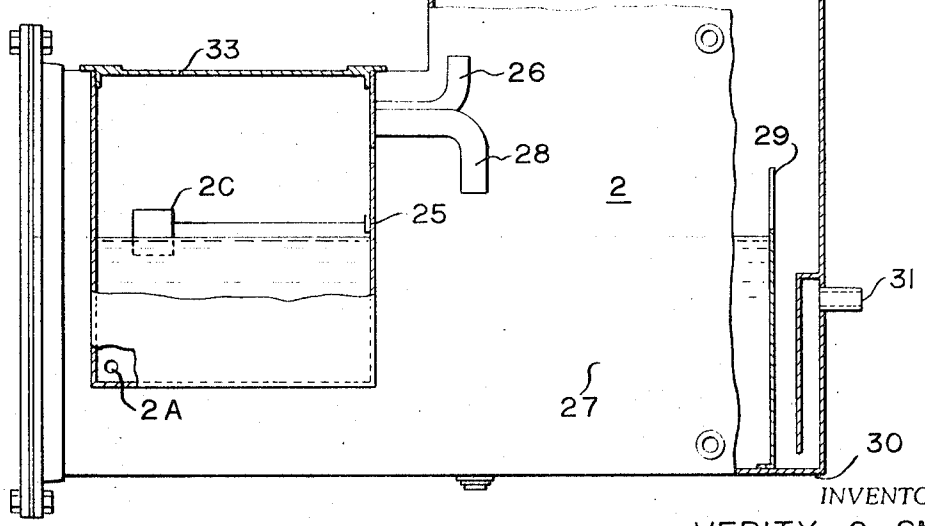


FIG. 1



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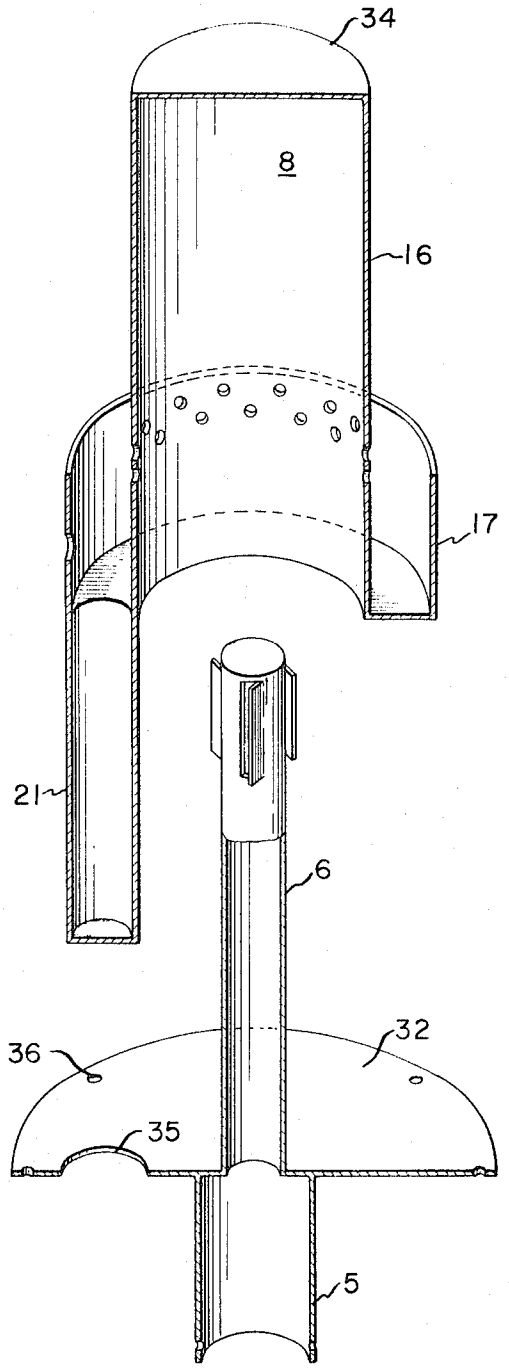


FIG. 3

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DISTILLATION APPARATUS HAVING CONCENTRIC RISER, EXPANSION AND CONDENSING CHAMBERS

This invention relates to a method and apparatus for purifying water by distillation.

At the present time a large number and wide variety of methods and apparatus for purifying water by distillation and subsequent condensation are employed. In many of these processes and apparatus, steam emerges from the distillation zone into the condensation zone at a relatively high velocity and scours the solid surfaces of the apparatus which it contacts. This scouring action is undesirable because the steam dissolves or entrains material from the walls and thereby becomes impure. It has been proposed to employ specialty high cost alloys or pure metals which do not introduce impurities into the steam under its scouring actions and furthermore do not partially ionize in the steam. However, these alloys or pure metals are expensive and a reduction or elimination of their use while maintaining high purity of the steam and condensate would be desirable. It is important that the purification apparatus can be dismantled easily for inspection of all surfaces coming in contact with the distilate and condensate. This allows the operator to easily and completely dismantle the apparatus into its component parts for inspection to determine whether repair is required.

In accordance with the present invention there is provided a process and apparatus for purifying water by distillation and subsequent condensation. Impure water is first heated in a distillation zone to form steam. The steam passes from the distillation zone through a riser which is constructed to cause the steam exiting therefrom to move in a circular path. By moving the steam in a circular path its velocity is reduced thereby reducing its scouring action on the apparatus. The steam passes from the riser through an expansion zone and into a condensation zone. Any liquid material formed in the expansion zone is collected and recycled to the distillation zone. The condensate collected in the collection zone can be all the condensate formed or only that which does not form on the side walls of the outer shell enclosing the condensation and distillation zones. The purified water is then recovered from the collection zone. The collected condensate contacts only materials which do not impart impurities to the thereto; such as tin coated copper, tin, titanium, stainless steel aluminum or the like. Any distillate which is condensed on a solid surface other than that produced from this type of material is recycled to the distillation zone. In this manner, the use of high cost materials can be minimized and the purity of the water product is maintained uniformly high.

The apparatus of this invention comprised an outer shell forming a lower distillation zone and an upper condensation zone. A riser is located above the distillation zone and is in open communication therewith. A filter may be provided between the riser and distillation zone to entrain impurities. The riser is provided with outlets which direct the emitted steam in a circular path. The riser outlets are in communication with an expansion zone in which any liquid formed prior to entering the condensation zone is recycled to the distillation zone. The expansion zone is generally concentric with the riser to minimize the height of the outer shell and has a volume sufficiently large to permit expansion of the steam exiting from the riser and thereby reduce its pressure. The steam exits through holes in the walls of the expansion zone into the condensation zone which generally surrounds the expansion zone. The condensed steam is passed from the condensation zone to a collection zone located below the condensation zone to collect only steam condensed on solid surfaces made from materials which do not add impurities to the water. The only parts of this apparatus that need be made from expensive metals or alloys are the expansion zone and collection zone, the top plate of the outer shell, and cooling coils. The collection zone also can be provided with heating means to vaporize dissolved gasses in the condensate prior to recovery. The condensate is recovered from the collection zone through an outlet extending through the outside wall of the apparatus.

FIG. 1 is a vertical cross-sectional view of the apparatus of this invention.

FIG. 2 is a top view of the apparatus of FIG. 1 taken through Line 2—2.

FIG. 3 is an exploded view of the two inner sections of FIG. 1 which form the riser, expansion zone and collection zone.

Referring now to FIG. 1 a water purification apparatus 1 is provided with a lower distillation zone 2 and an upper condensation zone 3. Impure water is introduced into the distillation zone 2 through an opening 2a in the wall thereof, regulated by float feeder 2c and is heated by means (not shown) to a temperature to distill the water therein. The distillate passes upwardly into a filter 4, which is retained by housing 5. In filter 4 any entrained particles from the distillate are separated therefrom. The distillate passes upwardly from the filter 4 into a riser 6 the outer and inner surfaces of which are made from a material which does not introduce impurities into the steam under the conditions therein. The distillate passes from the riser 6 through baffles 7 into an expansion zone 8. Any material which condenses in the expansion zone 8 is recycled through hole 9 in plate 10 into distillation zone 2.

The distillate exits from expansion zone 8 through holes 11, into condensation zone 3. The distillate passes upwardly through condensation zone 3 and contacts a coil of condensation tubes 12. A coolant is cycled through the coil 12 through inlet 13 and outlet 14. Usually cold water is employed as the coolant and is then cycled in its heated condition to distillation zone 2. Any distillate condensing on the coil 12, the upper plate 15 of the condensation zone 3, the outer surface 16 of the expansion zone 8 or in the collection one 17 is collected in collection zone 17. Any distillate condensing on the inner surface 18 of the condensation zone 3 is collected on the portion 10*a* of plate 10 located between the collection zone 17 and the outer shell 19 of the condensation zone 3. The condensate collected on plate 10, is cycled to the distillation zone 2 through opening 20 in plate 10. The outer wall of the collection zone 17 is located below the coils 12 but not in contact with surface 18.

The condensate in the lower section 21 of collection zone 17 is heated by heater 22 to evolve any dissolved gasses in the condensate. The condensate is removed from the purification apparatus 1, upwardly through standpipe 23 and through outlet 24.

The distillation zone 2 is provided with a feedbox 25 having an overflow pipe 28 and a vent 26 equipped with an eductor or vent valve (not shown) for the relief of excess volatile gasses which may build up in the purification apparatus 1. The feedbox 25 is attached to the wall 27 of distillation zone 2 and has a cover 33 which can be removed to introduce water therein. The overflow pipe 28 is employed to maintain the desired liquid level in distillation zone 2. The distillation zone 2 is provided with a weir 29 which extends across the width thereof. Any foam which may form during distillation is passed over the weir 29 into trap 30 wherein the foam condenses to a liquid and is then removed through outlet 31. A liquid level is maintained in the trap 30 to prevent the introduction of impurities into the distillation zone 2 and the escape of steam from zone 2.

Referring to FIG. 2 the relationship between riser 6, expansion zone 8, and collection zones 17 and 21 are shown. The plate 32 is the lower support of the collection zone 17 from which extends the lower section 21 of the collection zone 17.

Referring to FIG. 3, the expansion zone 8 is defined by plate 32 wall 16 and top 34. The collection zones 17 and 21 are formed of a unitary construction together with wall 16 and plate 34. The section forming the collection zone is placed on plate 32 so that the lower portion of the collection zone 21 fits into opening 35 on plate 32. Plate 32 is provided with holes 36 to permit attachment thereof to the lower portion of the purification apparatus 1, as shown in FIG. 1. The plate 32, riser 6, and filter holder 5 are also formed of a unitary construction as shown. In an alternative embodiment, the plate 32, collection zones 17 and 21, riser 6 and filter retainer 5 can be

formed of unitary construction while the wall **16** and plate **34** can be formed of a separate component. When employing either embodiment, the resultant apparatus can be easily dismantled for inspection.

The process and apparatus of this invention provide substantial advantages over the prior art. The employment of the riser and baffles in combination provide a substantial reduction of the scouring reaction of rising steam by imparting thereto rotational movement. Furthermore, by taking care that the recovered condensate contacts only solid surfaces which do not impart impurities to the condensate, a substantial reduction can be effected in the surface area of the apparatus which need be formed from expensive alloys or metals. However, when it is desired to recover all the condensate, the collection zone can extend to contact the inside surface of the shell wall. In this embodiment, the inside surface of the shell wall is also made of a material which does not impart impurities to the distillate or condensate. It is not necessary to this invention that a filter be employed between the distillation zone and the riser or that the collection zone be formed of an upper section and a lower section. However, the use of the filter is preferred to insure against impurities being introduced into the condensation zone. The use of a collection zone formed of two sections is especially desirable when it is desired to heat all the product to remove dissolved gasses. The use of the collection zone construction shown in FIG. **1** insures that all the condensate will be heated prior to being recovered since all the condensate is contacted with the heater prior to being removed from the collection zone.

The preferred form of the apparatus of this invention is as shown in the drawings. The relatively concentric arrangement of the riser, expansion zone and condensation zone provide ease of manufacturing. In addition, the arrangement of the expansion zone to enclose the riser and the condensation zone to enclose the expansion zone minimizes the height of the overall apparatus. It is to be understood that the process and apparatus of this invention includes all means for effecting the described flow pattern of distillate and the described selective recovery of condensate.

The rate and temperature of distillation can be maintained within narrow limits to effect a temperature profile in the riser, expansion zone and condensation zone so that substantially all of the distillate is converted to condensate in the condensation zone thus, the distillate temperature in the riser can be maintained between about 100° C and 100.5° C. The distillate temperature in the expansion zone can be maintained between about 99.8° C and 100.2° C while the pressure of the steam exiting therefrom can be maintained between about atmospheric and atmospheric plus 1 inch of water.

Having thus disclosed my invention and described in detail a preferred embodiment thereof, what I claim and desire to secure by Letters Patent is:

1. Distillation apparatus which includes a distillation chamber and a condensation chamber, conduit means connecting said chambers and terminating in the condensation chamber as a generally vertical riser having tangentially directed outlet ports, on the side of the riser cooling means in said condensation chamber spaced from and surrounding said riser, vertical wall means defining an expansion chamber surrounding said riser and situated between said riser and said cooling means, said wall means having openings below the level of said ports communicating to the said cooling means, and condensate collecting means beneath said cooling means.

2. Apparatus as defined by claim **1** wherein the inside of said expansion chamber communicates through drainage means with the distillation chamber.

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