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DISTILLATION APPARATUS UTILIZING FRICTIONAL HEATING AND COMPRESSION OF VAPORS

Filed July 7, 1966 2 Sheets-Sheet 1

FIG.1

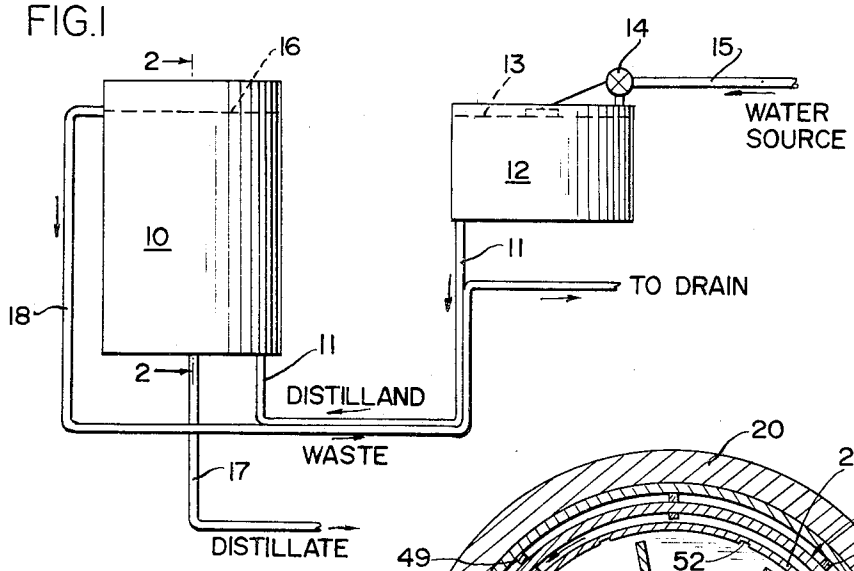


FIG.3

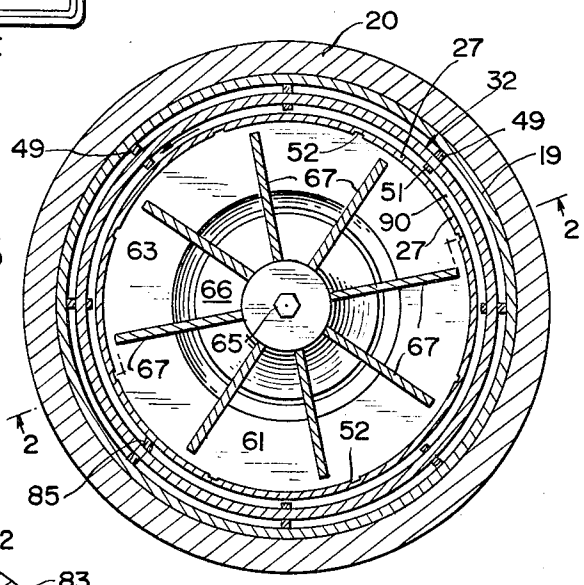
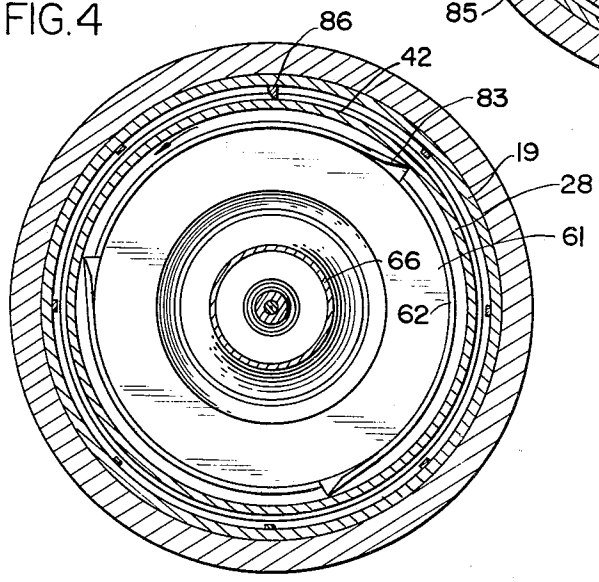


FIG.4

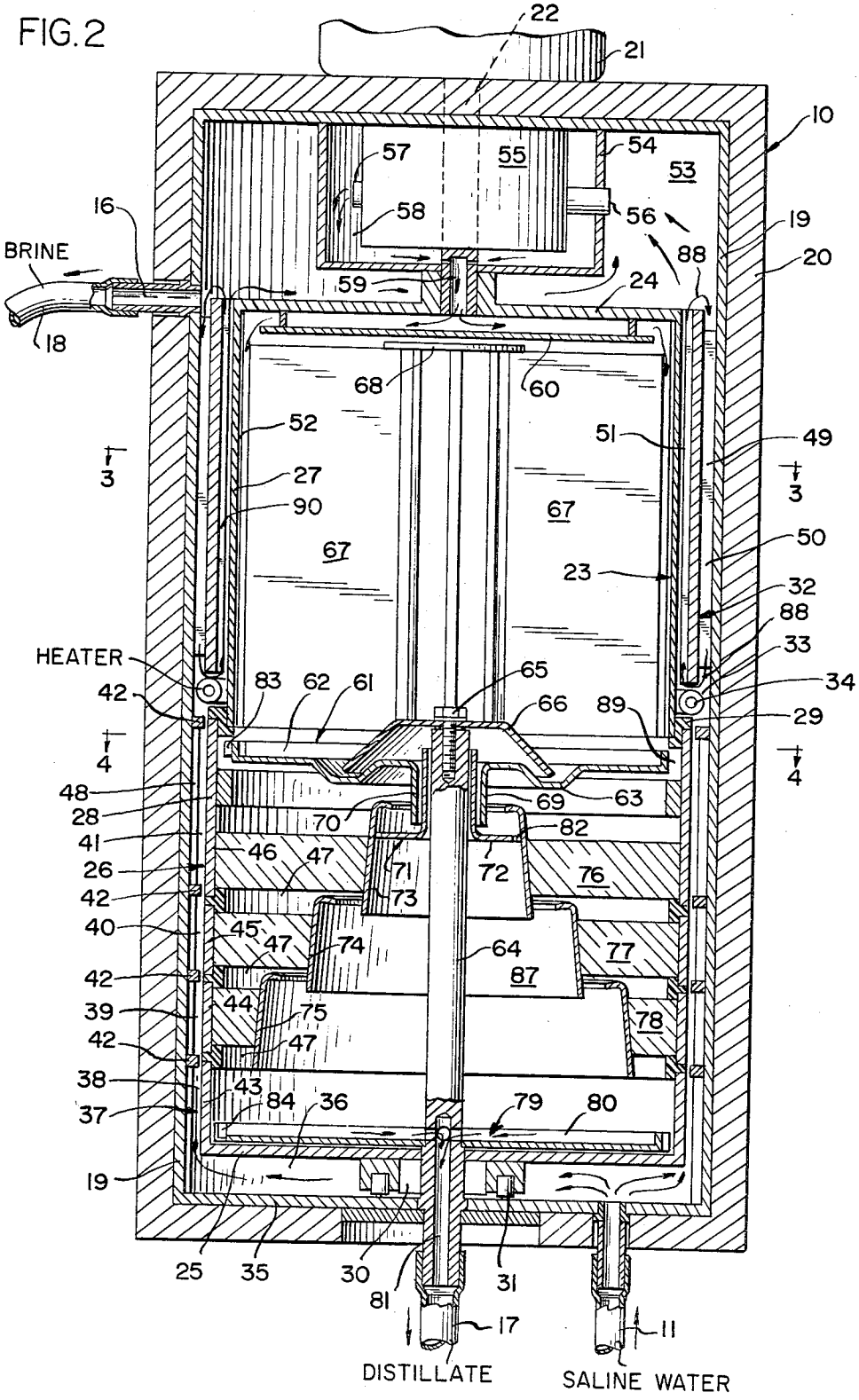


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FIG. 2



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DISTILLATION APPARATUS UTILIZING FRICTIONAL HEATING AND COMPRESSION OF VAPORS

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U.S. Cl. 202—187 4 Claims

ABSTRACT OF THE DISCLOSURE

A heat transfer apparatus for transferring heat between fluid masses in which a heat transfer surface member has opposite side surfaces in heat transfer contact with these masses together with means for moving this surface member and means for creating substantial relative movement between the surface member and at least one of the fluid masses with the result that the heat transfer from one mass to the other through the surface member is greatly enhanced due to this relative movement. The apparatus of this invention is particularly applicable to distillation apparatus which is also a part of the invention with the distilland being in contact with one of these surfaces for frictional heating thereof by the moving surface member and with the vapors resulting from heating the distilland being in contact with the other surface so that there will be efficient heat transfer through the surface member.

This invention relates to heat transfer apparatus for transferring heat between fluid masses separated by a heat transfer surface member that is movable with respect to at least one of these fluid masses.

One of the features of this invention is to provide an improved heat transfer apparatus for transferring heat between fluid masses separated by a heat transfer surface member including means for moving the surface member and means for creating substantial relative movement between at least one of the fluid masses and the heat transfer surface member with the result that the efficiency of the heat transfer between the moving surface member and at least one fluid mass is greatly improved.

In one embodiment of the invention the means for creating relative movement between the fluid mass and the heat transfer surface substantially prevents movement of the fluid mass in the same direction as the surface member.

In another embodiment the relative movement between the fluid mass and the heat transfer surface is obtained by directing the fluid mass moving at low velocity against the heat transfer surface moving at high velocity to thereby create substantial slippage between the fluid mass and the heat transfer surface to effect improved heat transfer.

Another feature of the invention is to provide such an apparatus in which one of the fluid masses has a higher viscosity than the other with the result that the moving heat transfer surface member generates heat by frictional drag on the fluid with the higher viscosity.

A further feature of the invention is to provide an improved heat transfer surface member having opposite side surfaces in contact on one side with a distilland and on the other side with a distillate, means for moving the surface member relative to the distilland and distillate, means for substantially preventing corresponding movement of the two fluids in order to improve the heat transfer from the hotter fluid through the surface member to the cooler distilland with the result that the heat transfer and the movement of the surface member relative to the distilland vaporizes the distilland and means for transferring this vapor from the distilland side of the surface member to the distillate side for condensation therein to produce said distillate.

Yet another feature of the invention is to provide means for compressing the vapors prior to their passage into the distillate side of the surface member.

A still further feature of the invention is to provide a distilling apparatus of any of the preceding features together with improved heat transfer means for heating the incoming distilland from the heat of the vapor and the distillate and at the same time cooling the vapor and the distillate by transfer of their heat to the incoming distilland.

Other features and advantages of the invention will be apparent from the following description of one embodiment thereof as shown in the accompanying drawings.

FIGURE 1 is a flow diagram of an apparatus including a water still embodying the invention.

FIGURE 2 is a vertical sectional view taken through the axial center of the still of FIGURE 1 along the line 2—2 thereof.

FIGURE 3 is a horizontal sectional view taken substantially along the line 3—3 of FIGURE 2.

FIGURE 4 is a horizontal sectional view taken substantially along the line 4—4 of FIGURE 2.

In the illustrated embodiment of the drawings the heat transfer apparatus is shown as embodied in a still such as a water still for recovering potable water from contaminated water. Because of the general nature of the invention, however, the apparatus of the invention is basically a heat transfer apparatus for transferring heat between fluid masses separated from each other by a movable heat transfer surface member having opposite side surfaces in contact with these masses. In order to achieve efficient heat transfer under these conditions with one fluid mass passing heat to the surface member and the other mass receiving heat from the surface member, the apparatus includes means for moving the surface member relative to the fluid masses and means for substantially preventing corresponding movement by at least one and preferably both fluid masses in the same direction as the movement of the surface member. When this apparatus is operated it is found that the insulating film of fluid, which is present when any fluid is in contact with a solid, is greatly reduced in thickness so that its insulating effect is reduced. Thus, the efficiency of the heat transfer is greatly increased.

As can be seen from the above description, the heat transfer apparatus of this invention lends itself ideally to a still. Thus, the moving heat transfer surface member generates heat in the liquid distilland. This heat generates vapors of the distilland which when directed into contact with the opposite side surface of the surface member (opposite to the side surface contacted by the distilland) efficiently transfers the heat from the vapors into the surface member and then from the surface member to the distilland to further aid heating and vaporization of the distilland. This heat transfer also causes the vapors to condense and form the distillate. The efficiency of the apparatus is further increased by providing means for compressing the vapors before they are directed to the vapor and distillate side of the movable heat transfer surface member. This is true because the compressing of the vapors raises the vapor temperature relative to the temperature of the distilland and this increased difference in temperature further increases the efficiency of heat transfer.

As stated above, the apparatus of this invention also provides means for utilizing the heat in the distillate for applying additional heat to the distilland. In order to supply the distilland to the final heat generating por-

tion of the heat transfer surface member the incoming distilland is stratified into successive zones of increasing temperatures prior to the final heat generating portion of the apparatus. Each of these zones is heated not only by the rotation of the apparatus but also by increasing the differential of movement between the exiting distillate and the incoming distilland in steps corresponding with the successive zones. This serves to increase the efficiency of heat transfer. In a specific embodiment the speed differential between the distillate and the distilland is increased from a low at the hottest zone to a high at the coolest zone. The result is that the heat transfer from the exiting distillate to the incoming distilland is at its peak at the coolest initial zone.

In the water still of the specific embodiment shown in the accompanying drawings the still **10** is supplied with contaminated water through a pipe **11** leading to the bottom of the still with the water flowing in this pipe from a supply tank **12** that is kept substantially filled to a predetermined level **13** as by means of a float controlled valve **14** in an inlet pipe **15**. The water level **13** in the supply tank **12** is exactly even with and therefore determines the water level **16** in the still **10**. In the flow diagram of FIGURE 1 the pure distillate water is withdrawn from the still through a bottom exit pipe **17**. The concentrated liquid containing the impurities is withdrawn from the top of the still **10** through an exit pipe **18** which leads to a drain or other place of disposal. Because the waste liquid in the pipe **18** is hot it is directed in heat transfer relationship with the incoming water in the supply pipe **11** in order to preheat with the incoming water in the supply pipe **11** in order to preheat this incoming water.

As is shown in the sectional view of FIGURE 2, the still **10** comprises a vertical cylindrical container **19** that is insulated on the top, bottom and sides by a layer of conventional insulating material **20**. Located on top of the container **19** is an electric motor **21** that rotates a vertical shaft **22** located substantially at the central longitudinal axis of the container **19**.

Positioned symmetrically within the container **19** is a heat transfer surface member or metal cylinder **23** having a top **24**, bottom **25** and a cylindrical side wall **26** in two end-to-end sections **27** and **28** interconnected at their adjacent ends by an insulating connecting ring **29**.

The cylinder **23** is connected to the lower end of the motor shaft **22** for rotation of the cylinder by the motor. The bottom end of the cylinder **23** is rotatably held in a bearing **30** surrounded by a fluid tight seal **31**.

Positioned between the upper section **27** of the rotatable cylinder **23** and the outer cylindrical container **19** is a fixedly mounted metal cylinder **32**. The bottom of this short upper cylinder **32** is spaced from the insulating ring **29** which is located between the top of the lower cylindrical section **28** and the bottom of the upper cylindrical section **27** to provide an annular space **33** in which is located an electric heater rod **34**.

The bottom **25** of the rotatable heat transfer cylinder **23** is spaced from the bottom **35** of the outer cylindrical container **19** to provide the supply space **36** into the bottom of which the supply pipe **11** empties as illustrated by the arrows at the bottom of FIGURE 2. The lower section **28** of the rotatable cylinder **23** has its outer surface spaced from the inner surface of the fixed cylinder **19** to provide the water flow space **37**. The space **37** is divided into a series of annular zones **38**, **39**, **40** and **41** progressing from the entrance or lower end of the space **37** to the exit or upper end thereof by a series of annular rings **42** fixed to the stationary cylinder **19** and extending toward but short of the outer surface of the lower rotatable cylinder section **28**. This lower section **28** is itself divided into subsections **43**, **44**, **45** and **46** by insulator connecting rings **47**. Each subsection **43–46** is approximately coextensive with each annular zone **38–41**. Extending inwardly of the fixed cylinder **19** into the water flow space **37** are a series of horizontally spaced vertical baffles **48** whose inner surfaces are positioned short of the inner surfaces of the horizontal rings **42**.

The space between the upper intermediate cylinder **32** and the outer fixed cylindrical container **19** is provided with a series of horizontally spaced vertical supports **49** which serve not only as supports for the intermediate cylinder **32** but also to divide the space **50** between the cylinders **19** and **32** into a horizontal series of vertical sections.

Located at the inner surface of the intermediate cylinder **32** and attached thereto are a series of horizontally spaced vertical baffles **51** which extend toward but short of the adjacent surface of the upper section **27** of the rotatable cylinder **23**.

As shown in FIGURE 3, the inner surface of the upper section **27** of the rotatable cylinder **23** is provided with vertical grooves **52** which are used to collect condensate in a manner to be described in detail hereinafter.

Located between the top wall **24** of rotatable heat transfer cylinder **23** and the top of the fixed cylinder **19** is a space **53** in which is located a cylindrical housing **54** containing a vacuum pump **55** with an inlet **56** communicating with the space **53** and an outlet **57** emptying into the space **58** between the pump **55** and the housing **54**. This pump is operated by the shaft **22** of the motor **21**. The space **58** into which the pump **55** exhausts is connected to the interior of the rotatable cylinder **23** at the top thereof through passages **59** in the motor shaft **22**. The passages **59** exit into the cylinder interior behind a circular baffle deflector **60** that is spaced from the top wall **24** and which has a circular edge extending toward but short of the inner surface of the upper cylindrical section **27**.

Beneath the bottom of the upper cylinder section **27** which is spaced inwardly of the lower cylinder section **28** is a hot condensate collection pan **61** having an annular outer wall **62** and a centrally located annular well **63**. This pan **61** is fixed in position on a vertical centrally located supporting rod **64** which passes through the bottom bearing **30** and the bottom **35** of the fixed cylinder **19**.

The top of the vertical axial rod **64** has attached to it as by means of a screw **65** an inverted dish-shaped steam trap **66** whose lower edge extends into within the annular well **63**. Mounted on this steam trap is a series of horizontally spaced vertical baffles **67** whose upper ends are connected by a strengthening disc **68**. The upper edges of these baffles **67** extend to short of the deflector **60** and their outer edges extend toward but short of the inner surface of the upper section **27** of the rotatable heat transfer cylinder **23**.

The hot condensate collecting pan **61** is located immediately beneath the bottom of the baffles **67**. This pan has a central annular portion **69** concentric with the supporting rod **64** and having sections spaced therefrom to provide liquid flow passages **70**. Located within this annular portion **69** is a deflector **71** with a bottom annular portion **72** beneath the bottom of the pan portion **69**.

Positioned around the supporting post **64** is a series of inverted flying cups **73**, **74** and **75** concentrically located with respect to each other and the supporting post **64** and increasing in diameter from the top cup **73** to the bottom cup **75**. The top cup **73** contains the deflector **71** whose outer edge is fixed to the inner surface of the cup **73** but which contains liquid flow openings **82** adjacent cup **73**. The upper cup **73** is generally horizontally aligned with the upper subsection **46** of the rotatable cylinder **23**. Similarly, the next lower cup **74** is generally horizontally aligned with the next lower subsection **45** and the lower cup **75** is generally horizontally aligned with the next lower subsection **44**. The lowest subsection **43** is beneath the edge of the lowest cup **75**.

The topmost inverted cup 73 is connected to the rotatable cylinder section 46 in heat transfer relation by a heat transfer ring 76 which may be made of a heat conducting metal such as aluminum. The next lower cup 74 is similarly connected to its subsection 45 by a ring 77 and the cup 75 is connected to its subsection 44 by a similar ring 78.

As can be seen from the above description, the supporting post 64, the condensate collecting pan 61, the steam trap disc 66 and the baffles 67 are fixed. The cups 73–75, the deflector 71 and the heat conducting rings 76–78 are rotatable with the heat transfer cylinder 23.

In order to collect cold condensate flowing downwardly from one cup 73–75 to the next and into the interior of the bottom rotatable subsection 43 there is provided a cold condensate collecting pan 79 that is mounted on the supporting post 64 immediately above the bottom wall 25 of the rotatable cylinder 23. This pan which has a generally annular rim 80 is fixed to the supporting post 64 and communicates through passages 81 in the supporting rod 64 with the exit pipe 17 for the distillate.

In order to aid in collecting distillate into the pan 61 the outer wall 62 is provided with spaced outwardly extending scoops 83 shown most clearly in FIGURE 4. The lower distillate collecting pan 79 is similarly provided with scoops 84.

In order to remove solids such as scale deposited from the distilland on the outer surface of the upper section 27 and lower section 28 of the rotatable cylinder 23 there are provided upper and lower scrapers 85 and 86.

The operation of the heat transfer apparatus of this invention as embodied in the illustrated water still operates as follows:

Contaminated feed water supplied from the tank 12 flows into the bottom of the insulated container 19 by way of the supply pipe 11. This water passes into the bottom supply space 36 and flows upwardly in the space 37 around the lower section 28 of the heat transfer cylinder 23 while the cylinder is being rotated by the motor 21 in the manner previously described. The water flowing upwardly is preheated by the frictional drag of the water against the rotating outer surface of the lower section 28. The water also receives heat in the manner described above from the distillate within the inner space 87 defined by the series of inverted cups 73–75. The water in the space 37 is divided into a succession of zones 38, 39, 40 and 41 by the annular rings 42 as well as the insulated divider rings 47. The result is that the water in each successive zone from the bottom zone 38 to the top 41 is at a higher temperature. This arrangement is very important as the water in the topmost space 41 is at the greatest temperature and there is not an averaging out of the water heat throughout all the zones as would otherwise occur.

At the start-up the electric heater 34 is energized so that the water leaving the upper zone 41 contacts this heater which raises it to the most efficient temperature before the water enters the final heating space 90 that is between the upper section 27 of the heat transfer cylinder 23 and the intermediate fixed cylinder 32.

After the start-up the electric heater rod 34 is deenergized as the rotation of the heat transfer cylinder 23 plus the heat transfer from the interior of the upper section 27 is sufficient to maintain the water at vaporizing temperature. As the water is heated, vapors thereof pass into the upper vapor space 53 above the top wall 24 of the heat transfer cylinder 23 where they are drawn into the inlet 56 of the pump 55, compressed and exhausted by way of the space 58 and passengers 59 into the interior of the cylinder section 27, being directed toward the inner surface of the cylinder by the top deflector baffle 60.

The baffles 51, which extend toward the rotating cylinder 23 from the fixed cylinder 32, substantially prevent movement of the water in the same direction as the cylinder 23. In other words, the baffles 51 substantially prevent arcuate movement of the water with the cylinder to thereby provide the desired relative movement or slippage between the cylinder 23 and the water.

In order to achieve thorough heating of the water in the space 90 the liquid water is recirculated as indicated by the arrows 88 of FIGURE 2, that is, the water passes over the top of the intermediate cylinder 32 and down between the mounting baffles 49 for this intermediate cylinder to the bottom thereof and then back up into the bottom of the space 90. This recirculation flow is brought about by the pumping action of the rotating cylinder section 27 and by the differences in temperature of the recirculated water.

The vapors flowing from the vapor space 53 through the pump 55 into the interior of the rotating cylinder section 27 are at a higher temperature within the section than they would be if they were uncompressed. In one embodiment of the invention the water entered the bottom of the still at about 60° F. The motor 21 rotated the cylinder 23 at about 1750 r.p.m. The addition of heat at start-up only by the heater 34 in combination with the slight pumping action of the rotating cylinder causes the recirculation as previously described. After this additional period the heat supplied by the frictional drag as well as heat transfer from the interior of the cylinder section 27 will maintain the heat balance and thus maintain boiling of the water at the top of the space 90. In this embodiment the space 53 was under a slight vacuum of 3–4 p.s.i. so that the boiling point of the water in the space 87 was only about 200° F.

Because the pump 55 imparts a pressure differential of about 3–4 p.s.i., as described, the temperature of the steam and water vapor in the interior of the cylinder section 27 is about 210° F. Because of this temperature difference, the steam condenses on the inner surface of the top section 27 and by centrifugal force the condensate is immediately collected in the vertical grooves 52. This not only aids in flowing the condensate downwardly to the collecting pan 61 but also removes the condensate water from the major portion of the inner surface of the cylinder section 23 so that it cannot retard heat transfer. As is well known, thin layers of water are very efficient heat insulators.

As the steam condenses on the inner surface of the drum section 27, the heat of the steam as well as the heat of condensation is transferred through the section 27 to apply further heat to the distilland flowing upwardly in the space 90. As soon as this generation of steam and resulting condensation thereof, as described, has commenced, the heater 34 can be de-energized as no longer needed.

The condensate or distillate flows by gravity down inner surface channels 52 into the collection area 89 that is generally between the insulator ring 29 and the rim 62 of the collecting pan 61. The build-up of distillate in this area permits scoops 83 to intercept the distillate and scoop it into the pan 61 toward the center thereof. This distillate flows beneath the edge of the steam trap 66 and through the space 70 to the rotating deflector 71.

The rotating deflector 71 flings the distillate outwardly against the inner surface of the first inverted cup 73. It then flows down the inner surface of the rotating cup and is flung from the lower edge thereof against the inner surface of the next lower cup 74. From here it likewise is projected from the lower edge of this cup 74 to the inner surface of the next succeeding cup 75. Finally, it is projected from the lower edge of this last cup 75 against the inner surface of the lowest subsection 43 of the lower section 28 of the heat transfer member. As can be seen in FIGURE 2, each successive cup is of larger diameter with the cylinder subsection 43 at the bottom of the largest diameter of all.

The purpose of the inverted cups and the heat transfer members 76, 77 and 78 surrounding them is to transfer efficiently the heat from the hot distillate in the pan 61 to the counter-flowing distilland in the space 37. This is

achieved as in the upper cylinder section **27** not only by efficient heat transfer members but also by having a large differential between the speed of movement of the distilland and the distillate. The distillate leaving the pan **61** by way of the passages **70** is at zero velocity because the pan and the passage are stationary. The inner surface of the first cup **73**, however, is rotating at a linear velocity governed by the diameter of the cup and the speed of rotation of the cylinder **23**. This acceleration of velocity in the hot distillate from zero causes slippage between the distillate and the cup. As discussed previously, this slippage increases the heat transfer efficiency between the distillate and the cup **73**. This heat is thereupon immediately transferred by the member **76** to the upflowing distilland in the space **41**.

If the distillate were allowed to remain on the inner surface of the cup **74** indefinitely, it would eventually accelerate to the velocity of the cup and the heat transfer would thereby be at a low efficiency. In order to avoid this, the distillate is not permitted to remain on the inner surface of the cup **73** but is immediately transferred from this surface by a combination of gravity flow and the rotational speed of the flared cup to the next lower cup **74** which is of larger diameter. The flinging of the distillate against the inner surface of cup **74** which is moving at a higher linear velocity than the smaller cup **73** causes the slippage to be even greater. There is therefore an even greater heat transfer efficiency than in the preceding cup. Next, the distillate flows from the lower edge of the cup **74** and is projected from this lower edge to the last and largest cup **75** where slippage is again greater. Thus, the heat transfer in the successive cups from the distillate to the distilland in the space **37** becomes more and more efficient from the top cup **73** to the bottom subsection **43** not only because the slippage becomes greater but also because the distance of heat transfer from the successive cups **73**, **74** and **75** to the space **37** is through smaller and smaller cross sections of the heat transfer members **76**, **77** and **78**.

The horizontal baffle rings **42** and the insulated spacers **47** isolate the successive zones **38**, **39**, **40** and **41** of the incoming distilland, as previously described. Thus, the temperature of the distilland in these sections is not a composite of all sections but is measurably different in each section. Thus, in the specific embodiment where the inlet water was at about 60° F. the temperature in the bottom space **36** was 60° F. but then was about 100° F. when leaving the first isolated space **39**, 140° F. leaving the next higher space **40** and 180° F. leaving the topmost space **41**. Thus, because of the separating into the different zones or stratification by the horizontal baffles **42** and insulator rings **47**, the distilland is at its highest possible temperature when it enters the final heating space **90**. Because of the vacuum in the vapor space **53**, as previously described, the boiling point is only 200° F. so that only suffiicient heat must be added to raise the temperature of the water the additional 20° F. This is accomplished as previously described by the frictional drag of the outer surface of the cylinder sectional **27** on the upwardly flowing water and also by heat transfer from the interior of this upper section during which the vapor within this interior is condensed.

At the bottom of the space **87** the scoops **84** direct the distillate toward the support rod **64** and through the passages **81** therein to the exit pipe **17**. The water in the exit pipe **17** is distilled or potable water ready for use.

As can be seen from the above description of the invention and the single illustrated embodiment thereof, the applications of the invention are numerous. Thus, in addition to the still shown and described, the invention can be used as a liquid heater and as an apparatus for achieving highly efficient heat transfer between two fluids of different temperatures. The highly efficent heat transfer is achieved by moving the heat transfer member at considerable velocity relative to a fluid. In certain instances, this is achieved by providing means such as the spaced baffles for preventing movement of the fluid while the heat transfer member itself is moved at greater velocity. In other instances, such as in the interior space **87**, this differential is achieved by projecting the fluid against a rapidly moving surface such as the inner surfaces of the successive cups **73**, **74** and **75** and the cylindrical section **43**.

Having described my invention as related to the embodiment shown in the accompanying drawings it is my intention that the invention be not limited by any of the details of description, unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the accompanying claims.

The embodiment of the invention in which an exclusive property or privilege is claimed is defined as follows:

1. Heat transfer apparatus for transferring heat between liquid masses comprising: a heat transfer surface member having opposite side surfaces in contact with said masses; means for moving said surface member relative to said liquid masses, said masses comprising a distilland and a distillate; means on said side surfaces for substantially preventing corresponding movement of at least one of said liquid masses in the same direction as said surface member, each movement preventing means comprising spaced stationary baffle members adjacent to but spaced from said surface member, said distilland being thereby heated by said moving of said surface member relative to the distilland and by heat conducted through said surface member from said distillate; means for collecting vapors of said distilland; passage means for conveying said vapors to said distillate side of the surface member; means in said passage means for compressing said vapors; and stationary scraper means against the side surface contacted by said liquid distilland to remove any solids deposited from said liquid.

2. Distillation apparatus, comprising: a heat conducting cylinder having inner and outer surfaces mounted for rotation about its central axis; means for rotating said cylinder about said axis; means for directing distilland along said outer surface for frictional heating by said rotating cylinder; means for substantially preventing movement of said distilland in the same direction as the cylinder surface; means for collecting vapors of said distilland; means for compressing said vapors; means for directing said vapors against said inner surface of said cylinder for condensation thereof to liquid distillate by heat transfer through said cylinder to said distilland; and means for substantially preventing movement of said vapors and said distillate at said inner surface in the same direction as the surface of said cylinder, both said motion preventing means comprising spaced stationary baffle members adjacent to but spaced from said inner and outer surfaces.

3. The apparatus of claim **2** wherein said baffle members are arranged substantially parallel to said central axis and said inner surface is provided with spaced, recessed condensate collecting means.

4. Distillation apparatus, comprising: a heat conducting cylinder having inner and outer surfaces mounted for rotation about its central axis; means for rotating said cylinder; means for directing distilland along said outer surface for frictional heating by said rotating cylinder; means for substantially preventing movement of said distilland in the same direction as the cylinder surface; means for collecting vapors of said distilland; means for compressing said vapors; means for directing said vapors against said inner surface of said cylinder for condensation thereof to liquid distillate by heat transfer through said cylinder to said distilland; means for substantially preventing movement of said vapors and said distillate at said inner surface in the direction of rotation of said cylinder, both said motion preventing means comprising spaced stationary baffle members adjacent to but spaced from said inner and outer surfaces arranged substantially parallel to said said central axis and said inner surface is

provided with spaced, recessed condensate collecting means; means for compressing said vapors prior to said directing of the vapors against said inner surface; and means for circulating said distilland from and back across said cylinder outer surface to promote heating and resulting vaporization of the distilland.

References Cited

UNITED STATES PATENTS

1,501,515	7/1924	Testrup	202—236
2,734,023	2/1956	Hickman	203—26
3,190,817	6/1965	Neugebauer et al.	203—26
2,140,623	12/1938	Hetzer	202—181
2,370,464	2/1945	Hickman	202—238 X
2,493,220	1/1950	Bibby	202—238 X
2,996,439	8/1961	Glover	202—236
3,233,879	2/1966	Mitchell	202—236 X
3,255,805	6/1966	Bechard	202—238 X
3,136,707	6/1964	Hickman	202—236

FOREIGN PATENTS

330,805	6/1930	Great Britain.
807,857	1/1959	Great Britain.

NORMAN YUDKOFF, Primary Examiner

F. E. DRUMMOND, Assistant Examiner

U.S. Cl. X.R.

202—238; 203—26, 100