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SOLAR DISTILLING APPARATUS
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2,398,292

FIG. 2.

FIG. 1.

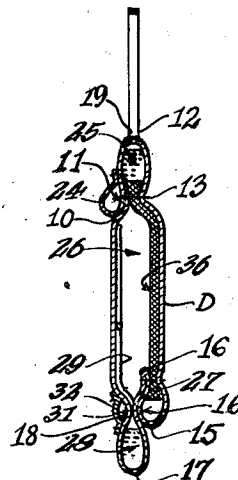
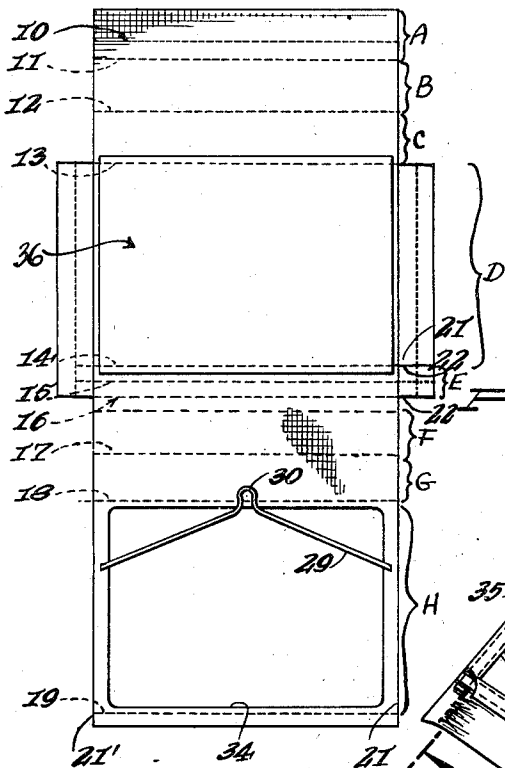


FIG. 3.

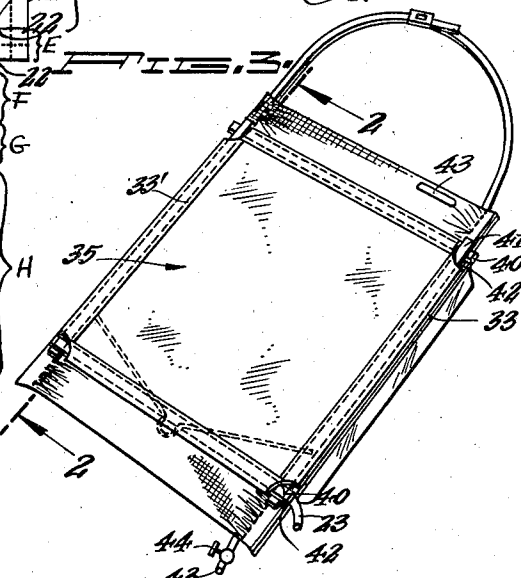
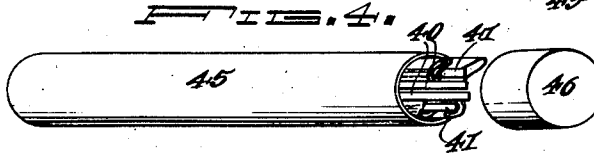


FIG. 4.



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SOLAR DISTILLING APPARATUS

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5 Claims. (Cl. 202—234)

This invention relates in general to distillation and in particular to a process of making an apparatus for distilling liquids, in particular sea water, and to correlated improvements designed to render such an apparatus collapsible and portable.

The need of a simple and convenient method of distilling impure water, such as sea water, for the production of fresh water for drinking and the like has long been recognized, but this need becomes increasingly important during times of war when the destruction of ships and airplanes at sea forces the crews to take to lifeboats, rafts and floats. Accordingly, any apparatus for distilling sea water to produce fresh water for drinking on lifesaving craft must meet, inter alia, the following stringent requirements:

1. The device must have a relatively low weight per unit of capacity.

2. The device must be compact and occupy a small space when not in use.

3. The device must be resistant to corrosion by sun, air, water and the action of the salts contained in sea water.

4. The device should be easy to erect and simple to operate.

5. The apparatus should be capable of being fabricated without the use of critical or scarce war material.

6. The device should operate upon a source of cheap, plentiful fuel without the use of an open flame which would create a fire hazard.

7. The fresh water produced should be free of salts, of harmful bacteria and should be substantially odorless and tasteless.

Accordingly, it is the general object of the present invention to provide an apparatus for the distillation of liquids, in particular sea water, which will satisfy the objects above described and meet the specifications recited.

It is a further object of the invention to provide a simple means for distilling sea water which is adapted for use on small lifesaving craft.

It is a further object to provide an apparatus for distilling sea water which will be collapsible, compact and light in weight, so that it can be carried in airplanes and installed as regular equipment in small lifesaving craft.

It is a specific object of the invention to provide a process for producing a collapsible, portable distillation apparatus from essentially a single piece of sheet material in a simple, rapid and inexpensive manner.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

According to the present invention there is provided a process for making a distillation apparatus by folding an elongated piece of liquid-impermeable material approximately in the center so as to bring the ends together and sealing the folded material transversely so as to divide the interior into essentially three compartments with the central compartment having the greatest length, a layer of liquid absorbent material being sealed in the seams dividing said compartments from each other and being adhered to the inner surface of one wall of the middle compartment, whereby the first compartment provides a reservoir for the liquid to be distilled, the middle compartment provides a space in which the liquid is distilled, and the bottom compartment provides a reservoir for the distillate. Optionally shaping or reinforcing members may be inserted both transversely and lengthwise of one or more of the compartments to maintain the shape and the spacing of the walls of one or more of the compartments.

When the apparatus is to be used for distillation by solar radiation, the sheet material is transparent to sunlight, or alternatively, if the sheet material is opaque, there may be cut in the front wall of the middle compartment a window which is covered with a transparent liquid-impermeable sheet material.

The invention accordingly comprises the several steps and relation of one or more of such steps with respect to each of the others, and the article possessing the features, properties, and the relation of elements, which are exemplified in the followed detailed disclosure, and the scope of the invention will be indicated in the claims.

For a more complete understanding of the nature and the objects of the invention, reference should be had to the accompanying drawing in which:

Fig. 1 is a top plane view of a template or pattern by which the basic sheet material is to be cut and folded;

Fig. 2 is a side elevation partly in section of the article produced by folding the sheet material shown in Fig. 1 along the lines indicated;

Fig. 3 is a perspective view of one embodiment of the distillation apparatus of the present invention, and

Fig. 4 is a perspective view of the apparatus of Fig. 3 in a folded and packaged condition.

It is to be understood that the apparatus comprises three main elements and several optional but desirable elements. The chief elements are (1) the transparent window, (2) the layer of

absorbent material, and (3) the shaping means, i. e., the means by which the article is given form and rigidity and proper disposition of the absorbent layer with respect to the window. Each of these elements will be described by reference to a particular embodiment, after which a general discussion of the elements will be given. It is to be understood that the invention is not limited to the specific embodiment described in detail hereinafter.

Referring to Fig. 1 the apparatus is produced by taking a single sheet of liquid-impermeable material and cutting therefrom an elongated piece as shown in Fig. 1, the piece being folded transversely and longitudinally along the broken lines as indicated.

Referring now to Fig. 2 it will be apparent that the transverse folds produce the following sections: The folds 10 and 11 provide the transverse strip A which forms the transverse sleeve 24. The fold 12 provides the wall section B of the upper liquid compartment 25. The fold 13 provides the back wall C of the upper liquid compartment 25. The fold 14 defines the lower edge of the middle or distilling compartment 26 and provides the back wall D thereof. Fold lines 15 and 16 define the double reverse fold E which provides a small channel 27 at the base of the middle compartment 26. The fold line 17 defines the back wall F of the lower liquid compartment 28. The fold line 18 defines the front wall G of the lower liquid compartment 28 and the space between fold 18 and fold 19 defines the front wall H of the middle compartment 26, while the fold 19 coincides with the fold lines 11 and 13. The folded material is stitched along the various fold lines as indicated by the letter S in Fig. 2.

Before the folding and sewing of the sheet material, there is adhesively united to the inner surface of the wall H a strip of absorbent material such as a textile tape 29 which is transversely disposed in a V-shape with a fold 30 extending through the stitching of the fold line 18. As a matter of fact, it is preferable not to stitch the fold 18 across the area occupied by the fold 30 by the tape 29. The function of this tape will be explained later.

The lower transverse pocket 31 may be formed either by making a double reverse fold in the sheet material at the fold line 18, or by attaching a separate strip of material 32 and sewing it transversely over the fold line 18 as shown in Fig. 2. Before the stitching of the material transversely along the fold lines 13, 14, 15, 16, 17 and 18, there is disposed and preferably adhesively united to the inner surface of the wall D a layer 36 of absorbent material having the width and breadth shown in Fig. 1, its length being sufficient so that the upper end extends into the liquid compartment 25 and its lower end extends into the channel 27.

The longitudinal side seams are also made by sewing together the overlapping layers of the sheet material. On one or both sides, however, the marginal longitudinal edges are cut along the fold lines 14 and 16 to sever the material to the fold lines 21 or 21', as the case may be, and thus provide a small section E, the edges 22 of which are brought together and stitched to form the tubular extension or spout 23. The marginal areas I, J, I' and J' are stitched both at the outer edges and along fold line 21 to form the longitudinal sleeves 33 and 33'.

When the apparatus is to be used for distillation by solar radiation, either the sheet mate-

rial must be transparent or a window should be cut in the wall H, for example as shown along the broken lines 34 in Fig. 1, and the opening covered with a liquid-impermeable material forming a transparent window. It is to be understood that when the base sheet material is inherently heat-sealable or is coated with a heat-sealable composition, all or part of the seams required in the manufacture of the article and referred to above as being stitched may, on the contrary, be formed by heat-sealing under heat and pressure with or without the aid of an organic solvent to soften the thermoplastic material; or alternatively, all or part of the seams may be formed by the use of a suitable adhesive.

By way of illustration but not by way of limitation, there will be shown a simple means of using battens to provide a proper rigidity and disposition of the walls in the apparatus. Referring to Fig. 3 there is disposed in the pockets 24 and 31, transverse battens 40 of rigid material, while there is disposed in the longitudinal sleeves 33 and 33' battens 41. The battens 40 pass through holes positioned adjacent the ends of the battens 41. If desired, the ends of the battens 40 may be rotatable and provided with threads which engage threads within the holes 42 of the battens 41, so that by rotating the ends of the battens 40 the transparent window 35 may be stretched transversely, while by rotating the ends of the rods 40 in the reverse direction, the battens 40 will be shortened, thus facilitating the removal of the battens 41 from the sleeves 33.

In the upper compartment 26 there is provided a slit 43 through which liquid may be introduced into the compartment 25. The liquid thus introduced will wet the upper end of the absorbent layer 36 and gradually saturate this layer with the liquid to be distilled. Upon disposing the apparatus so that the wall H or window 35 is parallel to the sun's rays, the absorbent layer will be heated and the liquid therein will be vaporized. The vapor will condense on the inner surface of the wall H or window 35 and drain downward and along the tape 29 and drip into the compartment 28, from which it may be drawn off through the outlet tube 43 which is provided with a pinch clamp 44. Any excess liquid in the layer 36 will drain into the channel 27 and run out through the spout 23.

When it is desired to compact or fold the apparatus, the battens 41 are removed and placed transverse the apparatus which is then rolled upon itself to give the compact body shown in Fig. 4. The compacted apparatus may then be packed in a container 45 which may be provided with a cap 46. Thus the apparatus can be folded into a small compact unit for carrying for shipment and for storage in a lifeboat or airplane.

The transparent window

The sheet of transparent material shown in the apparatus of Fig. 1 should be a flexible but form-retaining sheet of any suitable transparent material, such, for example, as a cellulose ester, a cellulose ether, or a synthetic resin. Preferably, there is employed for this sheet material a transparent plastic which is permeable to visible and infrared radiation such, for example, as cellulose acetate and cellulose aceto-butylate. It is obvious that evaporation can take place from both the front and rear surfaces of the absorbent layer.

Since the transparent window divides the warm moist air of the interior from the cool dry air on

the outside of the window, there will be normally a tendency of the window to become fogged by the condensation of droplets of water on the inner surface. Such droplets diffuse the light and decrease the radiation absorbed by the layer of absorbent material. Accordingly, it is desirable to retard or prevent fogging of the transparent window. This may be accomplished by forming the window of transparent material combined on one or both sides with a layer of water-absorbent, that is hydrophilic material, which absorbs the condensed water and prevents it from remaining as individual droplets, as described in my co-pending U. S. applications Serial Nos. 500,882 filed September 2, 1943, and 501,219 filed September 4, 1943.

The absorbent layer

For the layer of absorbent material, there may be employed a layer of a viscose sponge, a pile fabric, a layer of inter-felted fibres, such, for example, as textile felt or a soft, porous paper which has been sized with a water-insoluble substance such, for example, as casein, a resin or a cellulose ester which does not disintegrate when wet. Since the layer should be capable of being washed and wrung out, it is preferably formed of a material having a sufficient tensile strength for this purpose, that is, a textile fabric or felt, or sponge.

The absorbent layer is preferably colored black to render it more heat-absorbent and this may be done by dyeing or pigmenting the absorbent material with a suitable black dye or carbon black. To insure that the fresh water is free of harmful bacteria, the absorbent layer is advantageously rendered bacteriostatic or fungistatic and germicidal by combining it, e. g. by impregnation or coating, with a suitable water-insoluble germicide such, for example, as a phenyl mercury compound, finely divided ionized heavy metals, such as silver, copper or gold, or by means of an organic substantially water-insoluble germicide such, for example, as copper naphthenates, phenyl mercury chloride, phenyl mercury hydroxy quinoline, and dichlorodihydroxymethane.

The shaping means

When the sheet material is sufficiently self-supporting and rigid, no additional shaping means may be necessary. On the other hand, with flexible sheet material additional shaping means may be provided to give rigidity and to space the wall H or transparent window 35 from the absorbent layer 36, as required. Various means may be used to impart shape and rigidity such, for example, as (a) a plurality of transverse slats of rigid material united to the back wall D of the compartment 26 as described and claimed in the copending application Serial No. 500,550 filed August 30, 1943, or (b) by the use of stretching battens as disclosed in my parent co-pending application Serial No. 465,366 filed November 12, 1942, or (c) by inflating the chamber 26 with air or gas as described and claimed in my co-pending U. S. application Serial No. 501,219 filed September 4, 1943.

All other sheet materials used in the apparatus may be formed of any flexible non-porous sheet material such, for example, as an organic plastic, textile fabrics, felt or paper. Such fibrous materials should be stiffened and rendered waterproof by impregnating or coating them with a hydrophobic cellulose ester, cellulose ether, synthetic resin, rubber, and the like. In general, all such sheet materials should be water-impermeable.

Since most organic plastic materials contain residual volatile solvents or volatile plasticizers, they tend to undergo changes in dimension when subjected to such temperatures as are generated by the sun's rays. Therefore, in the now preferred embodiment, the sheet materials, before or after being incorporated in the device, are pre-heated to shrink them, as described in my co-pending U. S. applications Serial Nos. 500,882 filed September 2, 1943, and 501,219 filed September 4, 1943.

This application is a continuation-in-part of my co-pending application Serial No. 465,366 filed November 12, 1942, and Serial No. 501,219 filed September 4, 1943.

I claim:

1. Solar distillation apparatus comprising an enclosure formed of a single rectangular sheet of transparent water resistant material folded upon itself substantially midway of its length and sealed at its edges to form an enclosure, the resulting layers being incompletely secured together along transversely extending lines to form three superimposed communicating chambers, the uppermost chamber being relatively small and having means communicating therewith to supply the uppermost chamber with liquid to be distilled, the lowermost chamber having means communicating therewith for discharging distillate therefrom, the central chamber having absorbent material therein extending into the uppermost chamber past the transversely extending connection which forms the latter chamber to conduct liquid into said central chamber and distribute the same for exposure to solar radiation, said absorbent material being spaced from one wall of said central chamber to permit condensate to collect on said wall and flow downward thereover to the lowermost chamber.

2. Solar distillation apparatus comprising an enclosure formed of a single rectangular sheet of transparent water resistant material folded upon itself substantially midway of its length and sealed at its edges to form an enclosure, the resulting layers being incompletely secured together along transversely extending lines to form three superimposed communicating chambers, the uppermost chamber being relatively small and having means communicating therewith to supply the uppermost chamber with liquid to be distilled, the lowermost chamber having means communicating therewith for discharging distillate therefrom, the central chamber having absorbent material therein extending into the uppermost chamber past the transversely extending connection which forms the latter chamber to conduct liquid into said central chamber and distribute the same for exposure to solar radiation, said absorbent material being spaced from one wall of said central chamber to permit condensate to collect on said wall and flow downward thereover to the lowermost chamber, and means for securing said absorbent material to the opposite wall of said central chamber.

3. Solar distillation apparatus comprising an enclosure formed of a single rectangular sheet of transparent water resistant material folded upon itself substantially midway of its length and sealed at its edges to form an enclosure, the resulting layers being incompletely secured together along transversely extending lines to form three superimposed communicating chambers, the uppermost chamber being relatively small and having means communicating therewith to supply the uppermost chamber with liquid to be dis-

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therewith for discharging distillate therefrom, the central chamber having absorbent material therein extending into the uppermost chamber past the transversely extending connection which forms the latter chamber to conduct liquid into said central chamber and distribute the same for exposure to solar radiation, said absorbent material being spaced from one wall of said central chamber to permit condensate to collect on said wall and flow downward thereover to the lowermost chamber, means for securing said absorbent material to the opposite wall of said central chamber, the material forming said opposite wall being formed with a reversely folded portion located above said lowermost chamber and receiving the lower edge of the absorbent material, and means communicating with the reversely folded portion for discharging excess liquid supplied to the absorbent material and draining from the lower edge thereof.

4. Solar distillation apparatus as defined by claim 1 wherein said sheet of material is provided with retaining means adjacent that portion thereof which forms the central chamber, and relatively stiff members engaging said retain-

ing means for holding said central chamber extended.

5. Solar distillation apparatus comprising an enclosure formed of a single rectangular sheet of transparent water resistant material folded upon itself substantially midway of its length and sealed at its edges to form an enclosure, the resulting layers being incompletely secured together along transversely extending lines to form three superimposed communicating chambers, the uppermost chamber being relatively small and having means communicating therewith to supply the uppermost chamber with liquid to be distilled, the lowermost chamber having means communicating therewith for discharging distillate therefrom, the central chamber having absorbent material therein arranged to receive liquid from the upper chamber and to distribute and retain the liquid in position to be exposed to solar radiation, said absorbent material being spaced from one wall of said central chamber to permit condensate to collect on said wall and flow downward thereover to the lowermost chamber.

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