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ART OF CONCENTRATING PHARMACEUTICAL AND OTHER LIQUIDS

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Fig. 1.

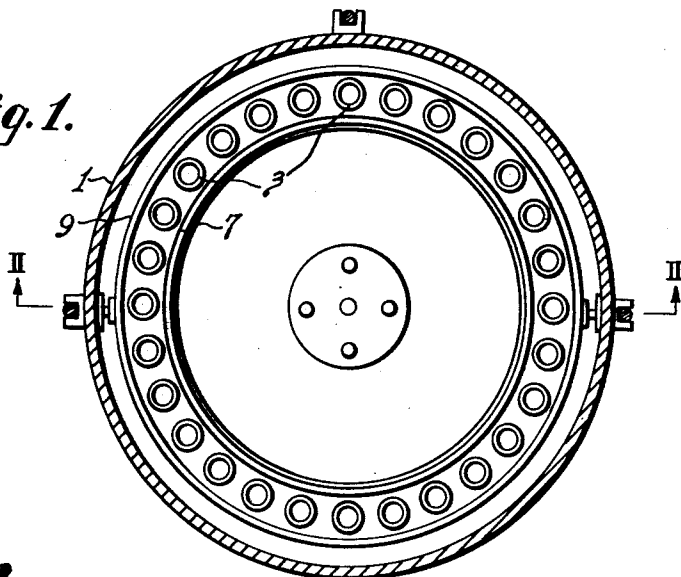


Fig. 2.

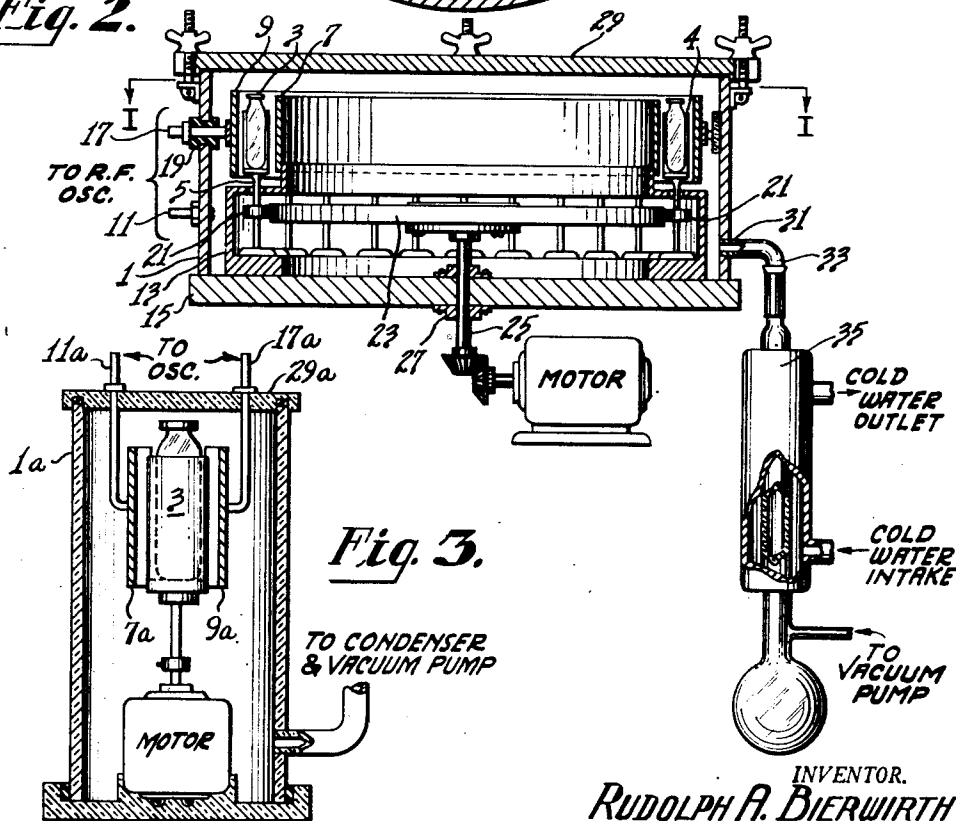


Fig. 3.

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ART OF CONCENTRATING PHARMACEUTICAL AND OTHER LIQUIDS

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4 Claims. (Cl. 159—6)

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This invention relates to the concentration and desiccation by evaporation or distillation of liquids containing animal, vegetable or mineral matter in solution, and has special reference to the art of dehydrating fluent matter of the type which effervesces or foams when subjected to heat or to a vacuum.

While the prior art is replete with so-called "save-all" systems for preventing the less volatile constituents of various ebullient liquids from being carried away in the foam or bubbles which are created when such liquids are subjected to heat or to a vacuum, an examination of such systems reveals that they are designed primarily to handle bulk quantities of liquid and are entirely unsuited for use in the dehydration or desiccation of bottled or packaged goods such, for example, as biological and pharmaceutical products. Thus, while it is common practice (see U. S. Patent No. 1,202,969) to provide a steam or hot water coil adjacent to the top of a still or other relatively large retort for the purpose of bursting the bubbles which emanate from the material being distilled, it would obviously be impractical to provide each of a large number of bottles or drug ampoules with such a "save-all" coil. Similarly, the use of rotating wires for breaking the bubbles (see U. S. Patent No. 1,250,427) would entail a formidable duplication of parts where a large number of containers are to be handled simultaneously. Nor does the addition of anti-foaming chemicals to the liquid (see U. S. Patent No. 1,440,973) or the use of goose-neck containers (see U. S. Patent No. 1,475,314) afford a satisfactory solution of the problem, since such means are barred in many cases either by the very nature of the material to be treated or because their use gives rise to other and complex problems of sanitation and packaging.

Accordingly, the principal object of the present invention is to provide an improved and rapid method of concentrating or desiccating liquids and other fluent matter, and one which lends itself readily to the processing of drugs and other bottled or packaged goods, in situ.

Another and important object of the invention is to provide an improved dehydrator of the type wherein the material is subjected to radio frequency energy, and one incorporating a highly efficient applicator or coupling system for subjecting numerous discrete containers or articles simultaneously and uniformly to the R.-F. energy.

Stated briefly: the foregoing and other objects are achieved in accordance with the invention by

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subjecting the liquid contents of an "over-sized" bottle, "test-tube" or other open-topped receptacle to a force (e. g., heat and/or a vacuum which produces molecular agitation in the liquid) of an intensity normally sufficient to cause the liquid to give off both gaseous and liquid emanations, and then rotating said receptacle about its vertical axis at a rate sufficiently rapid to prevent the generation of bubbles or other inflated or deflated liquid films which might be carried away with the gaseous emanations or vapor. When the receptacle is rotated at the indicated speed the liquid is spread by centrifugal force in a uniformly thin layer over the inner wall of the receptacle. This speeds up the dehydration process since the liquid now presents a greatly enlarged surface area to the ambient and to the electrodes or other source of energy. The invention may also be said to reside in the means and in the procedure hereinafter described for applying the foregoing principle to the processing of the contents of numerous containers simultaneously.

In the drawing Figure 1 is a top plan view, with the cover removed, and Figure 2 is a sectional elevation taken on the line II—II of Fig. 1, showing an evacuable dehydrator or "ampoule drier" which is constructed in accordance with the principle of the invention. Figure 3 is a sectional elevational view of another and simplified embodiment of the invention.

In Figs. 1 and 2 the invention is shown embodied in a so-called "ampoule drier" comprising an evacuable metal cabinet or chamber 1 containing a number (in this case, twenty-eight) of discrete ampoules or open-topped bottles 3 which are mounted in spaced circumferential array, each upon its own dielectric holder 4 and spindle 5, in the space between two concentrically arranged cylindrical electrodes 7 and 9. The inner electrode 7 is connected to a ground terminal 11 through a metal supporting structure 13 on the base 15 of the cabinet, and the outer electrode 9 is connected to a terminal 17 which extends through an insulating grommet 19 in the side wall of the cabinet. Each of the rotatable spindles 5 is provided with a gear 21 and these gears are coupled (as by friction) in driven relation with a common motor-driven gear or wheel 23 which is supported for rotation upon a shaft 25 which extends through a vacuum-tight bushing 27 in the base of the cabinet. The cabinet or chamber 1 is provided with an air-tight cover or lid 29 and there is a port 31 adjacent to the base 15 through which a connection 33 is made

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to a water-cooled condenser 35 and vacuum pump (not shown).

The degree of vacuum established in the chamber 1, the frequency and intensity of the electrical energy applied to the electrodes 7 and 9, and indeed the size and the speed of rotation of the ampoules or bottles 3 will ordinarily be chosen with a careful regard to the nature and the quantity of the drug or other ebullient liquid to be processed. It would obviously be impossible to correlate all of these factors in a single formula applicable to all materials. However, there are certain general rules which are applicable in most cases. Thus, it may be said, generally, that the glass or other dielectric containers 3 must be considerably larger than the original volume of liquid contained therein and that their speed of rotation should be sufficiently rapid to spread the liquid in a relatively thin layer over the inner side walls of the said receptacles without causing it to spill over.

Furthermore, the electrodes 7 and 9 should extend well above the normal level of the liquid within the containers 3 and should preferably extend as far as the highest level reached by the liquid while it is subject to centrifugal force. The centrifugal force applied to the liquid may be of the order of $100 \times$ gravity.

In applying the invention to the desiccation of a liquor containing the drug penicillin in dosage quantities (in this case 100,000 Oxford units) each serving comprised about 1 cubic centimeter of liquor and was contained in an oversized bottle of 20 cubic centimeters capacity. A pressure of about 5 centimeters of mercury was established in the chamber 1 and the receptacles were rotated at a speed of 3000 revolutions per minute, for about 3 minutes, while the electrical energy applied to the electrodes 7 and 9 was supplied at an average rate of 15 watts by an oscillator operating at the convenient frequency of 30 megacycles per second. This operation reduced the moisture content to about 4%. The desiccation was completed in a conventional vacuum drying oven using a pressure of about 5 millimeters of mercury and a plate temperature of 65°C . In one hour the moisture content was reduced to 0.6%. As claimed in copending joint application of George H. Brown and Rudolph A. Bierwirth, Serial No. 649,296, when a thin fluid film of penicillin liquor is dried rapidly, in the manner above described, to a point whereat its liquid content comprises no less than 5 percent by weight, the ultimate product comprises the amorphous form of penicillin, whereas if the said process is continued to a point whereat the liquid content of the film comprises not more than substantially 5 percent, by weight, the crystalline form of the drug is achieved.

In carrying the invention into effect it is preferable to employ bottles or ampoules made from glass tubing rather than ordinary cast or blown glass receptacles since the inner surface of the latter type of receptacle may contain irregularities which prevent the liquid from spreading evenly thereover. Ordinarily, a bottle type receptacle similar to those shown in the drawing is to be preferred to the test-tube or ampoule type, since the reduced neck portion of the bottle forms a positive barrier to the escape of the liquid and permits the use of a receptacle of somewhat smaller size for a given quantity of liquid. When, as shown in Fig. 3, the vacuum chamber is designed to accommodate but a single receptacle the electrodes may comprise a pair of curved

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plates 7a and 9a respectively, mounted with their concave surfaces presented in capacitive relation across an intervening space to the convex or cylindrical outer surface of the receptacle. In this case the evacuable chamber, here designated 1a, is provided with a cover 29a constituted of insulating material and the leads 11a and 17a for the electrodes 7a and 9a are supported on the lid.

In conclusion, attention is called to the fact that because the liquid is spread in the form of a relatively thin cylinder, it is possible to couple to it much more readily than if it were settled in a solid mass at the bottom of the bottle. Because of this improved coupling, it is possible to use a much lower oscillator frequency (e. g., 30 megacycles as compared to say, 150 megacycles) than had previously been planned for bottle drying.

It will now be apparent that the present invention provides an improved and rapid method of and apparatus for concentrating or desiccating liquids and other fluent matter, and that the invention lends itself readily to the processing of drugs and other bottled or packaged goods.

What is claimed is:

1. Apparatus for the treatment of liquid matter with an electric field comprising a cylindrical inner conductor presented across an intervening space to the interior of a cylindrical outer conductor, and a plurality of means arranged in circular array between said cylindrical conductors for supporting a plurality of liquid receptacles for rotation about their vertical axes in said space.

2. The invention as set forth in claim 1 and wherein means are provided for evacuating the space between said inner and outer conductors.

3. Method of concentrating the contents of a receptacle containing a liquid material of the type that effervesces when subjected to molecular agitation, said method comprising subjecting said material to molecular agitation of an intensity normally sufficient to cause said material to give off both liquid and gaseous emanations, subjecting said material to centrifugal force of an intensity sufficient to prevent the liberation of said liquid emanations while confining said material to the interior of said receptacle and then removing said gaseous emanations from said receptacle.

4. Method in accordance with claim 3 and wherein the centrifugal force applied to said material is of the order of $100 \times$ gravity.

RUDOLPH A. BIERWIRTH.

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