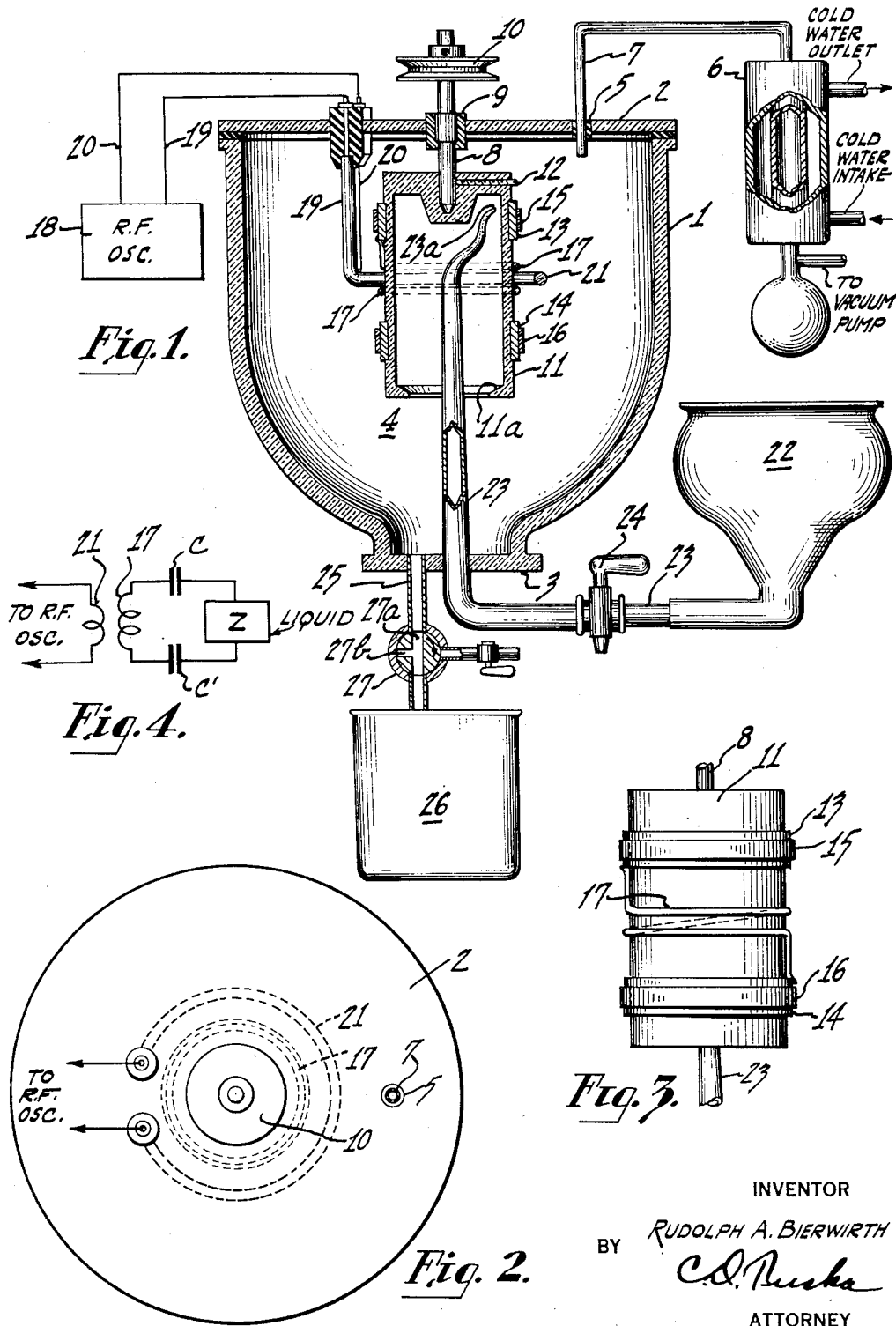


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ART OF SUBJECTING EFFERVESCENT MATERIALS TO
AN ELECTRIC FIELD
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ART OF SUBJECTING EFFERVESCENT
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This invention relates to improvements in the art of subjecting effervescent or ebullient liquids to an electric field and, though not necessarily limited thereto, will be described as applied to the concentration by evaporation or distillation of pharmaceutical and biological liquids.

It has previously been demonstrated (see co-pending application of Rudolph A. Bierwirth, Ser. No. 557,053) that various effervescent liquids such, for example, as penicillin liquor, may be dehydrated, in dosage quantities, by mounting the ampoules in which the liquid is contained between a pair of spaced apart electrodes and rotating them about their vertical axes at a speed calculated to cause the liquid to be spread, by centrifugal force, over the inner side walls of the ampoules. Bierwirth's method and apparatus not only prevent the generation of bubbles (which might be carried away with the vapor) but also speeds up the dehydration process. This is so because the liquid, when subjected to centrifugal force, presents a greatly enlarged surface area to the electric field between the spaced apart electrodes.

If an effort is made to increase the output of Bierwirth's apparatus by the use of a larger receptacle and more powerful electrical and mechanical forces it becomes increasingly difficult and eventually impossible to maintain satisfactory operating parameters such, for example, as an adequate coefficient of coupling between the electric field and the rapidly rotating liquid. This is especially so when the material being processed is subject to subatmospheric pressure since, in that case, if the electrical power is increased to compensate for the increased quantity of material being treated the danger of ionizing the ambient and establishing an arc-over is likewise increased.

Up to now the only electric field method of treating large quantities of effervescent liquids has involved the use of stationary electrodes, which are usually clamped to the outer surface of the receptacle, and an auxiliary "save-all" system mounted within or adjacent to the receptacle for breaking-up (rather than preventing the generation of) bubbles and foam. Such a bulk reducing save-all system is described in co-pending application of George H. Brown et al., Ser. No. 536,491, now abandoned.

While the Brown system for treating effervescent liquids with an electric field is capable of handling "bulk quantities" of such liquids, the quantity which can be treated is nevertheless limited, as in the Bierwirth system, to a predetermined charge. That is to say, neither the Brown system nor the Bierwirth system is capable of handling a continuous flow of material.

Accordingly, the principal object of the present invention is to provide a simple and reliable

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method of subjecting a moving stream or column of liquid to the action of an electric field, and one which may be applied to the treatment of liquids which effervesce or which are unstable or labile when subjected to such a field by any ordinary method.

Another and important object of the present invention is to provide an electronic centrifuge which may be operated continuously at subatmospheric pressures without danger of ionizing the ambient or causing an arc-over between the field electrodes or other parts of the centrifuge.

A related object of the present invention is to provide an electronic dehydration apparatus which shall be capable of concentrating any desired quantity of liquid, including liquids that are unstable or labile at ordinary temperatures, and one which, by reason of the simplicity and compactness of its parts, may be incorporated within a bell jar or other vacuum chamber of conventional form and dimensions.

The invention will be described in connection with the accompanying drawing wherein:

Fig. 1 is a partly diagrammatic sectional elevation of an electronic centrifuge constructed in accordance with the principle of the invention,

Fig. 2 is a top plan view of the device of Fig. 1,

Fig. 3 is an enlarged elevational view of the rotatable receptacle of Fig. 1, showing the arrangement of the electrodes thereon and,

Fig. 4 is an electrical diagram which will be referred to in explaining the operation of the device.

In the illustrated embodiment of the invention 1 designates an inverted transparent bell jar which is closed at its opposite ends by vacuum-tight lids or closure elements 2 and 3, respectively. The space 4 within the jar or chamber 1 is evacuated through a port 5 in the lid 2 by means of a suitable vacuum pump, not shown, but which will be understood to be connected to the said port through a water cooled condenser 6 and pipe 7. A rotatable spindle or shaft 8 extends into the evacuable space 4 through a vacuum-tight bearing 9 at the center of the lid 2. This shaft 8 is provided on its outer end with driving wheel 10 which may be driven by a suitable gear or belt, not shown, and has an inverted cylindrical or cup-shape receptacle 11 affixed to its inner end as by means of a set screw 12. The receptacle 11 is necessarily constituted of an insulating material, and is preferably formed of polyethylene or other suitable material.

Two spaced apart electrodes in the form of metal bands or rings 13 and 14 are mounted preferably one above the other, in capacitive relation, on the outer surface of the rotatable receptacle 11. As shown in both Figs. 1 and 3 the electrodes 13 and 14 may be seated in grooves in the cylindrical wall of the receptacle and secured there-

in as by means of insulating straps 15 and 16, respectively.

The energy required to establish an electric or "electrostatic" field within the rotatable receptacle 11 is applied to the capacitor electrodes 13 and 14 by means of an electrically secondary coil 17 which is mounted on the outer surface of the said receptacle preferably in the space between the said electrodes. The coil 17 here illustrated comprises but two turns of wire and has its opposite ends soldered, or otherwise conductively affixed, one to one electrode 13 and the other to the other electrode 14. The secondary coil 17 in turn receives its energy from a radio frequency oscillator 18 through two leads 19 and 20 which terminate within the evacuable space 4 in a primary coil 21 which extends in spaced relation around the secondary coil 17. This rotatable secondary coil 17 is thus inductively coupled to the stationary primary coil 21.

The penicillin liquor, or other fluent material, is entered into the rotating receptacle 11 from a reservoir 22 through a pipe or tube 23 which terminates in a restricted opening 23a adjacent to the closed or upper end of the said receptacle. A suitable valve 24 in the tube 23 is employed for regulating the flow of the liquid which is drawn from the reservoir 22 into the receptacle 11 by reason of the partial vacuum which is created within the evacuable space 4 in which the said receptacle rotates.

Since the liquid to be processed enters the electrified column (i. e. the space within the rapidly rotation receptacle 11) adjacent to the top of the said column, it may be said to be subjected to gravitation as well as to centrifugal force. Thus, as the drug liquor or other fluent material enters the rapidly rotating receptacle 11 from the nozzle 23a it will be spread in the form of a liquid film over the inner surface of the said receptacle and, as the "depth" of the liquid (on the inner side walls) increases, will flow gradually downwardly, through the electric field and over the inwardly turned rim 11a, from whence it drops onto the lower plate or base 3 of the bell jar 1. An outlet pipe 25 in the base 3 conducts the now concentrated liquid to a storage container 26 outside of the vacuum chamber. This pipe 25 is provided with a stop cock or similar valve 27 having two passageways 27a and 27b therein, which serve, selectively, (a) to pass the liquid into the container and (b) to admit air in the chamber 4 when the dehydration process has been completed.

In reducing the invention to practice it is important that the oscillator 18 be tuned to the frequency, or approximate frequency, of the utilization circuit. As indicated in Fig. 4 the utilization circuit comprises the secondary coil 17 and, in effect, two capacitors C and C', with the liquid (which is a dielectric and represented by the symbol Z) in series between the said capacitors. Since industrial oscillators are usually designed to operate most efficiently at a particular frequency (rather than over a wide band of frequencies) it is usually necessary to design the cup-shape receptacle 11 and its associated electrical fixtures with a careful regard to the frequency of the oscillator and also with regard to the desired capacity (in liters per hour) of the system. Thus, while the invention is obviously not limited to the use of an oscillator of

a particular frequency and power, nor to the use of a rotating receptacle of specific dimensions, it may well be set forth, by way of example, the details of construction and operation of a specific successful embodiment of the invention. In one such embodiment the apparatus was designed to effect a reduction of five-to-one, within one hour, of ten liters of penicillin liquor (or other semi-conducting liquid). In this case the electrical energy employed in heating the liquid was supplied by a two kilowatt oscillator operating at a frequency of 30 megacycles per second and the vacuum pump was adjusted to maintain a vacuum in the main chamber of the order of from 20 to 30 millimeters of mercury when the receptacle 11 was rotated at a speed of about 900 R.P.M. The centrifugal force to which the liquid material was subjected when rotated at this speed was estimated to be about 30x gravity. The dimensions of the polyethylene receptacle 11 were approximately as follows: thickness of walls=0.25 of an inch; depth=6 inches; inside diameter=4½ inches; inside diameter of the rim (11a)=3⅞ inches. The electrodes 13 and 14 comprised 1¾ inch copper bands spaced apart about 2¼ inches. The secondary coil (17) comprised two turns of number 10 gauge copper wire, spaced ⅝ inch between centers and the primary coil 21 comprised but a single turn of ⅝" copper tubing spaced about ½ inch from the secondary coil.

It will now be apparent that the present invention provides a simple and reliable "continuous flow" method of and apparatus for subjecting ebullient liquids to an electric field.

What is claimed is:

1. Apparatus for the treatment of materials comprising, a rotatable receptacle for the material to be treated, a plurality of ring-like electrodes in the form of metal bands mounted in spaced capacitive relation on the sides of said receptacle for generating an electric field within said receptacle, a transformer comprising a secondary coil mounted on said rotatable receptacle and connected to said electrodes and a stationary primary coil mounted adjacent to said rotatable receptacle in spaced inductive relation with respect to said secondary coil.

2. The invention as set forth in claim 1 and wherein said secondary coil is mounted in the space between said electrodes on said rotatable receptacle and said stationary primary coil is mounted in register with said secondary coil.

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