

Oct. 6, 1959

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2,907,117

DRYING DEVICE

Filed Feb. 15, 1957

2 Sheets-Sheet 1

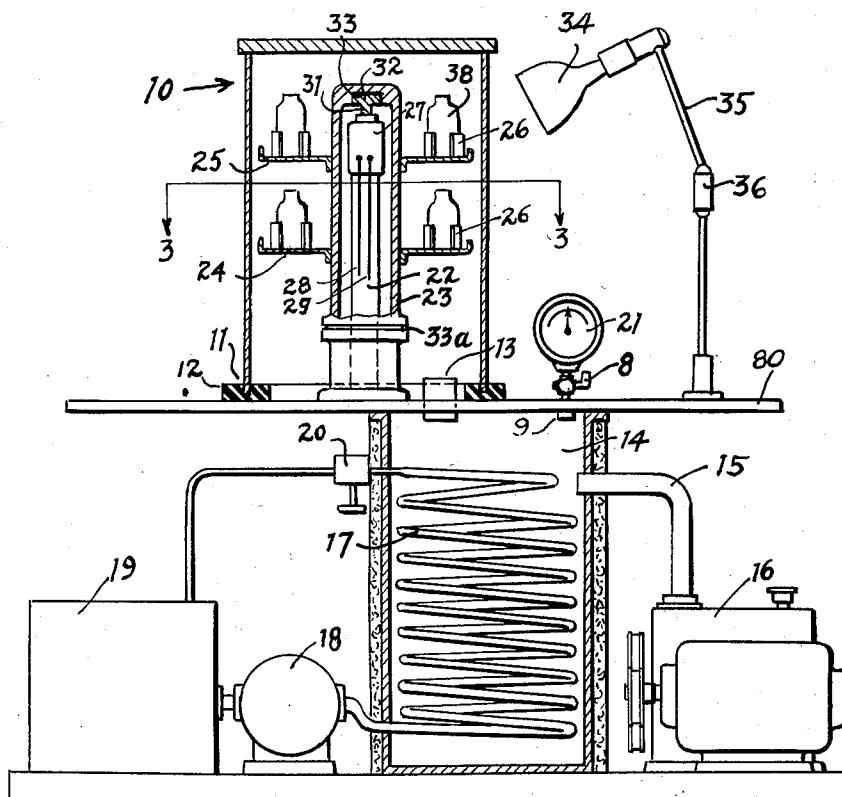


Fig. 1

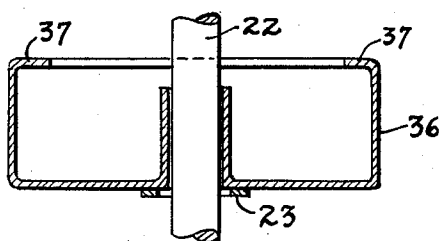


Fig. 2

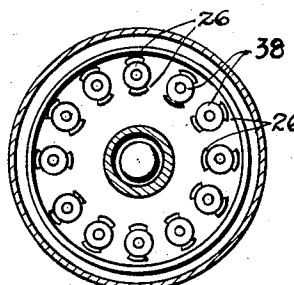


Fig. 3

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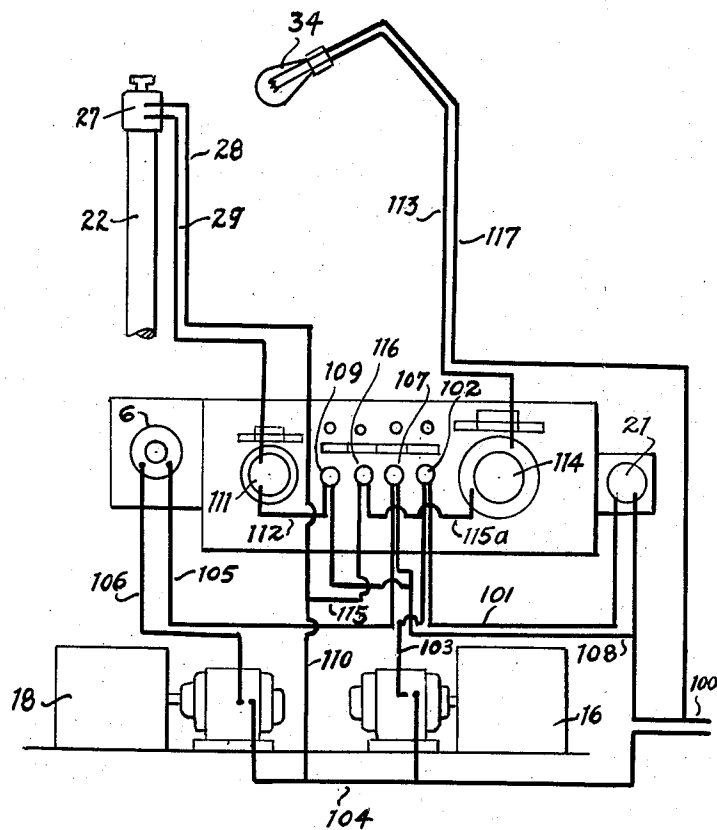


Fig. 4

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1

2,907,117

DRYING DEVICE

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2 Claims. (Cl. 34-44)

This invention relates to a drying device which is applicable to the "freeze drying" process of drying material. However, by the use of this apparatus, the conventional process of "freeze drying" is substantially improved. While this application covers the apparatus solely the improved method is covered in a co-pending application, Serial Number 641,764, filed February 21, 1957.

Conventionally, in the "freeze drying" process, the material to be dried is placed into a container and then subjected to refrigeration to bring the material below its freezing point. After the material is frozen (called "shell frozen" in the conventional process) it is subjected to both vacuum (which lowers its boiling point) and to radiant heat to cause evaporation of the water contained in the material. The material is then reduced to powder and is thereafter removed from the container.

The conventional process, as outlined above, is, as has been shown, a two stage one. The material must first be shell frozen and then placed under vacuum and dried.

The conventional process requires the two stage treatment for the reason that substantial reduction of the pressure above the liquid material would cause the same to froth and foam. This would cause splashing of the liquid and severe material losses.

We have discovered that such frothing and foaming can be prevented even if the material is placed under vacuum in liquid form. In order to do this, however, it is necessary to apply centrifugal force to the material at the same time.

In order to apply centrifugal force and vacuum to material at the same time, it is clear that the material must be placed within a closed system within which it may be subjected to the centrifugal force. Conventional centrifugal force producing devices are operated from without the system and generally extend without the system. Thus, if a conventional device is used, a "rotary seal" must be provided to prevent the inrush of air into the system. Such "rotary seals" are generally unsatisfactory and prevent adequate vacuum or centrifugal force conditions from being maintained.

Before closing this preliminary exposition of the invention it is pointed out that the word "vacuum" as used in the specification and claims relating to this invention does not mean the total absence of air in the system. The word is intended to cover the conditions produced by the removal of a major quantity of the air in the system so that a very low pressure is produced therein.

The invention may be briefly described as comprising, in combination, a container having vacuum producing means, refrigerating means and radiant heat producing means in operative relationship therewith. Centrifugal force producing means are located within the container and are actuable upon dryable material placed therein. Novel constructional features are employed so that the device is operable under low pressures and high

2

centrifugal forces. The details of construction employed are set forth broadly in the appended claims.

The invention will be further described by reference to the accompanying drawings which are made a part of this specification.

Fig. 1 is a sectional view through the preferred form of the drying device of this invention.

Fig. 2 is a detail view of a form of dryable material container that may be used where a large bulk of material is to be dried.

Fig. 3 is a sectional view through the vacuum container of this invention wherein the dryable material is disposed taken along lines 3-3 of Fig. 1.

Fig. 4 is a somewhat diagrammatic view showing the electrical circuit used in this invention.

The invention will now be described in detail by reference to the form thereof shown in the drawings. However it is pointed out that this form is shown and described for illustrative purposes only and is not to be construed as a limitation upon the invention. Various changes and modifications may be made with regard to the form of this invention without departing from the scope thereof as set forth in the appended claims.

The first container of this invention 10, wherein the dryable material is disposed, is made of transparent material such as glass. At its bottom portion 11 a seal 12 is provided which is preferably made of resilient rubber or rubber-type material.

A conduit 13 passes through the base 80 upon which container 10 rests, and also opens into container 14 which is made of metallic conductive material. An additional conduit 15 also opens into container 14 and in turn is secured to vacuum pump 16.

An additional conduit 9 opens into container 14 and joins gauge 21, which indicates the pressure within containers 10 and 14, to container 14.

A valve 8 is disposed within conduit 9 between container 14 and gauge 21. Valve 8 is normally closed but, when open, permits conduit 9 to communicate with the atmosphere. Thus valve 8 acts as a venting device when it is desired to open container 10.

Gauge 21 is in series with wires 100 and 101 which are part of the circuit consisting of wires 100, 101, switch 102, wire 103, vacuum pump 16, and wire 104. Gauge 21 also constitutes pressure responsive control means. By means of these means gauge 21 may be set for any predetermined pressure and controls the conditions within container 10 by turning pump 16 on and off.

A coil 17, which bears an expanding refrigerant, is disposed about container 14. Coil 17 in turn is connected to compressor 18 and condenser 19. The conventional valve 20 regulates the flow of refrigerant into coil 17. A thermostat 6 is in series with wires 105 and 106 which are part of the circuit consisting of wire 104, compressor 18, wire 106, thermostat 6, wire 105, switch 107, wire 108 and wire 100. Thus thermostat 6, which may be set to any predetermined temperature, controls the same by turning compressor 18 on and off. The sensing means for thermostat 6 are located within container 14. For clarity of illustration of the remaining elements of this invention these sensing means are not shown in Figs. 1-3 of the drawings.

A fixed vertical support 22 is centrally located within container 10. A rotatable vertical support 23 is disposed above support 22 and bears shelves 24 and 25 thereupon. Bottle holding supports 26 are disposed in spaced relationship upon shelves 24 and 25.

A motor 27 is disposed within support 22. Wires 28 and 29 are connected to motor 27 and pass through seal 12. Wire 29 is in series with rheostat 111 and wire 112 joins rheostat 111 to switch 109.

Motor 27 bears shaft 31 which bears key portion 32

3

at its upper end thereof. Key portion 32 fits into a mating groove 33 located within rotatable support 23. A bearing 33 is disposed between key shaft 32 and rotatable support 23.

A radiant heat device 34, comprising an infra-red incandescent bulb is located without container 10 and is supported upon support 35. A socket 36 is provided upon support 35 so that bulb 34 can be directed into ray impinging relationship with the dryable material contained within container 10. Bulb 34 is also connected to a power source. The circuit involved comprises wire 113, rheostat 114, wire 115a, switch 116, wire 117, wire 110, wire 104 and wire 100.

Fig. 2 of the drawings shows the form of material container that may be used where a large volume of material is to be dried. As shown herein a cylindrical container 36 bearing offset portions 37 is secured to support 23.

The operation of this invention will now be explained.

Container 10 is removed from seal 12 and a number of bottles of material to be dried 38 are placed within supports 26. Container 10 is then placed upon seal 12 and valve 8 is closed. Gauge 21 is set to the pressure desired and switch 102 is closed starting vacuum pump 16. At the same time thermostat 6 is set to the desired temperature and switch 107 closed starting compressor 18. Rheostat 111 is set to the desired rotational speed (about 1450 r.p.m.) and switch 109 closed thus starting motor 27 and producing centrifugal force. Generally the pressure produced is about .005 mm. and the temperature about -20°C .

After a period of about 3 minutes the material contained in bottles 38 is frozen. At this point it is no longer necessary to apply large centrifugal forces to the material since there is no danger of foaming and splashing. Rheostat 111 is then turned to reduce the speed of rotation of motor 27 so that bottles 38 now turn at a speed of about 3 r.p.m. Switch 116 is then turned on so that infra-red heat produced by bulb 34 impinges upon bottles 38. The intensity of the heat produced by bulb 34 is controlled by rheostat 114. The intensity used depends upon the material dried.

The conditions of pressure, temperature, and external heat are continued until the material contained in bottles 38 is reduced to powder form. When this occurs switches 102, 107, 109, and 116 are turned off and valve 8 is opened venting the container 10 to the atmosphere. Container 10 is then removed from seal 12, bottles 38 removed, and the apparatus is ready for the next cycle.

We claim:

1. A drying device comprising a first transparent container, a subjacent second metallic container, a conduit

4

joining said first and second containers, a refrigerant bearing coil surrounding said second container, a vacuum pump connected to said second container, a fixed vertical support member centrally within said first container, an additional rotatable vertical support member supported by said fixed support, a substantially horizontal dryable material container secured to said rotatable support, an electrical motor within said first container and supported by said rotatable support adapted to rotate the same and to thereby apply centrifugal force to said dryable material container, and an electrical radiant heat producing bulb without said first container, in spaced relationship thereto, and in ray impinging relationship with said dryable material container.

2. A drying device comprising a first transparent container, a subjacent second metallic container, a conduit joining said first and second container, a refrigerant bearing coil positioned within and contiguous to the wall of said second container, a vacuum pump operatively connected to said second container, pressure responsive control means operatively connected to said second container adapted to actuate said vacuum pump and thus control the pressure within the system, thermostatic control means within said second container adapted to actuate said refrigerant bearing coil and thus control the temperature within the system, a fixed vertical support member located centrally within said first container, an additional rotatable vertical support member overlying said fixed support, a substantially horizontal dryable material container secured to said rotatable support, an electrical motor operatively connected to said rotatable support adapted to rotate the same and thereby apply centrifugal force to said dryable material container, rheostat means operatively connected to said motor, and an electrical radiant heat producing bulb without said first container, in spaced relationship thereto, and in ray impinging relationship with said dryable material container.

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