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HIGH VACUUM, LOW TEMPERATURE, DRYING APPARATUS

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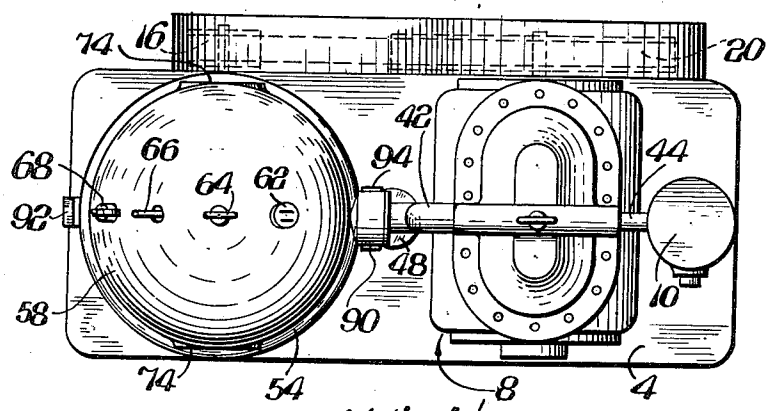


Fig. 1.

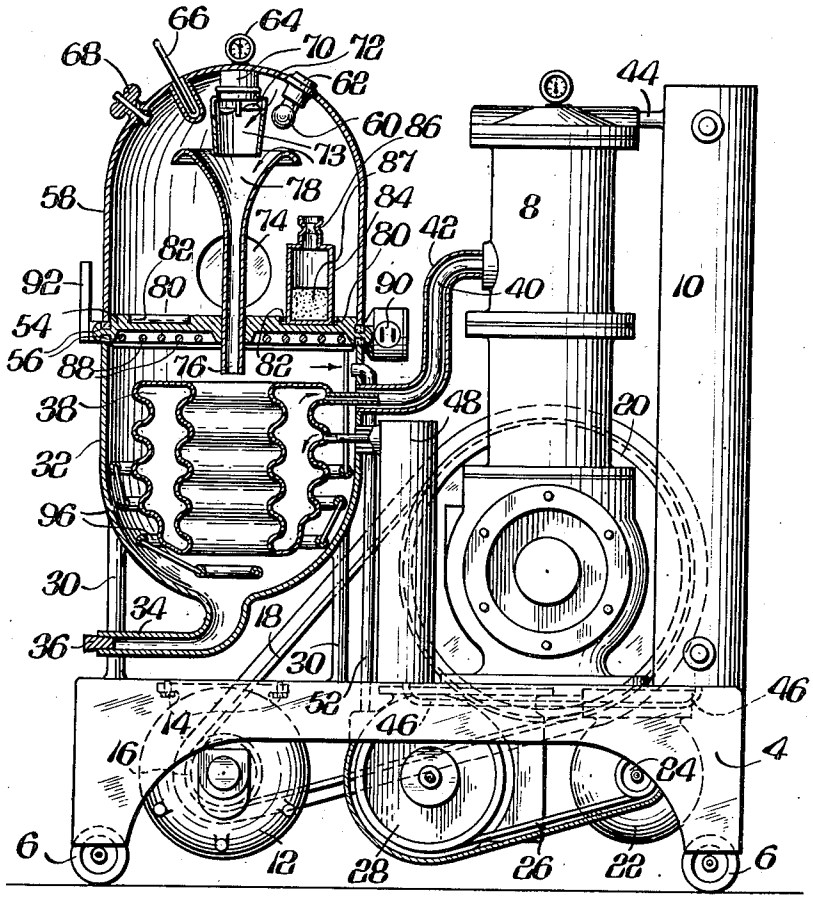


Fig. 2.

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HIGH VACUUM, LOW TEMPERATURE DRYING APPARATUS

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2 Claims. (Cl. 34—76)

In the preservation of sera, plasma, proteins or other substances for future use, it is necessary that the substances be as completely dried as possible, that this drying be uniform, that the physical structure—whether crystalline or amorphous—be not changed and that the chemical reactions be not interfered with, or, in the event that the product is a bacteriological culture or a virus or the like, its effectiveness be not in any way altered. The most recent and advanced method for accomplishing these objects consists in pre-freezing the material to be dried and then submitting the frozen mass to a high degree of vacuum in the presence of regulated heat, whereby the water of the frozen mass is sublimated while the mass is still at a temperature well below the freezing point.

Our invention therefore relates to a novel self-contained, portable, high vacuum, low temperature drying apparatus which, we have found in actual practice, is capable of efficiently and expeditiously carrying out the objects briefly outlined above, it being understood that, while by way of illustration we refer to sera, plasma, proteins and similar substances, our apparatus is not limited to the drying of these substances only, but is equally applicable to the drying of other substances as well.

The full nature of our invention, the structure of our apparatus, the method of its operation and the objects which are attained thereby will be more clearly understood from the following specification and the accompanying drawing in which:

Fig. 1 represents a diagrammatic top plan view of an apparatus embodying our invention.

Fig. 2 represents a view partly in cross section showing the essential parts of the invention.

Referring to the drawing in which like reference characters indicate like parts, and more particularly to Fig. 2, 4 designates a carriage or platform which is provided with the wheels or rollers 6 and which constitutes the sole support of the apparatus thus making the apparatus entirely self contained, portable and easily movable from one place to another. On the carriage 4 are suitably supported the compressor 8 and the condenser 10 which are shown only in outline as they constitute standard units of conventional low refrigeration equipment. 12 designates a motor which is secured to the under side of the top of the carriage 4 as at 14. The motor 12 is provided with the pulley 16 over which travels the belt 18 which also travels over the wheel or pulley 20 to drive the compressor 8. 22 designates another motor having the pulley 24 over which travels the belt 26 which also engages the wheel or pulley 28 to drive a high vacuum pump which is conventional and hence not shown in detail. The motor 22 and the vacuum pump are secured to the under side of the top of the carriage 4 in the same manner as the motor 12 is supported. The bolts or other fastening means of the motor 22 and the vacuum pump have been omitted from the drawing for clarity of illustration. If desired, both the compressor 8 and the vacuum pump can be driven through suitable connections from a single motor. On the carriage 4 is also supported by the legs 30 the lower compartment 32, which is preferably bell-shaped, and which is provided with a drain outlet 34 having the removable air tight plug 36. Within the compartment 32 is suitably supported the refrigeration coil 38 which communicates through the pipe 40 which in turn is enclosed in the outer pipe 42 with the compressor 8. The compressor 8 communicates with the condensor 10 through the conduit 44. The condensor 10 communicates through the pipe 46 and the stand pipe 48 with the refrigerating coil 38. The vacuum pump communicates with the interior of the lower compartment 32 through the pipe 52. Seated on the rim of the lower compartment 32 is the work platen 54 which is of the same shape as the rim of the compartment 32 and which extends slightly beyond it as clearly shown in Fig. 2. The work platform 54 is provided with registering annular recesses in its upper and lower surfaces for the reception of gaskets of sponge rubber or the like 56. Resting on the upper gasket 56 is the cover 58, which is also preferably bell-shaped, which is provided with an electric light 60 having the socket 62 into which the prongs of an electric plug (not shown) can be inserted, the plug being connected by means of an electric wire to a source of electrical energy. The point at which the electric light is mounted is made air tight. In the top of the cover 58 is a vacuum gauge 64, a thermometer 66 and a vacuum release valve or plug 68. Also mounted in the top of the cover 58 is an electric motor 70 suitably connected (by means not shown) to a source of electrical energy and adapted to propel the blade 72. Surrounding the blade 72 and spaced from the motor housing is the sleeve 73 which is preferably tapered downwardly. The cover 58 may be made of ordinary glass, shatter-proof glass, transparent composition, or it may be preferably made of metal such as steel or the like and, in that event, it is provided with one or more trans-

parent windows 74 through which the progress of the operation may be observed. Extending through the work platform 54 is the pipe 76 the lower end of which exhausts inside the lower compartment 32 and the upper end of which is in the form of a funnel 78. On the upper surface of the work platform 54 are formed a series of depressions or recesses 80 in each of which is positioned a thin film of mercury or other liquid 82 having a high boiling point. In each of the recesses and resting upon the film of liquid 82 is positioned a container 84 which is in the form of a bottle, an ampule, or the like and which preferably has an elongated neck somewhat restricted as at 86. Within each of the bottles or other containers 84 is a layer of frozen mass 87 to be dried, the cross sectional thickness of the mass being predetermined according to requirements or according to the nature of the material to be dried and also with due regard to the capacity of the apparatus or the degree of the drying desired.

The operation is as follows:

The cover 58 is removed from the work platform 54, and bottles containing the pre-frozen material are seated in the recesses 80. The cover 58 is replaced and care is taken to see that the vacuum breaking plug or valve 68 is tight. The refrigerating mechanism comprising the compressor 8 and the condenser 10 and their adjuncts are preferably already in operation so that the coil 38 is well below the freezing point. With the cover 58 in position the vacuum pump is operated so as to draw the highest possible vacuum in the enclosure (formed by the compartment) 32 and the cover 58 through the pipe 76. Simultaneously, the heating coil 88 carried by the work platform 54 is energized by applying an electric plug (not shown) leading from a source of electrical energy to the socket 90. The vacuum serves to press the cover 58 tightly upon its gasket seat 56 and the greater the vacuum the greater the pressure and hence the tighter and more leak-proof is the seal between the cover 58 and the work platform 54 and between the work platform 54 and the lower compartment 32. The handling of the bottles from the centrifuging and freezing apparatus onto the work platform 54 raises the temperature of the bottles up to about minus 20° F. to 30° F. and the heat from the coil 88 is so controlled as never to raise the temperature of the material 87 above a predetermined limit which is considered safe in that it will not interfere with the chemical reactions, the physical structure of the "life" of the material. Such temperature is perhaps about 100° F. The temperature thus applied tends to melt the frozen water but the continuous evaporation under the high vacuum results in constant cooling of the material 87 so that a balance is maintained between the heat delivered by the coil 88 and the loss of heat due to evaporation. In this way the mass of material 87 remains frozen throughout the drying operation. The thin film of mercury 82 serves to establish perfect contact between the bottom of the bottles 84 and the work platform 54 for even transmission of heat. The function of the motor 70, blowing as it does into the sleeve or funnel 73, is to expedite the movement of the vapors emanating from the bottles 84 and direct them into the pipe 76 thus increasing the vacuum. The sleeve 73 cooperating with the upper end of the funnel 78 and the blade 72 of the motor serves as a jet so that the vapors from the bottles 84 travel in substantially the manner illustrated by the arrows in Fig. 2. Since condensation is detrimental to the highest efficiency of the vacuum pump, which under certain circumstances must produce a vacuum as low as 100 microns or less, it is necessary that only completely dry gases be allowed to pass through the vacuum pump and the low temperature refrigerating coil 38 serves to condense and freeze the water vapor content of the gas drawn through the pipe 76 so that after a period of operation the refrigerating coil 38 is "frosted" or covered with a layer of snow or ice. 92 designates a thermometer which indicates the amount of heat supplied by the coil 88. The thermometer 92 may be a plain thermometer or may be of the thermostatic type whereby automatic regulation may be attained. When the operation is completed the valve 68 is opened to break the vacuum to permit removal of the cover 58 and afford access to the bottles 84. When the coil 38 is unduly frosted an electric plug (not shown) leading to a source of electrical energy is applied to the socket 94 so as to energize the coil 96 to melt the ice or frost deposited on the coil 38. The liquid thus produced is discharged through the drain 34 by removal of the plug 36. The gauge 64 indicates to the operator the degree of vacuum in the apparatus and the thermometer 66 indicates the temperature. In the event that complete sterility is required, a piece of sterile cotton, preferably treated with an efficient antiseptic, is inserted in the neck of each of the bottles 84 above the restriction 86. This will prevent contamination of the dried material within the bottle when it is exposed to room air during removal from the platform 54 to the point of use or storage, or while the bottle necks are permanently sealed by fusing or otherwise.

It will be seen that we have devised a compact, efficient, self contained and portable unit which is extremely easy to operate and which permits of exact control, and by which a relatively large quantity of material can be dried in each cycle. It will also be seen that in order to charge the unit with material to be treated, or to remove the material after it has been treated, it is merely necessary to remove the cover 58 without disturbing the compartment 32, its adjuncts and the remaining mechanism, that the vacuum drawn in the enclosure of the compartment 32 and the cover 58 serves automatically to seal the unit, and that to break the vacuum it is merely necessary to turn the plug 68. The detachable electrical connections to the light 60 and the motor 70 make it possible to remove the cover 58 easily, and, since the light 60, the motor 70, the thermometer 66 and the vacuum breaking plug 68 are all carried by the cover 58, they are also removed or applied with it without the necessity of dismantling. An important feature of our invention is the provision of the lower fixed compartment 32 and the work platform 54 which serves as a cover for the compartment 32 and which also serves as a support and vacuum seal for the cover 58. Also, the heating element 88 carried by the work platform 54 serves to apply the desired heat to a plurality of bottles 84 only one of which is shown for clarity of illustration.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is.

1. An apparatus of the character stated comprising a compartment having an upper open rim, a platform seated on the rim of the open end of said compartment, there being a plural-

ity of recesses in the upper side of said platform for receiving receptacles containing the material to be treated, a removable cover seated on said platform, means for effecting air tight connection between said platform and said compartment and said platform and said cover, there being a through opening in said platform, and means for producing a vacuum in the enclosure formed by said compartment and said cover, means for applying heat to said platform, and a predetermined quantity of heat-transmitting liquid of a relatively high boiling point in the recesses in said platform.

2. A portable, self contained apparatus of the character stated comprising a carriage, a refrigerating mechanism mounted thereon, a vacuum pump also mounted on said carriage, a lower fixed compartment, having an open top, also mounted on said carriage, a refrigerating coil in said lower compartment operatively connected to said refrigerating mechanism, a vacuum pump operatively connected to said lower compartment, a platform seated on the rim of said lower compartment and adapted to support the material to be dried, there being a through opening in said platform, a casing having an open bottom and seated on said platform for enclosing said material, and means for effecting air tight engagement between said platform and said lower compartment and said platform and said casing.

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