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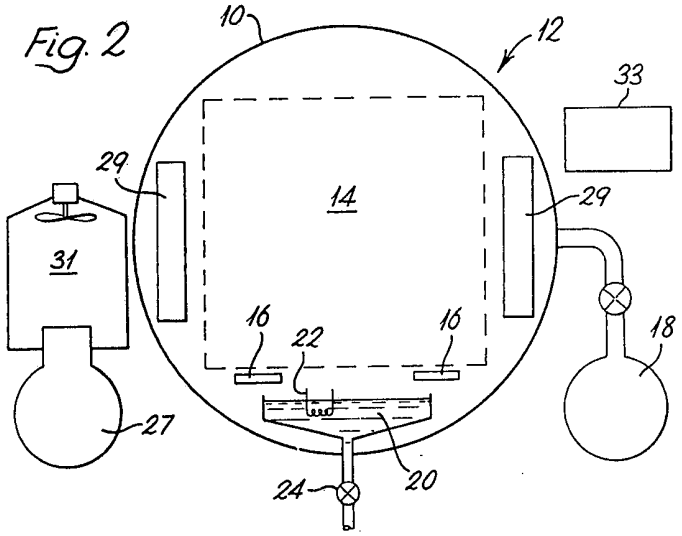
(54) Heat treatment of bulbs

(57) Heat treatment of bulbs for pest and disease control comprises placing the bulbs in a vessel 10 before evacuation of the vessel is effected by a pressure sensitive pump 18. Following evacuation, water vapor from a heated water bath 20 condenses on the bulbs and gives up its latent heat to raise them and accurately maintain them at the desired temperature for the necessary period. Following this, the vessel 10 may be further evacuated for vacuum drying of the bulbs before their removal from the vessel.

Fig. 2



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The drawing originally filed was informal and the print here reproduced is taken from a later filed formal copy.

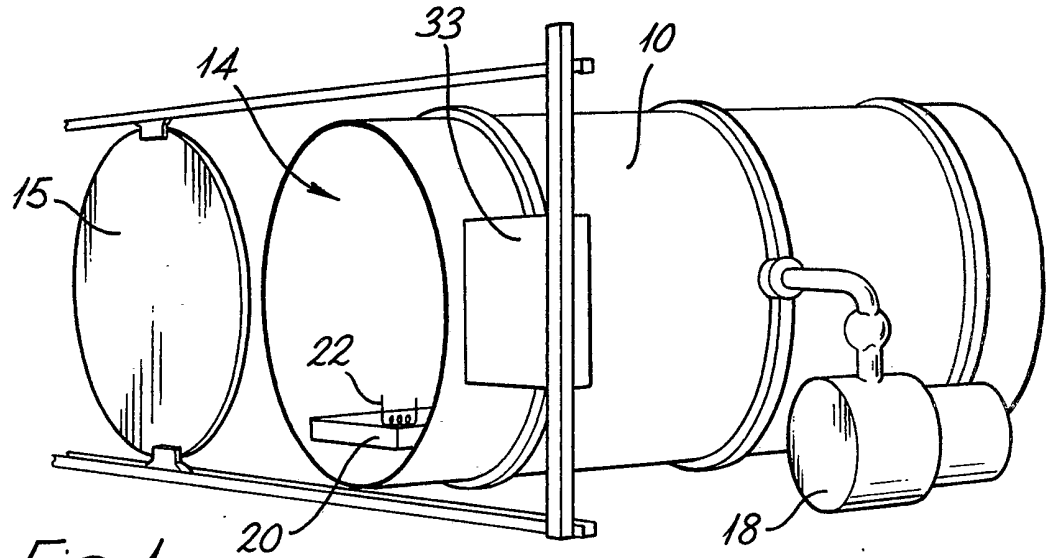
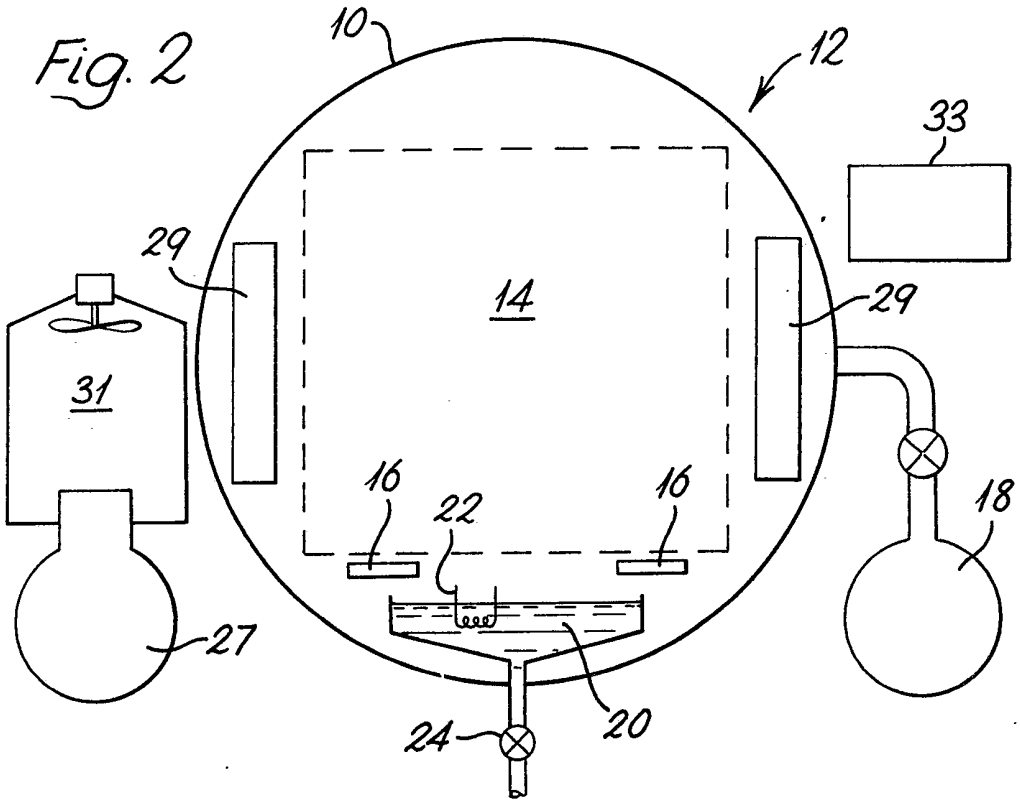


Fig. 1

Fig. 2



SPECIFICATION

Heat Treatment of Bulbs

The present invention relates to the heat treatment of bulbs and in particular, but not exclusively, to the heat treatment of narcissus bulbs for pest and disease control.

Hot water treatment of bulbs has been the standard method of eelworm control since 1918, and has since been applied to various other plant materials, not just for eelworms but also for the control of insect pests and fungal diseases.

The basic method of pest and disease control is to heat the affected plant material to such a temperature that the pest or disease is killed, whilst the plant tissue is undamaged. In most cases, the margin between the two is small so there is a real need for accurately controlling the duration of the treatment and its temperature.

Following early work, treatment of the narcissus bulb was standardised at immersion for 3 hours in a water bath maintained at a temperature of 43.3°C, but after increases in the incidence of eelworm infection in the 1950s it was suggested that higher temperatures and/or longer times should be used. The usual treatment has now become a 3 hour period of immersion in a water bath at a temperature of 44.4°C, with very little flower damage resulting from this.

Modifications and refinements to the technique include the pre-soaking of bulbs, and warm storage prior to treatment in an effort to reduce hot water damage.

The temperature for killing eelworm varies with the exact species, but for each there is a temperature below which the eelworm is unharmed irrespective of treatment time, and a temperature above which death is virtually instantaneous. Between these two limits there is a continuous range of lethal time-temperature combinations, with shorter treatment times being required for higher temperatures.

The efficiency of hot water treatment as a control method is completely dependent on ability to maintain the correct temperature throughout the treatment period. The water is used as a vehicle whereby the heat is transferred to the plant material. Practically all failures to control pests by this method have been due to poor heat control within the apparatus.

Lack of control will result in spatial and temporal variations in temperature within the bath, which can render the treatment process a failure.

An object of the present invention is to provide a method and apparatus for a more accurate heat treatment of bulbs than has been possible up to now with existing systems.

According to the present invention, a method of heat treating bulbs includes the steps of placing the bulbs in an enclosed space, reducing the pressure within the enclosed space and maintaining a reduced pressure in the enclosed space whilst providing in the enclosed space water at a preselected temperature or range of temperatures below that at which damage to the plant tissue would otherwise occur but sufficiently high to result in the death of pests and diseases associated with the bulbs under treatment whereby the water gives off vapour which condenses on the bulbs giving up heat to the bulbs to raise them to and maintain them substantially at said preselected temperature or range of temperatures.

Conveniently, the total reduced pressure maintained in the enclosed space is equal to or slightly less than the vapour pressure of water at said temperature or range of temperatures.

The method of heat treating bulbs according to the present invention relies on the water vapour condensing on the surface of the bulbs and the latent heat thus recovered being transferred to the bulk of the body via thermal diffusion.

In slightly more detail, the physics behind this method can be explained in the following way. Consider an arbitrary volume of water at temperature 0°C located inside a vacuum chamber. On evacuating the chamber the internal pressure drops and a point will be reached when the internal pressure will equal the saturation vapour pressure of the liquid at the given temperature. At this point the water will be boiling off and large amounts of vapour at a temperature θ°C will be produced. Vapour will condense on any surface inside the chamber if that surface is at a temperature less than θ°C. Thus any object placed inside the chamber before evacuation, with a temperature less than θ°C will increase in temperature due to vapour condensing on its surface. This latent heat will diffuse through to the core of the object and condensation at the surface will continue until the whole of the body has been raised to the temperature θ°C. Thus the temperature of the water bath sets an absolute limit on the final temperature of any body in the chamber, and as long as the water bath temperature can be maintained accurately to the required tolerance, a final object temperature of the desired value can be achieved.

One inherent disadvantage of heat treatment in water or through the condensation of water vapour is that the produce is wetted and bulbs cannot be stored wet. The use of vacuum techniques for heating also provides the opportunity to use the same equipment for drying and according to a preferred optional feature of the invention, the method of heat treatment described above is followed by a drying treatment of the bulbs comprising the steps of isolating the water from the bulbs and thereafter further reducing the pressure in the enclosed space to evaporate the heat treatment water from the surface of the bulbs.

One such method, for heat treating narcissus bulbs for eelworm infestation, comprises the steps of placing the bulbs in an enclosed space, reducing and maintaining in the enclosed space a reduced pressure in the range 92.5 to 55.3 mm Hg, providing in the enclosed space water at a temperature in the range 50°C to 40°C, and subjecting the bulbs to said heat treatment for between 0.1 hours and 4 hours. This is conveniently followed by the steps of isolating the water from the bulbs and thereafter reducing the pressure in the enclosed space to a

value of between 17.5 and 4.6 mm Hg thereby to dry (and cool) the bulbs.

In the drying (and cooling) phase referred to above, there is no requirement to hold a particular pressure for a period of time. The end pressure will depend upon the amount of drying required. At the values quoted above, the surface temperature of the bulb will be 20°C and 0°C respectively, with possibly slightly higher values internally which are of no practical significance.

The invention also includes an apparatus for performing the heat treatment method referred to above comprising a vessel having heat-insulated walls at least in part enclosing a space, means for reducing the pressure within the enclosed space and for maintaining a reduced pressure in the enclosed space, and a bath or the like in the enclosed space for water for providing in the enclosed space water vapour and means for heating water in the bath or the like to a predetermined temperature.

Conveniently, where the apparatus is also to be used for vacuum drying the heat-treated bulbs, then the apparatus will additionally include means for draining or otherwise isolating the water bath or the like from the bulbs and means for reducing the pressure in the enclosed space to a sufficiently low value to promote significant evaporation of the heat treatment water from the surface of the bulbs.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawing in which Figures 1 and 2 are partially diagrammatic side and end views of a vacuum heat treatment and bulb drying apparatus in accordance with the present invention.

Thus referring now to the drawing, a vessel 10 comprises heat-insulated walls 12 provided with stiffening rings 13 and at least in part enclosing a space 14 in which the bulbs are to be heat treated by the method of the present invention.

A sliding end door 15, shown open in the simplified view of Figure 1, is omitted from Figure 2 which shows instead roller tracks 16 on which the bulb-carrying trays will be supported in the vessel.

The purpose of insulating the walls 12 is to prevent the inner surfaces of the vessel acting as a large capacity condenser which would absorb from the water vapour heat intended for the bulbs.

Reference numeral 18 indicates a pressure-sensitive vacuum pump e.g. of the oil-sealed rotary piston type, for reducing the pressure within the enclosed space 14 and for maintaining the reduced pressure. Reference numeral 20 indicates a bath which during the heat treatment method will contain the water to be vapourised in the space 14. An adjustable thermostatically-controlled heater 22 is fitted in the bath to maintain the water there at the desired temperature.

In order that the same apparatus may also be used for drying the bulbs after heat treatment, the vessel 10 is additionally provided with a drain 24 for removing water from the bath 20 and with a refrigeration unit shown diagrammatically as compressor 27, evaporators 29 and condensor 31.

The apparatus is controlled from a control panel 33.

In operation of the apparatus above described to heat treat narcissus bulbs for eelworm infestation, for example, the final total pressure in the enclosed space is reduced to and maintained at 71.5 mm Hg and water at 45°C is provided in the bath to raise the temperature of the bulbs to within plus or minus half a degree of 44.4°C.

The bulbs are maintained at this temperature and pressure for about 3 hours by which time it can safely be assumed that any eelworm present has been killed.

The next step is to vacuum dry the bulbs by draining all the water from the bath 20 and thereafter reducing the pressure in the vessel 10 down to about 6 mm Hg and activating the refrigeration unit. The heat treatment water will now evaporate from the surface of the bulbs allowing up to 7.3% of the weight of each bulb to be lost in the form of water. This process will advantageously also involve some cooling of the bulbs of course (5.6°C for every 1% water loss).

In an alternative embodiment (not shown) intended for heat treatment at around 40°C, it is possible to use a liquid ring vacuum pump with the ring formed from mains water. However, the drying process then entails dropping the temperature below that of the mains water, thus the "ring" boils and pumping efficiency is lost. There are other vacuum pumping systems suitable for water vapour at the lower temperatures, but the mixed system, i.e. refrigeration and oil-sealed rotary piston pump, is widely recognised as the more efficient.

It is also envisaged that other heat treatment and/or drying regimes may also be used. For example, provided adequate precautions are taken to avoid overheating of the bulbs, it might provide advantageous to start the heat treatment at a significantly higher temperature than that suggested above e.g. in the region of 70°C or 80°C.

CLAIMS

1. A method of heat treating bulbs including the steps of placing the bulbs in an enclosed space, reducing the pressure within the enclosed space and maintaining a reduced pressure in the enclosed space whilst providing in the enclosed space water at a preselected temperature or range of temperatures below that at which damage to the plant tissue would otherwise occur but sufficiently high to result in the death of pests and diseases associated with the bulbs under treatment whereby the water gives off vapour which condenses on the bulbs giving up heat to the bulbs to raise them to and maintain them substantially at said preselected temperature or range of temperatures.

2. A method as claimed in Claim 1 in which the total reduced pressure maintained in the enclosed space is equal to or slightly less than the vapour pressure of water at said temperature or range of temperatures.

3. A method as claimed in Claim 1 or Claim 2 in which the heat treatment of the bulbs is followed by a drying treatment comprising the steps of isolating

the water from the bulbs and thereafter further reducing the pressure in the enclosed space to evaporate the heat treatment water from the surface of the bulbs.

4. A method of heat treating narcissus bulbs for eelworm infestation comprising the steps of placing the bulbs in an enclosed space, reducing and maintaining in the enclosed space a reduced pressure in the range 92.5 to 55.3 mm Hg, providing in the enclosed space water at a temperature in the range 50°C to 40°C, and subjecting the bulbs to said heat treatment for between 0.1 hours and 4 hours.

5. A heat treatment method as claimed in Claim 4 followed by a method of drying the narcissus bulbs comprising the steps of isolating the water from the bulbs and thereafter reducing the pressure in the enclosed space to a value of between 17.5 and 4.6 mm Hg.

6. An apparatus for performing the heat treatment method of Claim 1, Claim 2 or Claim 4 comprising a vessel having heat-insulated walls at least in part enclosing a space, means for reducing the pressure within the enclosed space and for maintaining a reduced pressure in the enclosed space, and a bath or the like, in the enclosed space, for water for providing in the enclosed space water vapour and means for heating water in the bath or the like to a predetermined temperature.

7. An apparatus as claimed in Claim 6 adapted also to be used for vacuum drying the heat-treated bulbs in accordance with the method of Claim 3 or Claim 5 and additionally including means for draining or otherwise isolating the water bath or the like from the bulbs and means for reducing the pressure in the enclosed space to a sufficiently low value to promote significant evaporation of the heat treatment water from the surface of the bulbs.

8. An apparatus substantially as hereinbefore described with reference to, and/or as illustrated in, the accompanying drawing.

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