

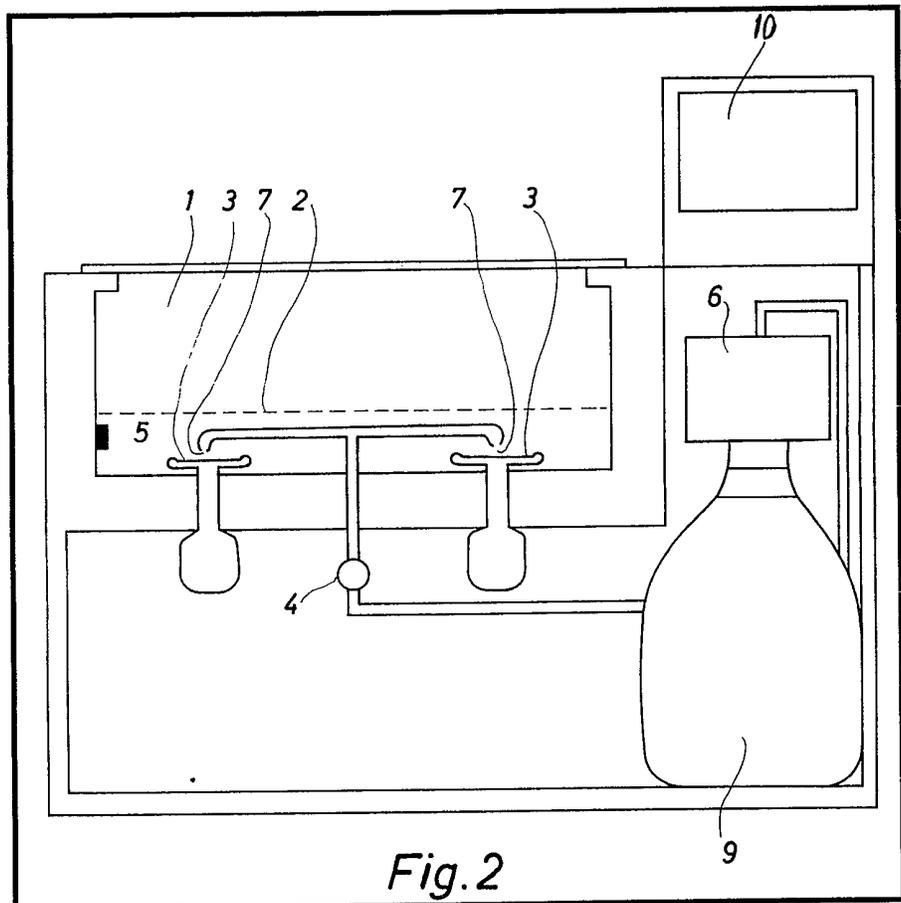
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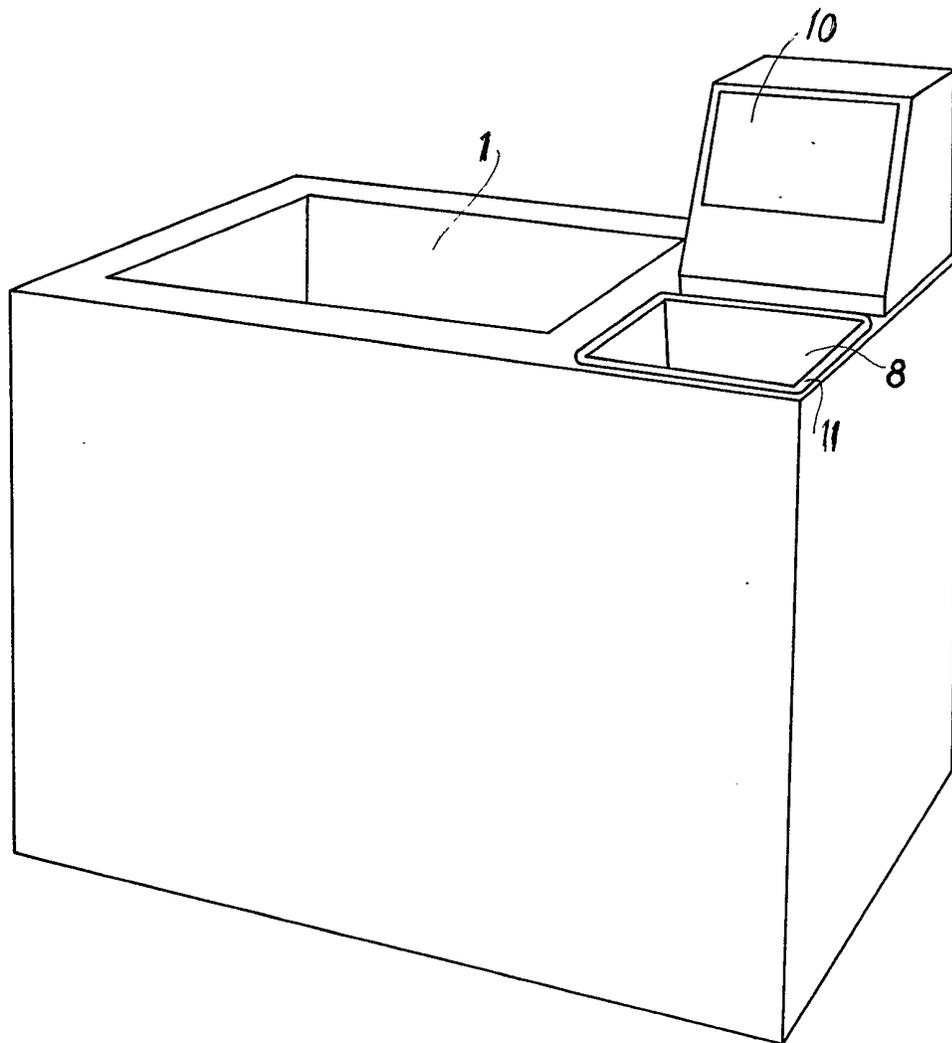
(54) Apparatus and method for freezing liquid such as semen

(57) Liquid such as bull semen is frozen in straws placed in a chamber (1) through which drops of liquid nitrogen liberated from nozzles (7) are blown by currents of air from blowers (3).

To avoid too sudden cooling of semen caused by large drops of liquid nitrogen liberated from the nozzles, a grid (2) of perforated stainless steel is placed between the blowers (3) and the part of the chamber where the straws of liquid are placed.

A thermostat (5) controls the supply of liquid nitrogen to the nozzles; the temperature in the chamber can be controlled to  $\pm \frac{1}{2}^{\circ}\text{C}$ .





*Fig.1*

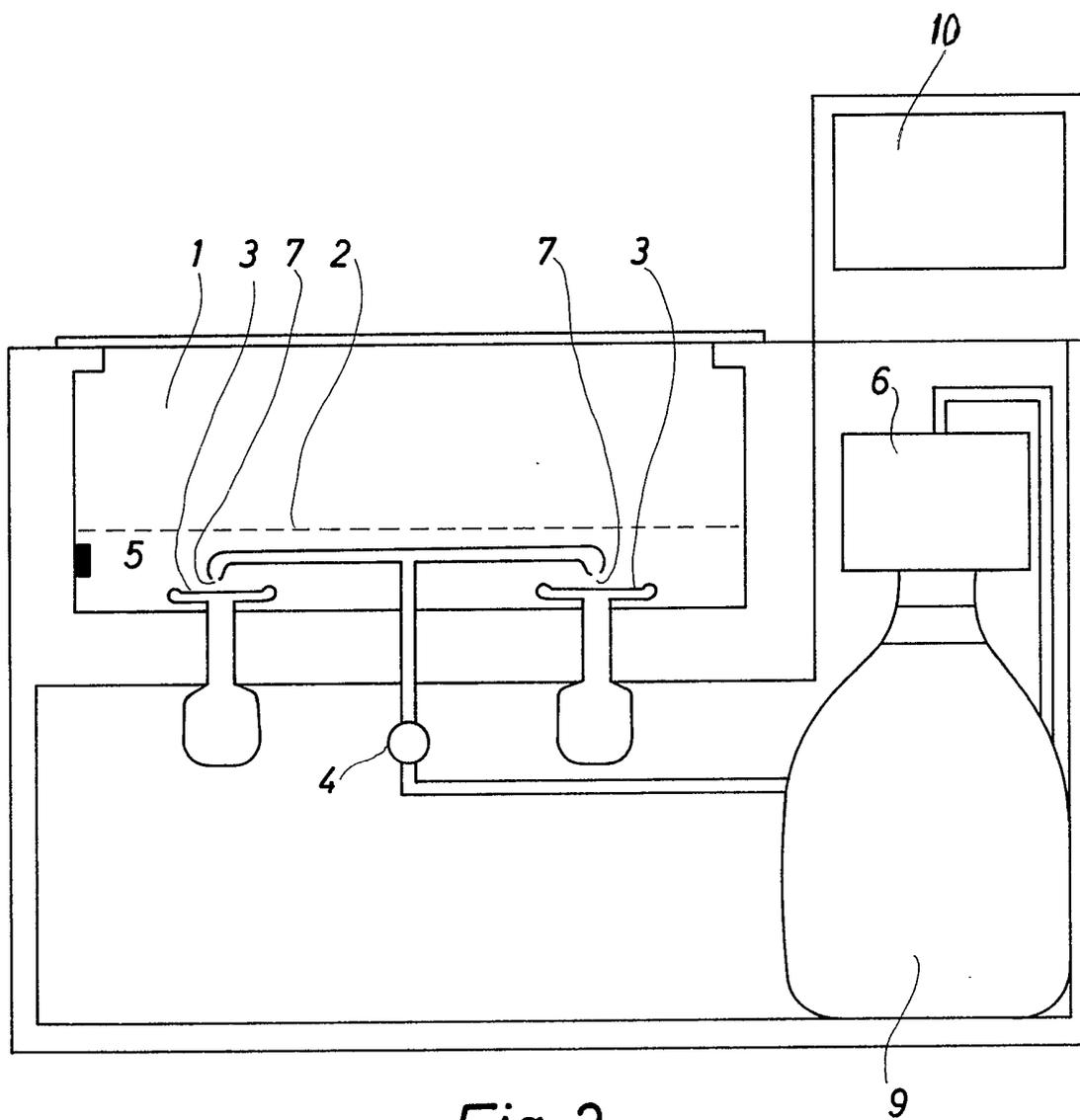


Fig. 2

## SPECIFICATION

**Apparatus and method for freezing liquid such as semen**

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The invention relates to an apparatus and method for freezing liquid, especially semen, preferably bull semen, the liquid such as semen being present in narrow hollow tubes (straws) located in frames situated in a chamber through which streams of nitrogen gas are blown by means of one or more blowers located in a portion of the chamber.

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U.S. Patent Specification No. 3,638,443 discloses a refrigeration system comprising spray nozzles for releasing cold liquids, such as liquid nitrogen, for a freeze chamber. Under the nozzles, an extended solid surface member of heat-conductive material is provided. Thereby, a too sudden cooling of the material to be frozen may be avoided. However, a freezing to particularly low temperatures is not possible therewith.

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The object of the invention is to provide an apparatus for freezing material such as semen to a low temperature, without a sudden cooling.

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The apparatus according to the invention comprises a chamber for holding tubes of liquid to be frozen above a grid, means for supply of liquified gas, means for liberating the liquified gas in droplets and for blowing the droplets upwards through said grid and past said tubes in the chamber, the grid being arranged to catch large drops of the liquified gas and prevent them from passing to the tubes of liquid to be frozen.

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Thus, the portion of the chamber containing the blower is separated from the portion of the chamber in which the straws of semen are placed by means of a grid. In this manner a freezing to a lower temperature is obtained, partly as a consequence of the direct access of the fluid to the freezing chamber and partly as a consequence of the lower heat capacity of the grid.

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The invention will be described below with reference to the accompanying drawing, in which:

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*Figure 1* is a perspective view of an apparatus for freezing bull semen; and

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*Figure 2* is a sectional view of the apparatus in Fig. 1.

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The apparatus illustrated in Figs. 1 and 2 for freezing bull semen is provided with a chamber 1, for containing straws, i.e. narrow hollow tubes, holding bull semen which has been diluted with a freeze-protecting liquid, e.g. glycerol. The straws are supported by conventional freezing frames (not shown). Under a grid 2 adjacent the bottom of the chamber 1, a plurality of air blowers 3 are provided for blowing upwards through the chamber 1 streams of air in which are suspended droplets of a liquified gas such as

liquid nitrogen supplied through nozzles 7 which break up the liquid into droplets, e.g. by having known atomisation means. The nozzles communicate with a container 9 for the liquid gas, e.g. nitrogen, through a magnetic valve 4. The chamber also contains a thermostat 5 for controlling the supply of liquid nitrogen by means of the valve 4 in response to the deviation from the desired

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temperature. In the line from the nitrogen container 9, a pump 6 is provided, the speed of which is variable, by a control on a panel 10, so that it is possible to adjust the velocity of the blowers and hence of the streams of air carrying the droplets.

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Instead of a single grid, two grids spaced apart from each other and having their apertures mutually displaced can be used. The grid is suitably made of metal such as stainless steel and can have circular holes of diameter 2 mm and spaced 2.5 mm apart between their centres.

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For the freezing procedure, the frames containing the straws of semen are placed in the chamber 1. The pump is actuated to send streams of droplets of liquified gas up through the grid 2; when the desired temperature is attained, the thermostat 5 closes the valve 4.

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The apparatus may obtain the desired temperature in a predetermined time, e.g. four to five minutes, as a consequence of the thermostat control; the desired temperature is obtained with an accuracy of  $\pm \frac{1}{2}^{\circ}\text{C}$ . During the freezing process, the grid 2 catches large, non-atomized drops of nitrogen, whereby a sudden cooling of the semen is avoided. Such a sudden cooling could otherwise have caused a reduced survival of the sperm cells in the semen.

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After freezing to the desired temperature, which may be set in the range  $-80^{\circ}\text{C}$  to  $-120^{\circ}\text{C}$ , preferably  $-110^{\circ}\text{C}$ , the straws are put into boxes with liquid nitrogen in an intermediary container 8 with liquid nitrogen, see Fig. 1. This intermediary container is provided with a nylon rim 11 to prevent the cold from causing formation of ice along the rim.

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Thus, one may freeze a higher number at a time of frames of semen-filled straws than previously in a given time, which is useful on large bull farms.

## CLAIMS

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1. An apparatus for freezing semen, which comprises a chamber for holding tubes of liquid to be frozen above a grid, means for supply of liquified gas, means for liberating the liquified gas in droplets and for blowing the droplets upwards through said grid and past said tubes in the chamber, the grid being arranged to catch large drops of the liquified gas and prevent them from passing to the tubes of liquid to be frozen.

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2. Apparatus as claimed in Claim 1, which

includes a thermostat arranged to control the supply of liquified gas to the means for liberating the gas.

3. Apparatus as claimed in Claim 1 or 2,  
5 wherein said grid is made of metal.

4. Apparatus for freezing liquid such as semen, substantially as hereinbefore described with reference to the accompanying drawing.

10 5. A method of freezing a liquid wherein apparatus as claimed in any preceding claim is used, the liquid being placed, held in tubes, in the upper part of the chamber, and droplets of liquified gas are blown upwards in a stream of air through the grid and past the tubes.

15 6. A method as claimed in Claim 5, wherein the liquified gas is liquid nitrogen.

7. A method as claimed in Claim 5 or 6, wherein the liquid to be frozen is semen.

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