

May 18, 1971

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3,579,290

STERILISATION OF SURGICAL INSTRUMENTS

Filed June 8, 1970

2 Sheets-Sheet 1

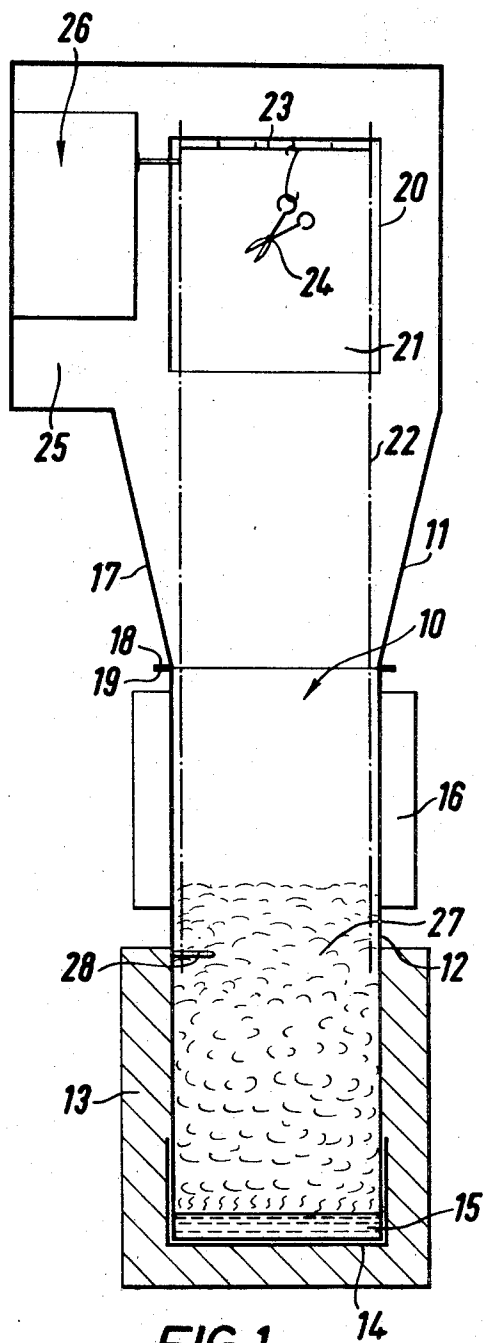


FIG. 1.

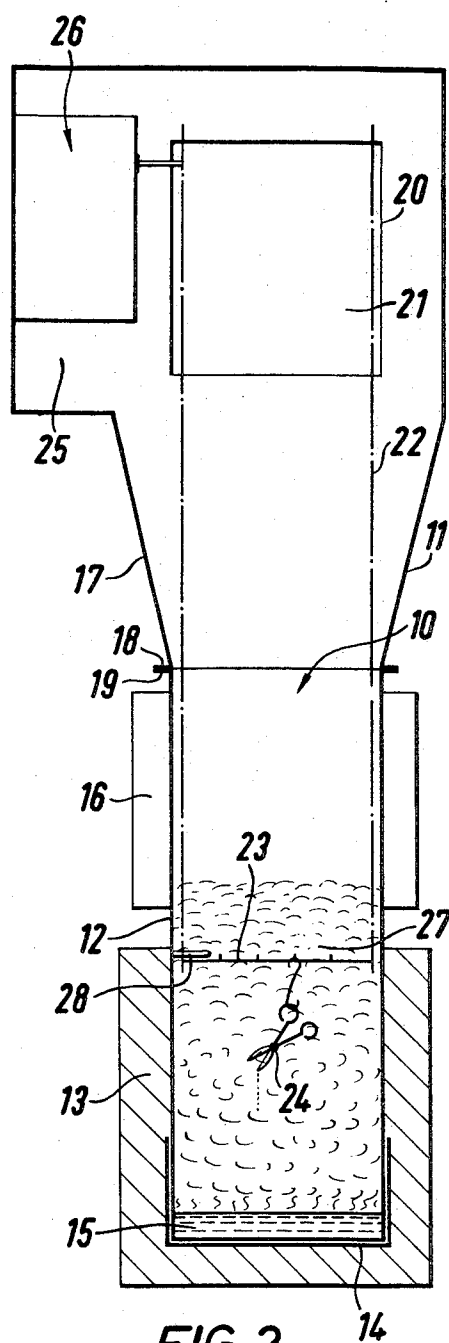


FIG. 2.

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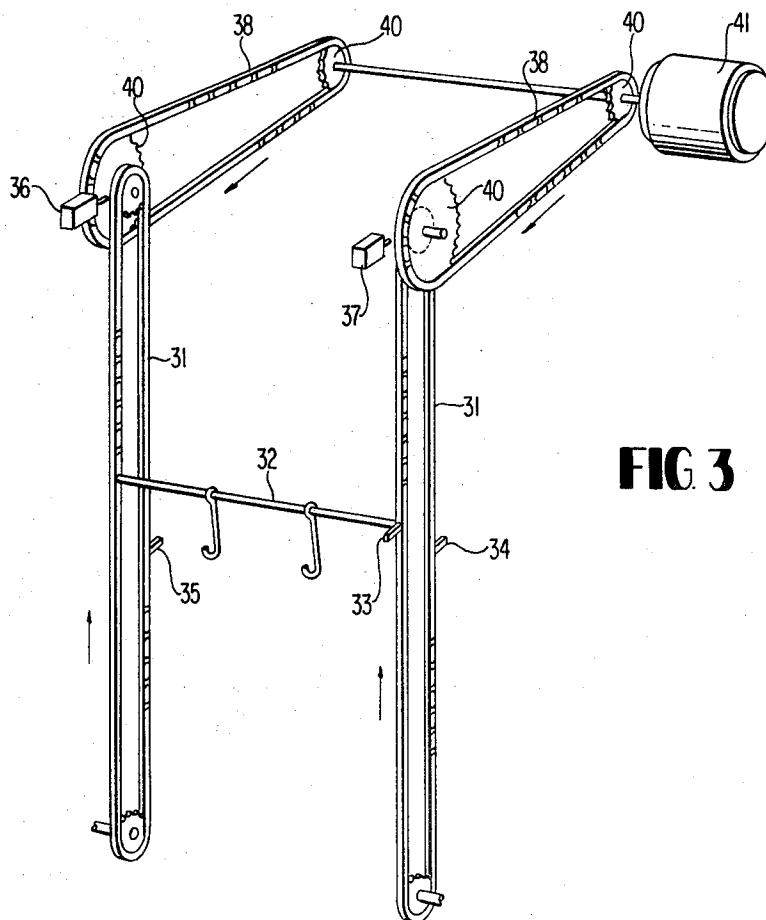


FIG 3

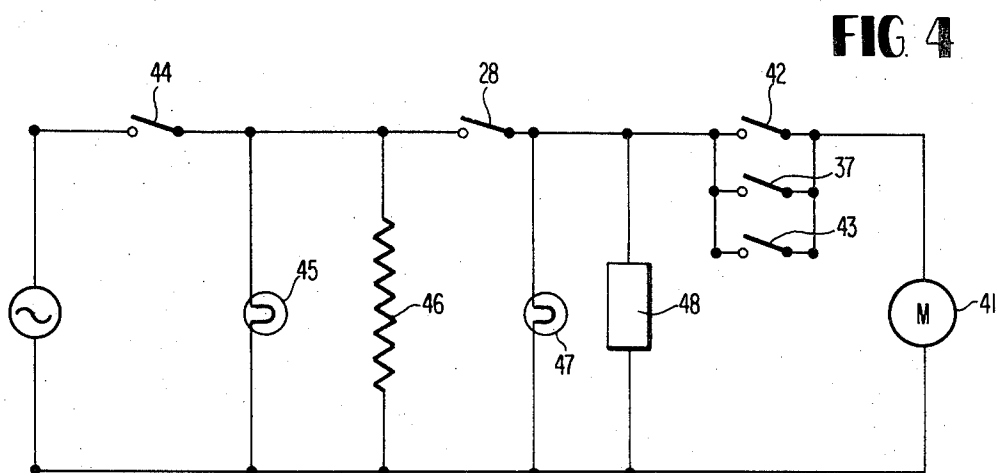


FIG 4

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STERILISATION OF SURGICAL INSTRUMENTS

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Continuation-in-part of application Ser. No. 713,395,
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No. 44,018

Claims priority, application Great Britain, Mar. 16, 1967,
12,419/67

Int. Cl. A61 1/00, 3/00

U.S. Cl. 21—2

20 Claims

ABSTRACT OF THE DISCLOSURE

A method of and apparatus for sterilizing articles such as surgical instruments which method comprises suspending the object or instrument in a boiling inert liquid or in a saturated vapor thereof, said liquid having a boiling point within the range of 160° C. to 190° C. until the temperature of the said object has been raised to that of the boiling liquid and then raising it to a zone above the vapor of the boiling liquid until adhering liquid has evaporated under the sensible heat of the instrument.

This application is a continuation-in-part application of Ser. No. 713,395, filed Mar. 15, 1968, and now abandoned.

The present invention relates to sterilization of equipment, in particular of surgical instruments.

Sterilization of surgical instruments has been largely carried out by heating in an oven at a temperature above 160° C. for about one hour or even longer for safety. More rapid methods have been proposed such as dipping into hot oil, but the removal of residual oil from the instruments has been difficult and the method has not been found satisfactory.

According to the present invention there is provided a method of sterilizing articles such as surgical instruments which method comprises suspending the object or instruments in a boiling inert liquid or in a saturated vapor thereof, said liquid having a boiling point within the range of 160° C. to 190° C. until the temperature of the said object has been raised to that of the boiling liquid and then raising it to a zone above the vapor of the boiling liquid until adhering liquid has evaporated under the sensible heat of the instrument.

The present invention also includes sterilization apparatus comprising a vapor tank adapted to accommodate a boiling inert liquid having a normal boiling point greater than 160° C. heating means for heating and boiling the liquid in said tank to provide a vapor zone within said tank, cooling means disposed in spaced relationship with the liquid in said tank to maintain a distinct vapor layer of said inert liquid therein, instrument support means disposed within said tank and movable between a first position in which an instrument supported thereby is disposed within said vapor layer and/or said liquid and a second position in which said instrument is not disposed within said layer and/or said liquid, the arrangement being such that on maintaining said support means and instrument carried thereby in said first position until the instrument has obtained the temperature of said vapor and/or liquid, movement of the support to the second position results in liquid adhering to the instrument evaporating under the sensible heat thereof.

The inert liquid should be nontoxic and have a high vapor density and a low viscosity and surface tension at its boiling point. Suitable inert liquids are to be found among the fluorocarbons, i.e., hydrocarbons or derivatives thereof in which the hydrogen is fully replaced by

fluorine. Examples of suitable fluorocarbons are fully fluorinated tributylamine or alkyl decalin. These products are sold under the initials Fc and a number. The product sold under the designation Fc43 has a boiling point between 169° and 174° C.

The inert liquid may be any straight chain, branch chain or cyclic saturated organic compound and in which all hydrogen atoms have been replaced by fluorine. Amine groups may be present if fluorinated as they lose their basic properties in this state.

The method according to the invention may be carried out in an insulated boiling tank provided with a cooled projection above it, which projection has at least the same height as the insulated part. The liquid is kept boiling at such a rate that the space in the insulated half of the tank above the level of the boiling liquid is filled with vapor, but the boiling should not be so fast that the vapor rises too high in the cooled zone or that liquid is entrained with the rising vapor. The instruments suitably supported on a rack or tray are lowered into the vapor space and will be readily heated to approximately the boiling point of the liquid and should be left there for the preferred sterilizing time according to the size of the instruments being sterilized and will be then raised to the cool zone of the tank where the sensible heat of the instruments will evaporate completely the remaining liquid in a very short time and the instruments may then be withdrawn hot and will be clean and sterilized.

Following is a description by way of example only and with reference to the accompanying drawings of a method of carrying the invention into effect.

In the drawings:

FIG. 1 is a diagrammatic section of the apparatus in accordance with the present invention with the instrument support tray disposed in the nonsterilizing position;

FIG. 2 is a diagrammatic representation of the apparatus in accordance with the present invention showing the instrument support tray in the sterilizing position;

FIG. 3 shows in more detail essential portions of the instrument carrying and moving system; and

FIG. 4 shows the essential parts of the electrical circuit.

The apparatus comprises an erect elongate vapor tank 10 formed with an upper tank portion 11 and a lower tank portion 12. The lower part of the lower tank portion 12 is insulated by means of insulating jacket 13 and is provided about the base and lower part of the side walls adjacent the base with an electrical heating element 14. The lowermost part of the tank 10 is adapted to accommodate a layer of inert liquid, which in the particular embodiment described is fully fluorinated tributylamine having a normal boiling point within the range 169° C. to 174° C.

The upper part of lower tank portion 12 is provided with a plurality of cooling fins 16 disposed about the outer surface thereof to provide a cooling zone in the upper part of said lower tank portion 12 and to define a sterilizing zone between the layer of liquid in the bottom of the tank and the said cooling zone.

The upper tank portion 11 is provided with a diverging taper 17 adjacent the upper part of the lower tank portion 12. The taper 17 is provided about its lower edge with a peripheral flange 18 which is adapted to engage with the corresponding flange 19 provided on the upper peripheral edge of the lower tank portion 12, means being provided for securing the flange 18 to flange 19 to provide a vapor-tight seal and to define tank cavity 10. Upwardly of the taper 17, the tank 10 is expanded to provide an access portion 20 having in one surface a vapor-tight entry door 21. The tank cavity 10 is further provided with two pairs of spaced guides 22 extending from the upper part of the sterilizing zone in the lower tank portion 12 to the entry

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portion 20 of the upper tank portion 11. The guides 22 are secured to the upper tank portion 11 and extend downwardly through the cooling zone defined by cooling fins 16 about the lower tank portion. The guides 22 are adapted to carry support means comprising an instrument support tray 23 upon which instruments 24 can be supported. The tray 23 is slidable in a vertical plane with respect to guides 22, and is supported by a chain mechanism which is coupled to controls and driving gear 26 for raising or lowering tray 23 within the tank cavity 10.

The upper tank portion 11 is provided with a space 25 adjacent the entry door 21 to accommodate motor means and driving gear and controls indicated generally at 26 for raising and lowering the tray 23 into and out of the vapor level, 27, formed in the sterilizing zone between the surface of boiling liquid 15 and the lower part of the cooling zone defined by cooling fins 16.

The lower tank portion 12 is provided in the upper part of the sterilizing zone with a thermostat 28 extending into the vapor layer 27. Thermostat 28 is coupled to the control and driving gear 26 and acts to prevent the driving gear raising tray 23 from the sterilizing zone and in the event of there being insufficient vapor.

The controls and driving gear 26 includes a delay circuit which controls the period during which the instruments 24 are disposed within vapor level 27. For small instruments such as forceps and scalpels, this period is set for 1 to 4 minutes as required. An indicator circuit is also included within the control system 26 which includes a signal lamp which operates when the sterilization cycle has been satisfactorily completed and which will not operate if for any reason the period of suspension of the instrument 24 within the vapor layer 27 has not been satisfactorily completed or if there was a fall in the vapor level indicated by thermostat 28 or a failure of the main current supply to the apparatus. A switch is also provided to operate an opening and closing the entry door 21 to reset the delay circuit on closing the said door.

In operation, the support tray 23 is disposed at the top end of guides 22. On opening door 21 the instruments are suspended from tray 23. The sterilization period is selected from the appropriate control for apparatus and driving gear 26 and on closing the door, the said switch operates to activate the driving gear 26 and lower tray 23 along guides 22 into the vapor and sterilization zone 27. The tray 23 and instruments 24 carried thereby are maintained in the vapor layer 27 until the instruments have obtained the temperature of the vapor in layer 27. At the end of the sterilization period, the control gear 26 acts to raise tray 23 up guides 22 to the position adjacent the entry door. In this position the sensible heat of the instruments 24 carried by tray 23 serves to evaporate any liquid carried by the instruments and the instruments are presented at entry door 21 in a clean and sterile condition.

FIG. 3 shows a more detailed form of the mechanical suspension system for the instruments to be sterilized. The system comprises chains 31 for raising and lowering a transverse bar 32 carrying hooks on which instruments may be hung. Provided on chains 31 are cams 33, 34 and 35 which, when moved by the chains, actuate switches 36 or 3. Drive chains 38 are provided for driving chains 31 via sprockets 40 from a motor 41. It is to be understood that these mechanical devices are well known in the art and form no part of the present invention, the purpose being merely to illustrate the mode of operation in more detail.

In the operation of the FIG. 3 system, the suspension bar 32, when moved to its uppermost position, causes cam 33 to operate switch 37 into the off position. Switch 37 is shunted with a push button switch (designated 42 in FIG. 4) and this controls the motor. When the starting switch is pressed, motor 41 revolves and chains 31 then carry suspension bar 32 downwards, and when it reaches the bottom position, cam 34 switches off motor 41 through

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switch 37. Switch 36 is then closed by cam 35 and this operates the timer (see below).

The timer circuit (designated 48 in FIG. 4, see below) can conveniently be a geared synchronous motor with a revolution time of 9 minutes and the spindle of which operates a switch via a cam, for instance, the switch (43 in FIG. 4) restarts the lifting motor 41 by shunting switch 37 through a relay.

FIG. 4 shows the chief parts of the electrical circuit arrangement. It is connected to the electric network via an on-off switch 44. Closing of switch 44 causes current to be applied to a signal lamp 45 indicating that power is on. The heater is represented as a resistor 46 connected in parallel with lamp 45. Also connected in parallel with it is the vapor layer thermostat 28 in series with a signal lamp 47. Connected in parallel with lamp 47 is the series arrangement of motor 41 and the three switches 37, 42 and 43 referred to above. These switches are in parallel to each other, as is apparent from the FIG. 4 diagram.

As may be seen from the electrical diagram and as was explained before, thermostat 28 determines whether there is a sufficient depth of vapor layer and remains in the on position as long as this layer is satisfactory. This is indicated by signal lamp 47 and also closes the electrical circuit so that the timer 48 may operate. If for any reason the vapor layer sinks below a safe level during the cycle, the machine will then cease to operate and the signal lamp will go out.

The system described above is one method by which the invention has been applied, but essentially similar systems may be used in which the instrument holder is put in and removed manually. The speed of all parts of the operation except the actual cycle time are merely a matter of convenience. The speed of lowering of the instruments is not important and the speed with which they are removed is also essentially unimportant as the instruments invariably emerge quite dry and very hot.

What is claimed is:

1. A method of sterilizing articles such as surgical instruments which method comprises suspending the object or instrument in a boiling inert liquid or in a saturated vapor thereof, said liquid having a normal boiling point within the range of 160° C. to 190° C., until the temperature of the said object has been raised to that of the boiling liquid and then raising said object or instrument to a zone above the vapor of the boiling liquid until adhering liquid has evaporated under the sensible heat of the instrument.

2. A method as claimed in claim 1 wherein the inert liquid is nontoxic, has a high vapor density, and has a low viscosity and surface tension at its boiling point.

3. A method as claimed in claim 1 wherein the inert liquid is a fluorocarbon.

4. A method as claimed in claim 1 wherein the inert liquid is a fully fluorinated tributylamine.

5. A method as claimed in claim 1 wherein the inert liquid is a fully fluorinated alkyl decalin.

6. A method as claimed in claim 1 wherein the inert liquid has a normal boiling point within the range of 169° C. to 174° C.

7. A method as claimed in claim 1 wherein the inert liquid is a straight chain, branched chain, or cyclic saturated organic compound and in which all hydrogen atoms have been replaced by fluorine.

8. A method as claimed in claim 1 wherein the inert liquid is an organic compound containing one or more fluorinated amine groups.

9. A sterilizing apparatus comprising a vapor tank adapted to accommodate a boiling inert liquid having a normal boiling point greater than 160° C., heating means for heating and boiling the liquid in said tank to provide a vapor zone within said tank, cooling means disposed in spaced relationship with the liquid in said tank to maintain a distinct vapor layer of said inert liquid therein, in-

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strument support means disposed within said tank and movable between a first position in which an instrument supported thereby is disposed within said vapor layer and/or said liquid and a second position in which said instrument is not disposed within said vapor layer and/or said liquid, and means for maintaining said support means and instrument carried thereby in said first position until the instrument has obtained the temperature of said vapor and/or liquid and thereafter moving the support to the second position, wherein liquid adhering to the instrument evaporates under the sensible heat thereof.

10. Apparatus as claimed in claim 9 wherein the heated part of the vapor tank is insulated and wherein the cooling means defines a cooling zone above the heated part of the tank to condense the vapor and maintain the vapor in a distinct layer above the liquid.

11. Apparatus as claimed in claim 9 in which a thermostat extends into the vapor zone and is operatively coupled to driving and control means for the instrument support means to prevent return of said means to the second position in the event there is insufficient vapor in the vapor zone, said driving and control means constituting part of said support movement means.

12. Apparatus as claimed in claim 9 in which there is provided a motor means for moving said instrument support means between said first and said second position, and further including controls for said motor means including a delay circuit which permits preselection of the residence time of said instrument support means in the vapor layer and/or liquid zone, at the end of which time the instrument support means is returned to the second position, said motor and controls therefor constituting part of said support movement means.

13. Apparatus as claimed in claim 9 comprising an erect tank having an upper tank portion and a lower tank portion, the lower part of the lower tank portion being provided with a heat insulating jacket and wherein said heating means comprises an electrical heater for heating the inert liquid disposed therein.

14. Apparatus as claimed in claim 13 wherein the upper tank portion is provided with a taper adjacent the lower tank portion connected thereto and wherein, above the taper, the tank is expanded to provide an access portion having in one surface thereof a vapor tight entry door.

15. Apparatus as claimed in claim 13 wherein the tank cavity defined by the upper tank portion and the lower tank portion is provided with spaced guides extending vertically from the upper tank portion to the heating zone in the lower tank portion, said spaced guides constituting part of said support movement means.

16. Apparatus as claimed in claim 13 wherein the tank cavity defined by the upper tank portion and the lower tank portion is provided with spaced guides, which guides

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are adapted to carry said support means comprising an instrument tray, said tray being adapted to carry instruments to be sterilized, said tray being slidable vertically with respect to and along said guides, said spaced guides constituting part of said support movement means.

17. Apparatus as claimed in claim 13 wherein the tank cavity defined by the upper tank portion and the lower tank portion is provided with spaced guides, which guides are adapted to carry said support means comprising an instrument tray, said tray being supported by a chain mechanism coupled to control and driving means for raising and lowering the tray within the tank cavity, said spaced guides, chain mechanism and control and driving means constituting part of said support movement means.

18. Apparatus as claimed in claim 11 further including an access door provided in the upper part of the upper tank portion, a microswitch mounted on the upper part of the upper tank portion in close proximity to said door, and control means for actuating and effecting the sterilization cycle operatively connected to said microswitch, wherein opening or closing of said door actuates the microswitch and resets the control means.

19. Apparatus as claimed in claim 13 wherein the upper part of the lower tank portion is provided with a plurality of cooling fins disposed about the outer surface to provide a cooling zone in the upper part of that portion.

20. Apparatus as claimed in claim 19 wherein the tank cavity defined by the upper tank portion and the lower tank portion is provided with spaced guides secured to the upper tank portion and extending downwardly through the cooling zone, said spaced guides constituting part of said support movement means.

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U.S. Cl. X.R.

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