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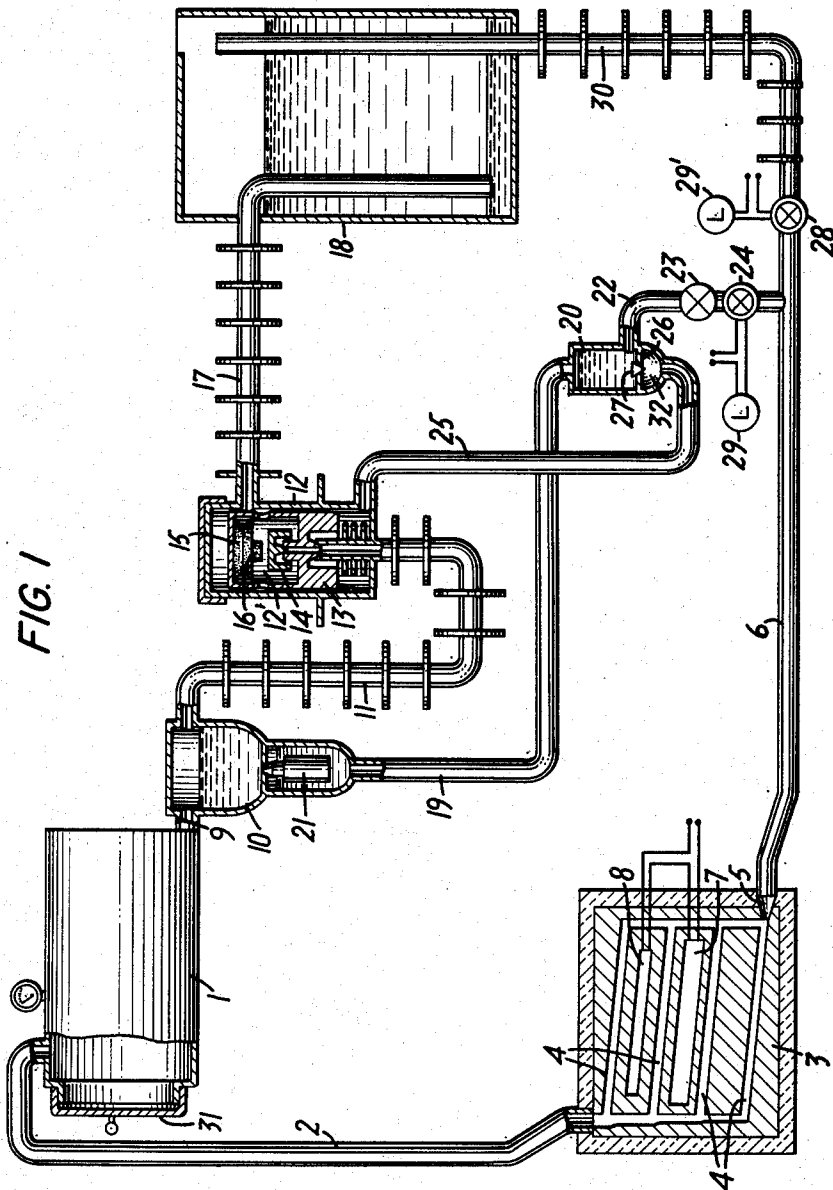
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3,107,975

ARRANGEMENT FOR A STEAM-HEATED AUTOCLAVE

Filed Aug. 31, 1960

2 Sheets-Sheet 1



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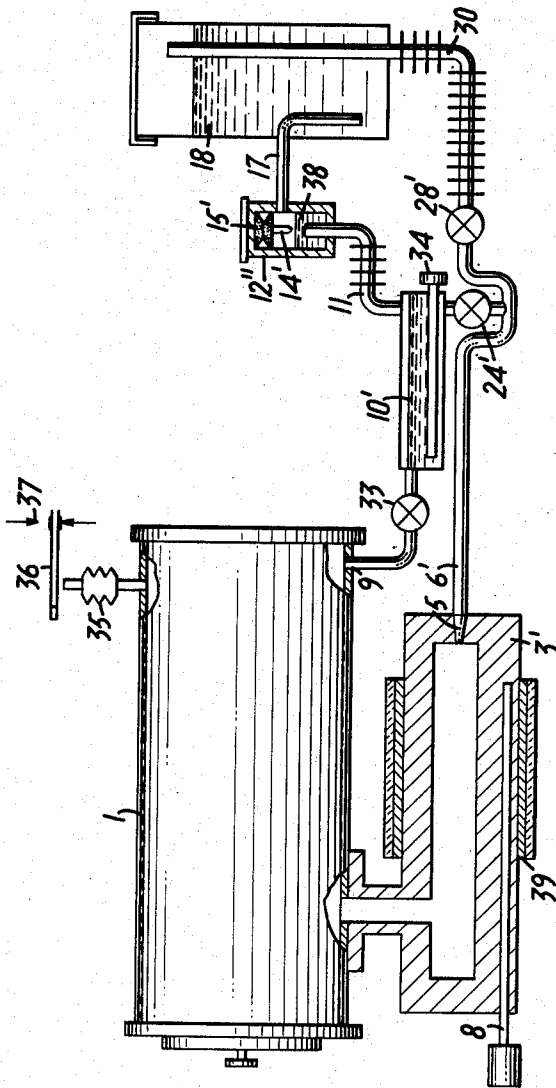


FIG. 2

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ARRANGEMENT FOR A STEAM-HEATED AUTOCLAVE

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This invention relates to a heating apparatus for sterilizing medical instruments and the like. More particularly, this invention relates to an apparatus including a steam heated autoclave and a heat accumulator wherein the steam is generated.

The importance of reducing the time required to effect a sterilization without unduly increasing the power required is well known. Thus various apparatuses have been devised which utilize heat accumulators which are capable of generating high temperature vapors at high rates and thermostats which control the temperature of the autoclave and increase the efficiency of the sterilization thereby. Sterilization of instruments and the like can be effected in a comparatively short time by the use of such apparatuses.

An important object of this invention is to provide a new and improved sterilization apparatus with improved sterilization efficiency.

Another object of this invention is to provide a new and improved sterilization apparatus in which the sterilizing space may be ventilated without reinfection.

Another object of this invention is to provide a new and improved sterilization apparatus in which the sterilization process is substantially automatic.

This invention creates an arrangement which accomplishes all the afore-mentioned objects by an ingenious coordination of all the required measures. Such measures may be applied individually or in combination in accordance with this invention.

A closed circuit has been created for the purpose of supplying steam. This circuit is formed by a conduit which carries water to the heat accumulator and which is connected with the condensation water container which receives the condensation water discharged from the autoclave. The condensation water conduit is connected to a water storage tank and is equipped with a thermo-valve. This circuit provides rapid replenishment of the required quantity of steam at sufficiently high temperatures with economical water consumption and rapid elimination of air from the sterilizing space, which air has an unfavorable effect on heat economy. Said thermo-valve is arranged within the conduit used for the elimination of air and permits passage through the air discharge path only as long as no steam passes through.

A further improvement in the invention is obtained in the addition of another conduit to the pipe system which feeds water to the heat accumulator, such conduit being connected with the outside air and being equipped with a valve which closes said conduit during the sterilizing process. When this valve is open, air is permitted to pass through the heat accumulator, is sterilized therein, and subsequently enters the autoclave. By this improvement, a balance of pressures after the sterilization process can be achieved without reinfection of the sterilized objects in the autoclave.

Further objects of the invention and further details comprised by it, especially the arrangements for automatic

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operation, are explained in the following examples of practical execution which are accompanied by drawings in which:

FIGURE 1 is a schematic arrangement in accordance with the invention;

FIGURE 2 illustrates an arrangement which is simpler than that illustrated in FIGURE 1.

In the figures the same or corresponding parts of the apparatus are indicated by the same reference numerals.

The autoclave is indicated by the reference numeral 1 and is connected by means of a steam conduit 2 to a heat accumulator 3. This heat accumulator 3 consists essentially of a heat-insulated block made of aluminum or some other material which is a good heat accumulator. The heat accumulator 3 is similar to a flue boiler and is equipped with a system of channels 4 at the lowest point of which there is connected a water supply pipe 6 opening into the heat accumulator by means of a spray nozzle 5. Suitable heating organs 7 are arranged between channels 4 and are capable of heating the heat accumulator 3 to a temperature of approximately 250° C. In order to maintain this temperature automatically, a thermostat 8 is likewise placed in the heat accumulator 3 and is connected with the heating current.

The bottom of the autoclave 1 is openly connected to a pipe 9 through which the air displaced from the autoclave 1 may escape. This pipe 9 opens into the top of the condensation water container 10 which receives the condensation water which is formed in the autoclave 1. From the upper part of this condensation water container 10, a cooling pipe 11 which is equipped with cooling fins leads to a valve body 12 which consists of a safety valve 13, a check valve 14 and a bellows-like vessel 15 which acts on the check valve 14. The bellows-like vessel 15 contains a liquid which evaporates at a temperature of about 80° C., for example ethyl alcohol. When this liquid is evaporated, the bellows-like vessel 15 is inflated and thereby closes the check valve 14 by means of its stop 16. An air discharge conduit 17, likewise equipped with cooling fins, is connected to the upper part of the case surrounding the valve 12. An air discharge conduit 17 provides passage for the air which is expelled from the autoclave 1 to the water storage tank 18 and is subsequently released to the atmosphere.

The condensation water is conveyed from the condensation water container 10 through the floating valve 21 and the pipe 19 to the intermediate water vessel 20, and is returned from the intermediate water vessel 20 to the heat accumulator 3 through the pipe 22, the reduction valve 23, the check valve 24 and the water supply pipe 6. Furthermore, the bottom of the housing of the valve body 12 is connected with the bottom of the intermediate water vessel 20 by the pipe 25. The intermediate water vessel 20 is divided into an upper part and a lower part 32 by the dividing wall 26 which is provided with a connecting opening which can be closed by the check valve 27. The vent pipe 30 leads from the juncture of the pipe 22 and the water supply pipe 6 to the water storage tank 18 and ends above the maximum water level of said tank 18, the end of said vent pipe 30 thus being in contact with the atmosphere. The vent pipe 30 provides passage for atmospheric air to the water supply conduit 6 and thereby through the heat accumulator 3 to the autoclave 1, thus allowing the autoclave 1 to be aired with sterilized

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air. The pipe 30 is equipped with cooling fins and with a check valve 28 which, like the check valve 24, may be operated by hand or may be fashioned as a magnetic valve which can be electrically operated at a given time by means of an appropriate timing device, for example the switch clock 29.

The arrangement just described operates as follows: When the check valve 24 is opened on starting the autoclave, the water stored in the intermediate water vessel 20 flows through the pipe 22, the reducing valve 23, and, with check valve 28 closed, flows through the water supply pipe 6 and the nozzle 5 into the heat accumulator 3, which has been previously heated to approximately 250° C. The water speedily evaporates in the system of channels 4 and is conveyed as steam through the steam conduit 2 to the autoclave 1. The condensation water which is formed as a result of the cooling of the steam during warming of the autoclave 1 is conveyed through pipe 9 to the condensation water container 10 and returns to the intermediate water vessel 20 through the floating valve 21 and the pipe 19. The air contained in the autoclave 1 is displaced by the steam flowing in and likewise conveyed through the pipe 9 over the water in the condensation water container 10 and through the cooling pipe 11, the safety valve 13 and the open check valve 14 into the valve space 12', from which it is connected through the air discharge conduit 17 to the water tank 18 where said displaced air may rise in the form of air bubbles and escape to the atmosphere. As soon as the air is removed from the autoclave 1, the bellows-like vessel 15 is heated by the steam which follows the air and as a result the ethyl alcohol contained inside evaporates and the vessel is distended so that its stop 16 closes the check valve 14. This causes the pressure in the autoclave 1 to rise, which results in a closing of the check valve 27. Thereafter, the autoclave 1 operates in a closed cycle. The condensation water is conveyed, as a result of its own weight and the pressure exerted on its surface, from the water container 10 to the intermediate water vessel 20 through the pipe 19, and from there to the heat accumulator 3 through the reducing valve 23, the open check valve 24, and the conduit 6. From the heat accumulator 3, the water again returns as steam to the autoclave 1.

In this manner the steam pressure in autoclave 1 is quickly raised to the desired value, to which the reducing valve 23 has been adjusted. As soon as such pressure is reached, the valve 23 closes and thereby stops the further supply of water to the heat accumulator 3, preventing further increase of the steam pressure in autoclave 1. Further amounts of free air may be formed in the autoclave 1, for example the air which is given off from textiles when they are sterilized. This and other residual air will collect on the bottom of autoclave 1 and will be conveyed over the water in condensation water container 10 and into the cooling pipe 11 by means of the pressurized steam in the autoclave 1, which is constantly moving out of the autoclave 1 and being condensed in cooling pipe 11. Consequently, the bellows-like vessel 15 will become at least partially shielded by air and, because of the poor heat conductivity of air, the heat supply from the autoclave 1 to the bellows-like vessel 15 is reduced or completely interrupted. The bellows-like vessel 15 is thus cooled and contracts. As a result, the check valve 14 is released and opened by the force of the steam pressure from autoclave 1, and the air gathered in cooling pipe 11 is quickly forced out. After said air has escaped, the steam which follows it heats the valve body 12 and the bellows-like vessel 15 which results in renewed closing of the check valve 14. During the time required for the heating of the bellows-like vessel 15, the air discharge conduit 17 and part of the valve body 12 have been filled with the steam which followed after the escaping air. This steam condenses after the check valve 14 has been closed, thereby creating a partial vacuum in the valve body 12 and the air discharge conduit 17 which causes

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water from the tank 18 to be sucked into the valve body 12, said water filling the space inside the valve body 12 which before had been filled with steam. This water continues to flow through the pipe 25 into the lower part 32 of the intermediate water vessel 20 and fills said lower part. The water which is sucked out of the tank 18 cools the bellows-like vessel 15 when it flows through the valve body 12. The check valve 14 is thereby re-opened so that newly accumulated air can escape. This process is repeated until all air is removed from the autoclave. Afterwards, there is no longer sufficient cooling of the valve body 12 to cause the valve 14 to be released, that is, the pressure in the cooling pipe 11 becomes too low to cause lifting of check valve 14.

After the time desired or needed for sterilizing, as indicated on the switch clock 29, has elapsed, check valve 28 is opened and check valve 24 is closed simultaneously. The pressurized steam contained in autoclave 1 is thereby provided with a means of escape to a lower pressure, and a balancing of pressures is obtained. The steam contained in the autoclave 1 passes through the steam conduit 2, the heat accumulator 3, the water supply pipe 6, the check valve 28 and the vent pipe 30 to the water tank 18 and is thereby cooled and condensed. As a result of the cooling of the autoclave 1 after the steam has substantially escaped, a partial vacuum is created in said autoclave 1. Thereby, outside air is sucked in through the mouth of the vent pipe 30 which is placed above the water level in the water supply tank 18 and is conveyed through the check valve 28, the water supply pipe 6, the heat accumulator 3 and the steam conduit 2 to the autoclave 1 until the pressure in said autoclave is increased to atmospheric pressure. At this point, the door 31 of the autoclave 1 may be opened without any trouble. When the air which is sucked into the autoclave 1 flows through the heat accumulator 3 it is heated and sterilized. Inasmuch as each opening of the check valve 14 causes some loss of water from the closed water circuit which can not be replaced during the sterilization process, a shortage of water develops in the intermediate water vessel 20. The water supply in said water vessel 20 is automatically replenished in that after the pressure in the autoclave has been balanced at atmospheric pressure, the check valve 27 opens and admits the water which is stored in the lower part 32 of the intermediate water vessel 20 to the upper part of said water vessel. After this replenishment is completed the apparatus is ready for the next sterilization process to begin.

The arrangement illustrated in FIG. 2 is simpler than the arrangement described above in that the floating valve 21 and the check valve 27 in the condensation water line, which may be dispensed with, have been eliminated. The cooling pipe 11' in FIG. 2 leads directly and without any check valve from the condensation water container 10' to the thermo-valve 12''. The thermo-valve 12'' is likewise simplified over the thermo-valve shown in FIG. 1 and has a permanent opening leading from the exit end of said thermo-valve to the air discharge conduit 17. Furthermore, the arrangement in accordance with FIG. 2 includes a closing organ 33 between the exit opening 9 of the autoclave 1 and the condensation water container 10', such closing organ 33 being suitably fashioned in the manner of a magnet which closes automatically when the sterilizing process is terminated.

In contrast to the arrangement as shown in FIG. 1, the condensation water container 10' is equipped with a thermostat 34 which actuates a contact whenever the water inside said container has reached a temperature which corresponds to the desired sterilizing temperature within the autoclave. Since this thermostat 34 is made to act on the temperature of the water in the condensation water container 10', the switching process which starts the switch clock for the purpose of measuring the time of sterilization is effected only when there is no air anywhere in the autoclave 1. The thermo-switch in the

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water container 10' can attain its switching temperature only when all air has been removed from said autoclave.

The water supply pipe 6' which leads to the heat accumulator 3 and conveys to it the water to be injected is likewise equipped with a check valve 24' which interrupts the water supply to the heat accumulator as soon as the desired sterilizing temperature is reached within the autoclave 1. This valve may take the shape of a magnet valve which may be caused to act automatically as soon as the steam pressure corresponding to the desired temperature prevails in the autoclave. For such purposes, the autoclave may be equipped with a pressure switch 35 which lifts a lever 36 as soon as the desired pressure has been attained in the autoclave. When the switch lever 36 is lifted, it closes a circuit created by contact 37 and the magnetic valve 24'. In addition, such a contact 37 may simultaneously act on a time switch clock (not illustrated) which on termination of the desired period of sterilization acts on suitable circuits whereby magnetic valve 33 is closed and the check valve 28' is opened. When the valve 28' is opened and the valve 33 is closed, the vent pipe 30 is openly connected to autoclave 1 through said valve 28', water supply pipe 6', valve 24' and heat accumulator 3'. This connection allows the pressurized steam in autoclave 1 to escape to said vent pipe 30 and, when the cooling of the autoclave causes a subsequent decrease of the pressure therein, further allows air to pass from the atmosphere through the heat accumulator 3, wherein it is sterilized, to the autoclave 1.

In addition, the arrangement shown in FIG. 2 differs from that shown in FIG. 1 in that the bellows-like vessel 15' is directly connected to the valve plug 14' which closes the passage 38 in the thermo-valve 12'' when said vessel 15' is distended on heating. The air or steam passes from the cooling pipe 11' directly to the combination of the bellows-like vessel 15' and the valve plug 14' without first passing through a safety valve such as safety valve 13 shown in FIG. 1. The air discharge conduit 17 which leads to the water storage tank 18 is therefore always openly connected to the cooling pipe 11' when the valve plug 14' has not closed the valve passage 38. Closing of said valve passage will occur whenever steam from the condensation water container 10' flows into the thermo-valve 12'' through the pipe 11'. In this arrangement as well as in the arrangement illustrated by FIG. 1, short openings of the thermo-valve 12'' will be effected for the elimination from the autoclave 1 of any air which is subsequently formed in said autoclave during the sterilization process.

After the desired sterilization in the autoclave 1 has been obtained, the valve 24' may be closed. The closing of valve 24' interrupts the steam supply to the thermo-valve 12'' and causes said thermo-valve to cool and open. Also, the condensation of steam in the water container 10' and the cooling pipe 11' will cause the pressure therein to be reduced below atmospheric pressure, and water will therefore flow from the water storage tank 18 through the air discharge conduit 17 and the open thermo-valve 12'' to the water container 10'. Thus, the supply of water in the water container 10' is sufficiently replenished for purposes of the next sterilization process.

The thermo-switch 34 may also serve to adjust the temperature of the autoclave 1 to the desired sterilization temperature. This temperature is, for example, 134° C. for the sterilization of instruments, but is only 120° C. for the sterilization of objects containing rubber.

As shown in FIG. 2, the accumulator 3' is different from that shown in FIG. 1, and is arranged immediately below the autoclave and is connected to the autoclave by means of a short pipe. In the arrangement illustrated in FIG. 2, said heat accumulator is heated by a winding 39, the outside surface of which is equipped with heat insulation. The inner structure of the heat accumulator 3' may be selected as desired. In addition to the type of inner structure indicated in FIG. 1, a spiral tube ar-

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angement in which the water is heated and then injected into a heat chamber by means of a nozzle, or other such suitable structure, may be used.

The invention is not limited to autoclaves in its application. It may be used for the heating of washing machines, solid objects, liquids or gases whenever a comparatively large quantity of heat is required within a short time, and whenever the electrical energy for heating or some other source of heat with sufficient capacity is not available, so that a heat accumulator in accordance with the invention may be used.

Instead of water, any suitable liquid which may be evaporated easily may be used. In special cases, other such liquids may be even more suitable than water. A large number of easily boiling liquids which are well known are available for such purposes. Wherever water is mentioned in the above description or in the claims, it is understood that water may be replaced by any other suitable liquid.

I claim:

1. In a heating apparatus comprising an autoclave connected to a heater for producing steam from liquid water, and a closed circuit comprising a condensation water container connected to said autoclave and a water supply pipe connected to said heater with suitable connections and valves for continuously withdrawing condensate from said condensation water container and supplying said condensate to said heater, said connections to said condensation water container being so arranged as to create a vapor space in said condensation water container, a water supply tank, an air discharge conduit, and a thermo-valve, said thermo-valve comprising a valve seat, a valve plug, a heat responsive element and a valve body surrounding said heat responsive element, said air discharge conduit communicating with said valve body and discharging below the water level of said water supply tank, and said valve seat communicating with said vapor space of said condensation water container, whereby cold air from said vapor space is permitted to pass freely through said thermo-valve but steam from said vapor space entering said valve body causes said heat responsive element to close said valve plug on said valve seat, and the passage of steam is substantially prevented, and whereby said thermo-valve permits water to flow from said water supply tank through said air discharge conduit, said valve body and said valve seat to said condensation water container when said autoclave is at atmospheric pressure, thereby automatically replenishing the supply of water in said condensation water container.

2. An apparatus as described in claim 1 wherein an intermediate water container is inserted into said closed circuit, said intermediate water container being divided into an upper and a lower portion separated by a check valve allowing water to flow from said lower portion to said upper portion but substantially preventing the flow of water from said upper portion to said lower portion, and wherein said condensation water container is divided into an upper portion and a lower portion, each portion having a vapor space, said portions being connected by a valve which is open when the water level in said lower portion is low and closes when the water level in said lower portion is high, and wherein said upper portion of said intermediate water container is connected by a pipe to said lower portion of said condensation water container and to said water supply pipe, said lower portion of said intermediate water container is connected to said valve body, and said vapor space, said upper portion of said condensation water container is connected to said autoclave and to said valve seat.

3. An apparatus as described in claim 2 wherein said valve seat in said thermo-valve is vertically oriented and said valve plug rests freely thereupon, whereby air from said vapor space in said condensation water container may freely escape through said valve when the pressure in said condensation water container is above atmospheric pres-

sure, but unsterilized water from said water tank is substantially prevented from entering said autoclave when said pressure is below atmospheric pressure.

4. An apparatus as described in claim 1 wherein said thermo-valve, comprising said bellows, said valve plug, said valve seat and said valve body, is an integral vertically sliding unit enclosed in an outer casing, said valve seat being connected to an opening in the bottom of said unit, said outer casing having a connection in its bottom to the vapor space of said condensation water container, and said outer casing having a connection in its top to said air vent pipe, and said unit normally resting freely

on top of said connection to said condensation water container with said opening communicating with said connection, whereby said thermo-valve may function as a pressure relief valve.

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