

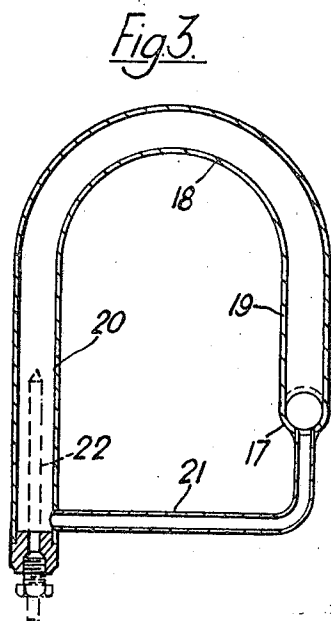
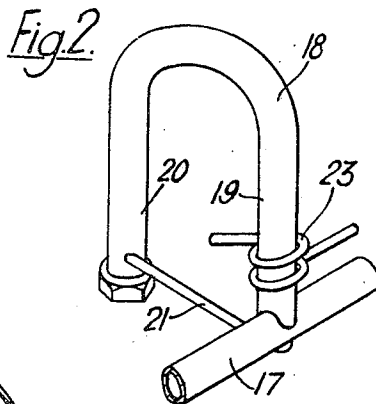
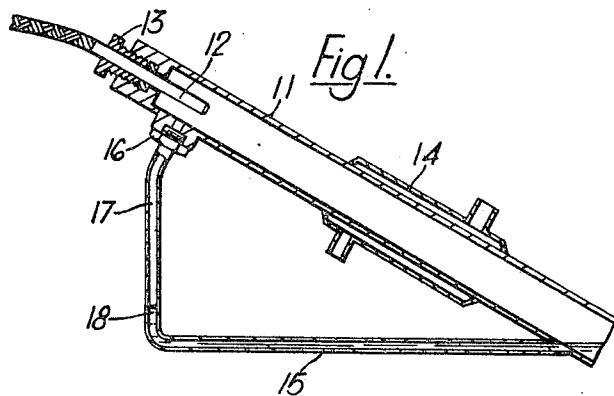
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AIR-DETECTING DEVICE FOR STEAM STERILIZERS

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1

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AIR-DETECTING DEVICE FOR STEAM STERILIZERS

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6 Claims

ABSTRACT OF THE DISCLOSURE

An air-detecting device for use with steam sterilizers comprising an upwardly-extending water-cooled condensing tube and an upwardly-extending air-collecting tube, these being joined in communication with one another at their upper ends. Air-stream mixture exhausting from the sterilizing chamber, upon entry of sterilizing steam to that chamber after its prior evacuation, is admitted to the lower end of the condensing tube. The air-collecting tube has extending horizontally from its lower end a condensate collecting passage which has its end remote from the air-collecting tube connected in communication with the lower end of the condensing tube. If the level of air collected within the air-collecting tube rises above, a tolerable level, a temperature sensor within the device becomes bathed in this air and signals out a warning of an unsatisfactory sterilizing cycle.

DESCRIPTION OF INVENTION

This invention relates to steam sterilizers and, more particularly, is concerned with equipment for ensuring that each sterilization cycle is satisfactory in the sense that the materials to be sterilized are maintained at an adequately high temperature for a sufficient period of time.

The general principle of operation of the control equipment on a sterilizer is based on measurement of the temperature of the steam/air mixture in the sterilizer, since the steam temperature decreases with increasing air contamination at any specified pressure.

When a steam sterilizer chamber is evacuated under pulsing conditions to a vacuum in the order of 20 mm. Hg the partial pressure of the residual air will be insufficient to move the steam temperature by any significant amount, providing the equipment is totally air tight and no air leaks take place. If, on the other hand, there is any leakage in the equipment then the partial pressure of the air during the sterilizing stage will be increased and the sterilizing temperature will be reduced.

Where materials to be processed are present in the sterilizer chamber they present a condensing load, and where there is air or other non-condensing gases present there tends to be an increase in the concentration of these materials in the parts of the load most inaccessible to the steam. This increase in concentration results in incomplete steam penetration of portions of the load being at temperatures lower than those pertaining in the free chamber space. The extreme instance of this effect is where a single casket loaded with standard towels is the sole load in the chamber. Under such conditions, the majority of the non-condensable vapours in the chamber become concentrated in the centre of this single casket, and if the partial pressure of these non-condensable gases is much in excess of 0.5 mm. Hg then these gases combined with air not completely removed from the casket can result in a depression in temperature in the centre of the casket by several degrees. If conditions suitable for the adequate sterilization of a single casket, as described above, are present at the start of the sterilizing cycle, then these conditions will also be

2

suitable for other conditions of loading where the concentration of air in the load will be less acute.

A similar effect can be observed if the quality of the steam supply to the chamber is not satisfactory and contains non-condensable gases resulting from an inadequate installation or unsatisfactory boiler operation.

Equally, failure to maintain temperature will result if there is a failure in the steam supply to the chamber resulting in a fall in steam pressure during sterilization.

Finally, a fault in process equipment could result in inadequate removal of air from the load even if the conditions in the chamber appear adequate. Such air could make its presence felt in the vapour space in the sterilizer chamber after commencement of sterilization as a consequence of downward displacement.

In view of the variation in the type of load which may be placed in a sterilizer, a device which may be set up to simulate the conditions pertaining to one type of load may not adequately simulate a load of different character or weight. It is the object of the present invention to provide a device which will ensure that satisfactory predetermined conditions are present in the sterilizer at the commencement of the sterilizing cycle and that these conditions are maintained throughout the sterilizing cycle whilst at the same time there is also a monitoring of the effectiveness of the process prior to sterilizing to ensure that this has been adequately carried out. The device presented can be arranged to:

(1) Monitor the conditions of the gases present in a sterilizer chamber at the commencement of the sterilizing process after air has been removed from the chamber and load, and will only permit sterilization to proceed when the non-condensable gases present are all in a concentration below a predetermined level, and

(2) Detect failure in the steam supply during the sterilization process and interrupt the process in this event.

(3) Detect the presence of excessive quantities of air displaced from the load by downward displacement during sterilization and to signal a failure to sterilize in this event.

According to the present invention, an air detecting device is provided external to the sterilizer chamber, but connected thereto. Such a device may comprise a tube with access at one end to the sterilizer chamber and arranged for accumulating air or non-condensable gases separated from the steam as the result of condensation, with provision made for the disposal of the steam condensate without loss of the separated air or non-condensable gases, and for the detection of more than a pre-determined volume of accumulated air by an appropriate temperature sensing device which normally registers steam temperature but will register a lower temperature when exposed to air.

In one arrangement, the tube is inclined and connected at its lower end to the sterilizer chamber and the temperature sensing element is disposed at its other end, whilst a branch tube of smaller bore which is sealed by condensable gases which become separated from the steam. A variation in the angle of inclination to the horizontal will vary the volume of non-condensable gases which need to be accumulated before they influence the temperature sensing element.

In another and preferred arrangement, the condenser tube is of inverted U configuration. The U-tube may have a shorted leg connected at its lower end to the sterilizer drain line, and longer leg in which the temperature sensing element is disposed, the longer leg having a drain connection for condensate leading back to the drain line in an arrangement such that steam condensate collecting in said longer leg seals the drain connection but cannot rise above a predetermined level.

Forms of air detecting device or simulator according to the invention will now be described by way of example and

3

with reference to the accompanying drawings, in which:
FIGURE 1 is a view in longitudinal section of one embodiment,

FIGURE 2 is a pictorial view of a second embodiment, and

FIGURE 3 is a view in section of the device of FIGURE 2.

The device illustrated in FIGURE 1 comprises an upwardly sloping blanked-off tube 11 communicating with pipework connected to the sterilizer chamber and having a thermocouple probe 12 extending into it through a gland 13 at the blanked-off end. The probe is insulated from the metal of the tube. Surrounding a region of the tube a short distance from the blanked end and the probe 12 is a small jacket 14 through which can be circulated cold water so as to provide a simple condenser. The tube 11 is mounted as close to the sterilizer chamber as is possible, preferably at a level below the bottom plate of the sterilizer chamber and inclined at an angle of just above horizontal to the vertical, so that there will be ready drainage of the condensate out of the tube away from the probe 12 and free circulation in the tube of the steam/air mixture in the sterilizer pipework. Just below the thermocouple probe 12 the tube 11 has a depending side branch 15 sealed thereto by a gland 16 and having at its lower end a horizontal run returning to the lower end of the larger tube 11.

In operation, the tube 11 is sufficiently closely associated with the sterilizer chamber to partake of the atmosphere therein. Upon admission of steam to the evacuated sterilizer chamber, containing a residual mixture of air and steam under reduced pressure, the residual mixture has access to the load to be sterilized and also to the tube 11 of the air detection device. If the condensation in the tube 11 is greater than that in the sterilizer load and the resistance to flow between the chamber and the air detection device is less than the resistance to vapour flow from the chamber vapour space to the inside of the load, there is accumulated in the tube of the air detection device in the early stages of the sterilizing cycle sufficient non-condensable gases to influence the equilibrium temperature to the extent necessary to indicate the presence of these non-condensable gases.

By careful selection of the capacity of the condenser 14 and the volume in the tube 11 in which the non-condensable gases accumulate, it is possible to simulate quite closely the conditions within the sterilizer load and measure temperatures which are in close accord with those obtaining in the centre of a pack, i.e. low temperature when air is present and higher temperatures satisfactory for sterilizing when there has been pruing of the air prior to sterilization.

The side branch 15 is arranged to be sealed along the lower run by steam condensate resulting from the effect of the condensing jacket 14. Its angle to the horizontal can be varied and consequently the volume of non-condensable gases, accumulated in the vertical stem 17 above the level of condensate 18, can be varied and therefore provides a means of regulating the sensitivity of the device in relation to its tolerance of non-condensable gases i.e. with little volume this reservoir soon becomes filled with cool non-condensable gases and these flow out on to the thermocouple probe much earlier than they would do if there was a large volume. Consequently, a low volume makes the equipment sensitive to the presence of small quantities of non-condensable gases in the steam, whilst a large pocket reduces this sensitivity.

Further, when the thermo-couple signal is employed as a control signal in an automatic or semi-automatic sterilizing cycle, it is necessary that a very positive impulse be given to the control equipment in the event of their being a more than acceptable quantity of non-condensable gases present. If there was merely an accumulation of air, in the main condenser tube 11, there would be a slow reduction of temperature and this would reduce the sensitivity of the equipment. However, with the addi-

4

ional pocket that is provided in the branch 15, the air in this pocket is tending to cool by virtue of heat loss to the surrounding atmosphere and its own low thermal conductivity, and therefore at the stage when this reservoir becomes filled and overflows, there is a comparatively sudden marked reduction in the temperature recorded by the thermo-couple probe.

In automatic operation, the condenser can be interlocked with the drying stage of sterilizer operation, in which case the temperature of the equipment is stabilized with cold water once per sterilizing cycle at the end of each cycle. Alternatively, it can be interlocked with the exhausting system so that water is circulated through the condenser during each vacuum pulse stage and at the vacuum stage immediately prior to sterilization; or if desired water can be left on the condenser all the time.

Modifications of the arrangement described are possible without departing from the scope of the invention. Thus, the water-cooled condenser could be replaced by air cooling, the air coming from such source as a circulating fan or motor; however the degree of control over the process in this way will not be as effective. Also the thermo-couple probe could be replaced by some other form of temperature-sensing element.

An alternative embodiment of the invention is illustrated in FIGURES 2 and 3 of the drawings.

It comprises principally an inverted U tube 18 having a short leg 19 and a longer leg 20. The lower end of the short leg 19 communicates with the drain line 17 of the steam sterilizing autoclave. The longer leg 20 extends down below the level of the drain line 17 and its lower end portion contains a temperature sensing element 22 that projects up through a fluid-tight fitting at the bottom of the leg. The temperature sensing element may be a thermocouple, a resistant bulb or a liquid expansion bulb; it is adjustable in height with respect to the U tube leg 20. The bottom end of the longer leg 20 of the U tube is connected back to the underside of the drain line 17 by means of a pipe 21 that communicates with the drain line in the same region as the short leg 19 of the U tube.

In operation, steam and entrained air enters the U tube 18 and the return pipe 21 quickly becomes sealed with condensate with the result that air is trapped above the condensate in the vicinity of the temperature sensing element 22. The constant level of condensate is maintained in the longer leg 20 of the U tube by virtue of the return pipe 21 to the main drain line 17. As the air builds up above the condensate, so it becomes cooled by contact with the condensate which is itself losing heat to the surrounding atmosphere. When sufficient air has accumulated to fill the space between the surface of the condensate and the sensitive portion of the temperature sensing element 22 the latter commences to measure the temperature of the air rather than the temperature of the mixture of steam and entrained air. The sensitivity of the arrangement and its tolerance to air entrained in the steam in the sterilizing chamber and drain line can be adjusted by raising or lowering the temperature sensing element so as to change the distance of the sensitive portion above the free condensate level.

As the partial pressure of air in the sterilizer chamber is low, a considerably greater concentration of air in steam is necessary if there is to be a significant temperature reduction for the purpose of creating a signal to operate the control equipment. The salient feature of the device described is its ability to concentrate air in the steam without itself being influenced by condensate. Additional cooling of the short leg 19 and the U tube 18 by means of a water jacket or cooling coil, such as the coil 23, increases the volume of steam condensed and consequently the volume of air accumulating to depress the equilibrium temperature.

As the temperature sensing element 22 normally senses the temperature of the steam, any lowering of steam pressure during sterilization will result in reduced steam tem-

5

6

perature and this also will be sensed and used as feedback to the controller. By virtue of the large capacity of the condensing coil provided, vapours will be continuously drawn into the device giving ability to sample the vapours during the course of the sterilizing process and to detect air in pre-determined amount displaced from the load by steam.

What we claim is:

1. A device for detecting an excess of air and other non-condensing gases in the air-steam mixture exhausting from a steam sterilizer chamber, including a tube assembly comprising an upwardly-extending condensing tube leg provided with indirect cooling means having an inlet/outlet connection at its lower end through which it receives said air-steam mixture from an exhaust line of said steam sterilizer, an upwardly-extending air-collecting tube leg communicating at its upper end with the upper end of said condensing tube leg, a condensate collection passage extending horizontally from the lower end of said air-collecting tube leg, the end of the condensate collection passage remote from the air-collecting tube leg being in communication with the lower end of said condensing tube leg and with said inlet/outlet connection, and a temperature sensor disposed within said tube assembly at a level above the lower end of said air-collecting tube leg and at a position where it becomes bathed in air collected in said air-collecting tube when the level of that air has risen to a predetermined level.

2. A device according to claim 1, wherein said indirect cooling means utilizes water as the cooling medium.

3. A device according to claim 1, wherein said indirect cooling means utilizes air as the cooling medium.

4. A device according to claim 1, wherein the condensing tube leg is inclined relative to the horizontal, the air-collecting tube leg is substantially vertical, and the temperature sensor is disposed within the upper end of the condensing tube leg.

5. A device according to claim 1, wherein the tube assembly comprises an inverted U-tube, one vertical leg of which constitutes the condensing tube leg while the other vertical leg constitutes the air-collecting tube leg and is longer than the condensing tube leg.

6. A device according to claim 5, wherein the temperature sensor is mounted within the air-collecting tube leg and is adjustable as to height therein.

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