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GRAVITY DISPLACEMENT STERILIZER

Filed Dec. 13, 1967

2 Sheets-Sheet 1

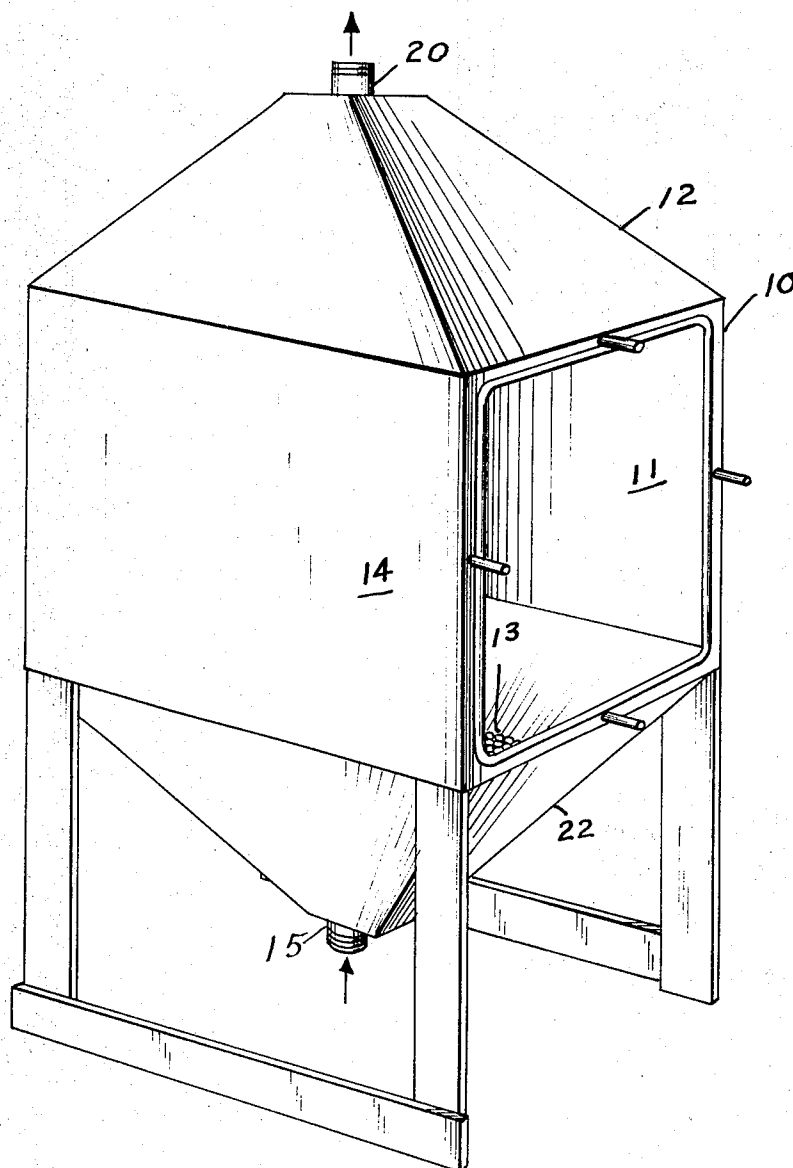


FIG. 1

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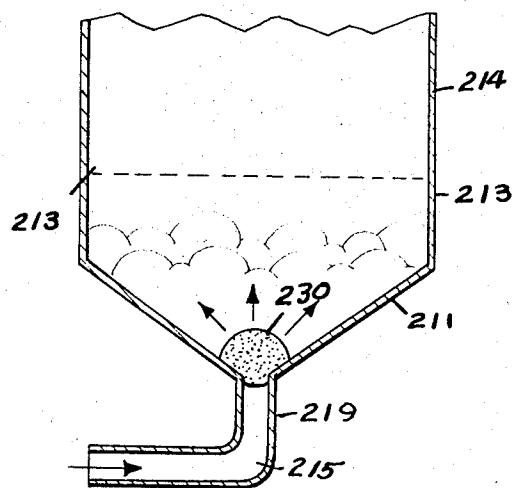
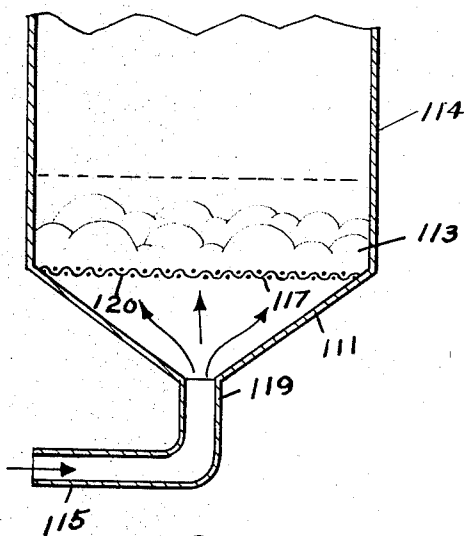
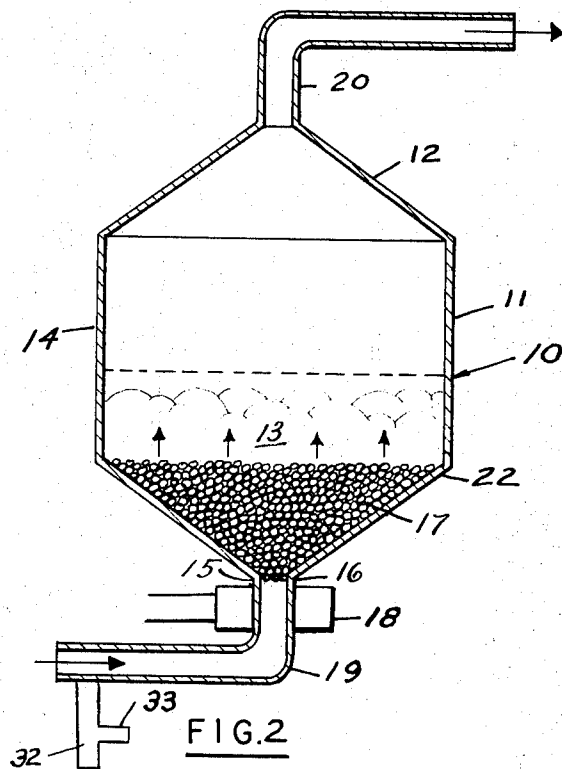
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2 Sheets-Sheet 2



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GRAVITY DISPLACEMENT STERILIZER

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U.S. Cl. 21—91

9 Claims

ABSTRACT OF THE DISCLOSURE

A gravity displacement sterilizer comprising hood, diffuser and intermediate sections and including a gas outlet in the hood section and a gas inlet in the diffuser section. The hood and diffuser sections are in the form of truncated cones with the widest portion thereof connected to said intermediate section. Diffusion means is located in said diffuser section to direct incoming sterilizing gas so it is distributed generally uniformly over the entire cross-sectional area of said intermediate section, said gas distribution being accomplished generally without turbulence to provide for a minimum of mixing of the sterilizing gas and air present in the sterilizer.

The sterilizer disclosed has a chamber having a configuration such that gas will pass from the inlet through the sterilizing section of the chamber to the outlet with minimum turbulence and therefore with minimum mixing of one with the other. Thus, the gas contents can be moved from the inlet to the outlet as a single body and one gas can be readily displaced from the chamber by another without the need of expensive vacuum pumps. The diffusing section which starts with the gas input line gradually increases in cross sectional area to the size of the sterilizer section. The purpose of the diffusing section is to reduce the vertical component of velocity of the gas so as to result in minimum turbulence inside the sterilizing chamber, thereby insuring a reasonably non-turbulent exchange of air and gas. The idea is to keep the interface between the gas and air reasonably stable. At the top of the sterilizing section is a discharge chamber which may be a facsimile of the bottom, but inverted. To further minimize turbulence a filter is provided. This filter can be a sintered ceramic or metal filter, a sack of porous nylon, several layers of perforated sheet material, or a layer of beads.

A preconditioning chamber is connected in series with the inlet wherein the gas from a source is conditioned by heating, cooling, or mixing. Sterilizing gas is normally stored in liquid form. When liquified gas is released from its pressure vessel, it immediately starts to boil and vaporize. The preconditioning chamber may be made to promote the transition from liquid to gas and insure that suitable vaporized gas is introduced to the diffuser chamber.

Various efforts have been made in the art to admit steam or gas to a sterilizing chamber to give optimum, uniform distribution of the sterilizing medium. Examples of patents that show such efforts are Pat. No. 1,850,923, Pat. No. 2,208,552 and Pat. No. 3,150,935, and British Patent 1,077,246.

None of these patents have attempted to utilize the admission of the sterilizing medium to displace the air in the sterilizer as a single body.

It is known in the sterilizing art that air in the sterilizer during a sterilizing cycle and air entrained in the goods to be sterilized is an enemy to all sterilizing processes.

In the sterilizer and process disclosed herein, a casing is provided with a diffusing chamber at the bottom and a hood at the top. The hood and diffusing chamber are both made of gradually increasing cross sectional area

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toward the central chamber so that air or gas can flow from the inlet, through the diffusing chamber to the sterilizing part and thus out through the hood and through the discharge with a minimum amount of turbulence introduced into the medium. By so doing and by admitting the gas through the diffusing chamber at a very low velocity, the air in the chamber can be lifted as a body from the chamber and through the hood to the discharge, thereby removing substantially all of the air from the chamber and thereby eliminating an evacuating pump and the inherent expense of maintaining and operating such a pump. Further, when the displacement method is used in accordance with the process disclosed herein, the walls of the chamber may be made much lighter than would be necessary to withstand a vacuum created by a vacuum pump were it used to evacuate the chamber and where a positive pressure is not used.

In one embodiment of the invention, beads can be used to fill the diffusing chamber in order to more completely diffuse the gas at the diffuser. These beads provide paths for the air between them and thereby diffuse the gas uniformly over the bottom of the chamber. By providing beads of the proper size and shape and by providing the correct angle on the diffusing chamber walls and the hood walls and the correct velocity of gas to prevent turbulence of the sterilizing gas, the air can be substantially completely removed from the chamber with a minimum waste of time and gas.

It is, accordingly, an object of the invention to provide an improved sterilizing apparatus.

Another object of the invention is to provide an improved sterilizing apparatus wherein the sterilizer chamber has a generally streamlined shape and the sterilizing gas is admitted to the chamber through a diffusing medium whereby the low velocity gas sweeps the entire body of air in the sterilizer out as a body.

A further object of the invention is to provide an improved sterilizing apparatus wherein a diffusing chamber is provided filled with beads which diffuse the sterilizing gas and distribute it evenly throughout the chamber.

With the above and other objects in view, the present invention consists of the combination and arrangement of parts hereinafter more fully described, illustrated in the accompanying drawings, and more particularly pointed out in the appended claims, it being understood that changes may be made in the form, size, proportions, and minor details of construction without departing from the spirit or sacrificing any of the advantages of the invention.

In the drawings:

FIG. 1 is an isometric view of the sterilizer according to the invention;

FIG. 2 is a longitudinal cross-sectional view of the sterilizing chamber; and

FIGS. 3 and 4 are views similar to FIGS. 1 and 2 of other embodiments of the invention.

Now with more particular reference to the drawings, and to the method which may be carried out by the drawing, the sterilizing chamber is generally indicated at 10 having side 14. It has an intermediate or sterilizing chamber 11 which may be considered to be the sterilizing section, a hood 12 integrally attached to the sterilizing chamber and a diffusing section 13 likewise attached to the sterilizing chamber section. The sterilizer is provided with an inlet 15 for air, gas, and steam and an outlet 20 for air, gas, and steam to be exhausted.

The hood 12 and the diffusing section 13 each provide means to direct the main body of air from the sterilizing chamber 11 to the outlet with a minimum amount of turbulence so that gas entering the diffusing chamber

through the inlet 15 will have its velocity progressively decreased as it moves through the beads 17 and when it reaches the transition from the diffusing section to the sterilizing section, the velocity of gas will be the same as the velocity of the gas at the entrance to the hood 12, since the passageway through this portion will be substantially constant in cross sectional area.

The chamber itself, including the exhaust hood and the diffusing section, may be fabricated from steel or other suitable material commonly used in the manufacture of sterilizer chambers. Since the chamber will be operating very close to atmospheric pressure, the chamber need not be made to withstand heavy vacuums or high pressures, unless the pressure during the sterilizing cycle is high. The preferred sterilizing gas will be a mixture of 12% ethylene oxide and 88% dichlorodifluoromethane although any standard gas mixtures may be used. For example, any of the following mixtures could be used:

- (1) 10% ethylene oxide, 90% carbon dioxide, sometimes referred to as carboxide;
- (2) 20% ethylene oxide, 80% carbon dioxide, known in the trade as Oxfume 20;
- (3) 12% ethylene oxide, 88% dichlorodifluoromethane, known as Pennoxide;
- (4) 11% ethylene oxide, 79% trichlorofluoromethane, 10% dichlorodifluoromethane, known as Cryoxide; and
- (5) 11% ethylene oxide, 54% trichlorofluoromethane, 35% dichlorodifluoromethane, known as Benvicide.

The gas mixture may be preheated in the preheat chamber 18, which will be connected in series with the inlet pipe 19. The porous member 20 supported over the inlet 15 prevents the glass beads 17 from falling into and obstructing the inlet passage. The line 19 may be connected to a tank of ethylene oxide or other microbicidal sterilizing gas. The porous member 20 could be a screen, perforated metal, or a porous woven sheet, such as nylon.

The beads 17 may be made of glass, stainless steel, or suitable plastic, or any other suitable material. It has been discovered that beads between the range of sizes 2 to 10 mm. in diameter are most effective. The beads must have a sufficient density so that they will not be agitated by the flow of gas through them. The beads must be of sufficient size to provide the proper voids between them for diffusing the gas.

The sides 22 of the inlet chamber may be disposed at an angle of approximately thirty-five degrees to a center line drawn through the inlet 15 and outlet 16 and, thus, a generally streamlined even path of flow will be provided from the inlet 15 to the intermediate sterilizing chamber 11. Likewise, the sides of the hood 12 may be disposed at an angle of approximately thirty-five degrees to the line drawn through the inlet 15 and outlet 16, thereby providing a gentle decrease in the cross sectional area and a corresponding increase in velocity of gas. It is important that the gas flowing through the sterilizer have a gradual decrease in velocity from the inlet to the sterilizing chamber and a gradual increase in velocity from the sterilizing chamber to the exit, rather than an abrupt change so that turbulence of the gas and, thus, a mixing of gas with the air will not result. The several embodiments of the invention shown herein show several structures which distribute the gas from the inlet uniformly over the sterilizing section. The air entrained in the voids between the beads must be swept out as the gas passes through. The gas may be preheated by the preheater 18. The preheater may be heated by means of an electrical coil around the pipe to vaporize the liquified gas.

The gas is introduced into the inlet and into the diffusing section at the bottom of the sterilizer chamber. It passes through the glass beads 17, which reduce its velocity and thus prevent mixing of the sterilizing gas and the air in the sterilizer chamber. The low velocity gas is evenly distributed over the cross sectional area of the sterilizing chamber by the shape of the inlet. Since the gas is generally heavier than the air in the chamber, it

will push or displace the air from the chamber and move it through the outlet at the top of the chamber. The configuration of the chamber and the size of the outlet are such that the air is displaced freely, preventing mixing of the air and the displacing sterilizing gas.

Experiment has determined that the velocity of the sterilizing gas entering the chamber should be such as to give approximately one chamber volume change in approximately five minutes. A total of 15 minutes should be sufficient at this flow rate to completely displace the air from the sterilizing chamber and provide a sterilizing gas concentration of approximately 450 milligrams per liter of ethylene oxide at atmospheric pressure; charging to pressures above atmospheric would provide higher concentrations.

After the air has been displaced from the chamber by the gas, moisture is introduced at the desired concentration level and the sterilizing exposure period began at selected temperature. This temperature may be in the range of 130° F.

The chamber 10 will be provided with all of the conventional piping, controls, and gauges required to carry out the sterilizing cycle desired. Examples of chambers of sterilizers that have controls designed to carry out similar cycles, but not using the displacement idea disclosed herein are found in Pat. No. 3,068,064 and Pat. No. 2,080,179. Obviously many other gas and steam sterilizing cycles familiar to those skilled in the art can be used wherein air is to be removed from a chamber with the structure disclosed herein. The same idea disclosed herein can be used with a variety of gases and vapors, for example, substantially the same idea of sweeping out one gas with another could be carried out in a sterilizer utilizing steam as the active sterilizing medium.

When a sterilizing gas is used that is lighter than air, outlet 16, in FIG. 1, can be used as the inlet and the supply of gas connected to this as the inlet. The inlet 15 would then be used as the outlet for air and gas purged from the chamber.

The inlet 19 may be connected to a supply of air 32 and a supply of steam 33. The chamber can obviously be provided with a steam jacket if it is desired to provide additional heat. The steam to the chamber can be utilized to moisturize the load or for use in sterilizing. The air supply from line 32 can be used to purge the gas from the chamber after a sterilizing cycle.

As an example of one application of the device disclosed, air at 30 p.s.i.g. may be suitable. Steam at 270 degrees Fahrenheit and 26 p.s.i.g. may be used as the steam supply. Ethylene oxide gas at 1 p.s.i.g. may be used. Suitable regulators, piping, and valves to control the gas used will be obvious to those skilled in the art.

An alternate embodiment of the invention is shown in FIG. 2, wherein the sterilizing section 110, diffusing section 111, and hood, and door 113, are similar to those shown in FIG. 1. The inlet pipe 119 is likewise similar. A suitable outlet will be provided.

Instead of the bed of beads in the bottom of the sterilizing chamber, a sintered metal plate 117 having uniform pores 120 evenly distributed over it is shown, which acts as a diffuser. The pores may be in the order of 100 microns, or a metal plate with holes .001 inch in diameter spaced ½ inch apart can be used.

In the embodiment of the invention shown in FIG. 3, the chamber 210 has a diffusing chamber 211, a hood, and an intermediate sterilizing chamber 213, and door 214, as in the other embodiments. The inlet 215 and outlet are provided. Instead of the beads shown in the embodiment of FIG. 1, a filter stone 230 such as a material known as microporous porcelain or silicon carbide is attached over the inlet 215 so that gas coming through the inlet pipe 219 is diffused through the porous stone and distributed evenly throughout the chamber.

The following examples of gases shown may be used with either embodiments of the invention.

Ethylene oxide concentration of 500 milligrams per liter of 88-12 gas; 650 milligrams per liter of 80-20 gas; and 1600 milligrams of ethylene oxide per liter of the dilutant gas can be achieved in a sterilizer by simple air displacement as set forth herein. Thus, a prevacuum with subsequent charging to greater than atmospheric pressure is not required to introduce the sterilizing gas in an adequate concentration.

Concentration of ethylene oxide in excess of approximately 500 milligrams per liter will prove no sufficient reduction of exposure time when sterilizing freely exposed organisms. At greater than 40° C., packaged organisms will be influenced by greater diffusion rates at higher concentrations.

The sterilizing examples that follow are merely illustrative of cycles that may be used. Obviously other cycles familiar to those skilled in the art may be used with the chamber and general method disclosed without departing from the spirit of the invention. Throughout the examples, the pressures shown are in pounds-per-square inch gauge.

EXAMPLE I

In a chamber having a sterilizer section 24 inches long by 24 inches wide by 24 inches high loaded with surgical instruments and other metallic articles:

- (1) Admit ethylene oxide gas to chamber at 1 p.s.i. and 160° F. at a flow rate of 1.8 c.f.m. for 5 minutes to sweep the air out of the load and chamber.
- (2) Admit steam to chamber at 2.2 p.s.i. and 130° F. for 5 minutes.
- (3) Admit ethylene oxide gas at 7 p.s.i. and 160° F. to increase chamber pressure to 7 p.s.i.
- (4) Maintain chamber pressure at 7 p.s.i. for suitable exposure period.
- (5) Admit air to chamber at 1.8 c.f.m. at room temperature for 15 minutes.

EXAMPLE II

In a chamber having a sterilizer section 24 inches long by 24 inches wide by 24 inches high loaded with surgical towels, gowns and/or sheets:

- (1) Admit ethylene oxide gas at bottom of chamber at 1 p.s.i. and 160° F. at a flow rate of 1.8 c.f.m. for 5 minutes to sweep the air out of the load and chamber.
- (2) Admit steam to chamber at 2.2 p.s.i. and 130° F. for 5 minutes and hold.
- (3) Admit ethylene oxide gas to bottom of chamber at 7 p.s.i. and 160° F.
- (4) Maintain chamber pressure at 7 p.s.i. and 130° F. for suitable exposure period.
- (5) Admit air to top of chamber at 1.8 c.f.m. at room temperature for 15 minutes.

EXAMPLE III

In a sterilizer chamber 24 inches long by 24 inches wide by 24 inches high loaded with towels, gowns and/or sheets:

- (1) Open bottom chamber to drain at atmospheric pressure. Admit steam to top of chamber at 270° F. and 27 p.s.i. at a rate of 1.8 c.f.m. with bottom to sweep the air out of the goods and chamber.
- (2) Close opening and admit steam at 270° F. and 27 p.s.i. until pressure in chamber reaches 27 p.s.i. and 270° F.
- (3) Maintain the steam inside the chamber at 27 p.s.i. and 270° F.
- (4) Reduce pressure in chamber to 0 p.s.i. and admit air to top of chamber at atmospheric pressure for 15 minutes.

EXAMPLE IV

In a sterilizer chamber 24 inches long and 24 inches wide by 24 inches high, loaded with surgical instruments and other metallic articles:

- (1) Open bottom chamber drain to atmospheric pressure and admit steam at 270° F. and 27 p.s.i. at 1.8

c.f.m. for 5 minutes to sweep the air out of the goods and chamber.

- (2) Close drain and admit steam at 270° F. at 27 p.s.i. until chamber pressure and temperature reach 27 p.s.i. and 270° F.

- (3) Maintain said chamber at 270° F. and 27 p.s.i. for 10 minutes.

- (4) Open drain and admit air at atmospheric pressure to top of chamber for 15 minutes.

Charging the sterilizer by simple air displacement disclosed herein is at least as effective as charging by prevacuation.

It will be understood that the partition of the diffuser section may be made of a porous member, such as a woven nylon sheet, a porous block, a fine screen, sheet of material having many small holes or many other materials.

The foregoing specification sets forth the invention in its preferred practical forms but the structure shown is capable of modification within a range of equivalents without departing from the invention which is to be understood is broadly novel as is commensurate with the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A sterilizer comprising

a chamber having an inlet and an outlet at opposite ends thereof,

said chamber having an intermediate section,

a hood section joined to said intermediate section, said outlet being located in the end of said chamber containing said hood section,

said hood section gradually reduces in cross section from said intermediate section toward said outlet, an exhaust line in fluid communication with said outlet,

a diffuser section, said inlet being located in the end of said chamber containing said diffuser section, said diffuser section being attached to said intermediate section and having decreased cross section progressively toward said inlet,

diffuser means in said diffuser section and in fluid communication with said inlet, said diffuser means having a plurality of open paths connecting said diffuser section to said intermediate section whereby a gas admitted through said inlet to said diffuser section will flow to said intermediate section and said gas will be distributed generally uniformly over the entire cross sectional area of said intermediate section substantially without turbulence.

2. The sterilizer recited in claim 1 wherein said diffuser means comprises a screen having small holes therein forming a partition between said diffuser section and said intermediate section whereby gas from the said inlet may be distributed uniformly over the entire cross sectional area of said intermediate section and gas in said intermediate section may be moved as a body from the said diffuser section to said hood and thence to said outlet.

3. The sterilizer recited in claim 1 wherein:

said diffuser means comprises a perforated plate having relatively small openings therein,

said plate forming a partition between said diffuser section and said intermediate section,

said holes being generally uniformly distributed over said plate whereby gas from said inlet is directed to said diffuser section and from said diffuser section through said openings in said plate to said intermediate section whereby gas in said intermediate section is moved toward said outlet generally as a body.

4. The sterilizer recited in claim 1 wherein said diffuser means comprises a porous stone disposed over said inlet and adapted to diffuse gas from said inlet generally uniformly through said diffuser section and thence to said

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intermediate section whereby gas in said intermediate section is moved toward the outlet generally without turbulence.

5. The sterilizer recited in claim 1 wherein said diffuser section is generally in the shape of a truncated cone.

6. The sterilizer recited in claim 1 wherein said hood section is generally in the form of a truncated cone.

7. The sterilizer recited in claim 1 wherein said diffuser means comprises:

a plurality of pellets disposed in said diffuser section defining a bed extending substantially to said intermediate section,

the area of said bed of pellets adjacent said diffuser section at the section where it is attached to said intermediate section being substantially equal to the cross sectional area of said intermediate section whereby gas entering said inlet is diffused uniformly throughout said intermediate section and said gas flows uniformly through said intermediate section to said outlet.

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8. The sterilizer recited in claim 7 wherein an air supply and a steam supply are connected to said inlet.

9. The sterilizer recited in claim 7 wherein an air supply and a sterilizing gas are connected to said inlet.

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