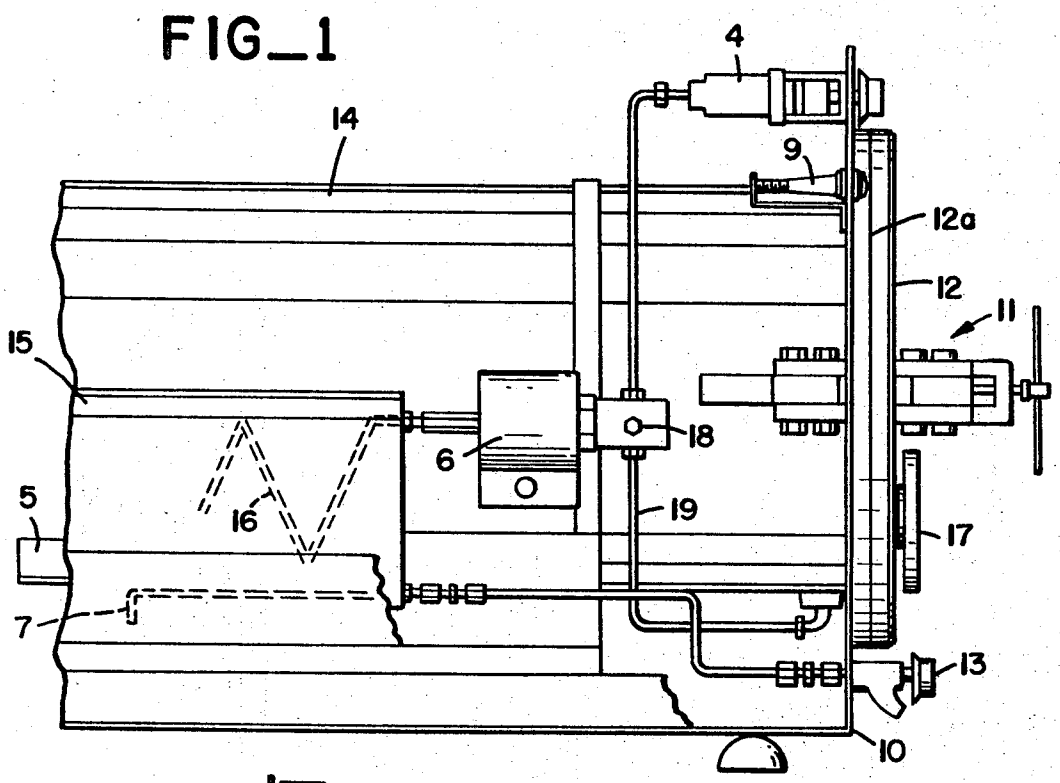
April 13, 1971 H. D. LARRO 3,574,529

AUTOMATIC STERILIZING AUTOCLAVE

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FIG_1



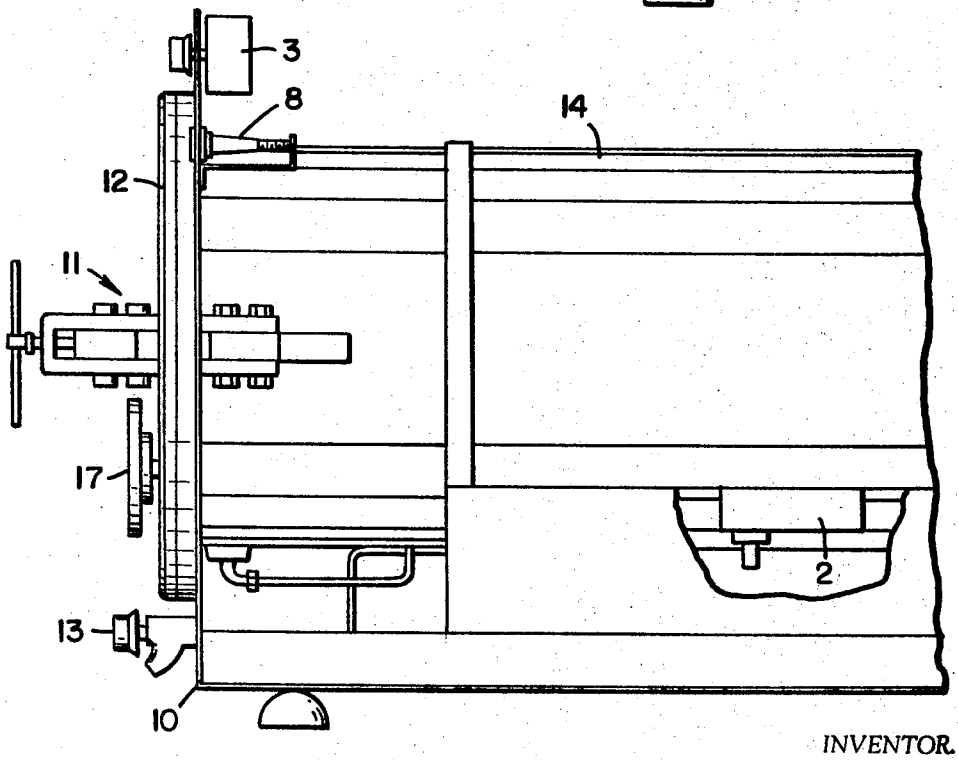


FIG_2

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AUTOMATIC STERILIZING AUTOCLAVE

Filed Jan. 3, 1969 4 Sheets-Sheet 2

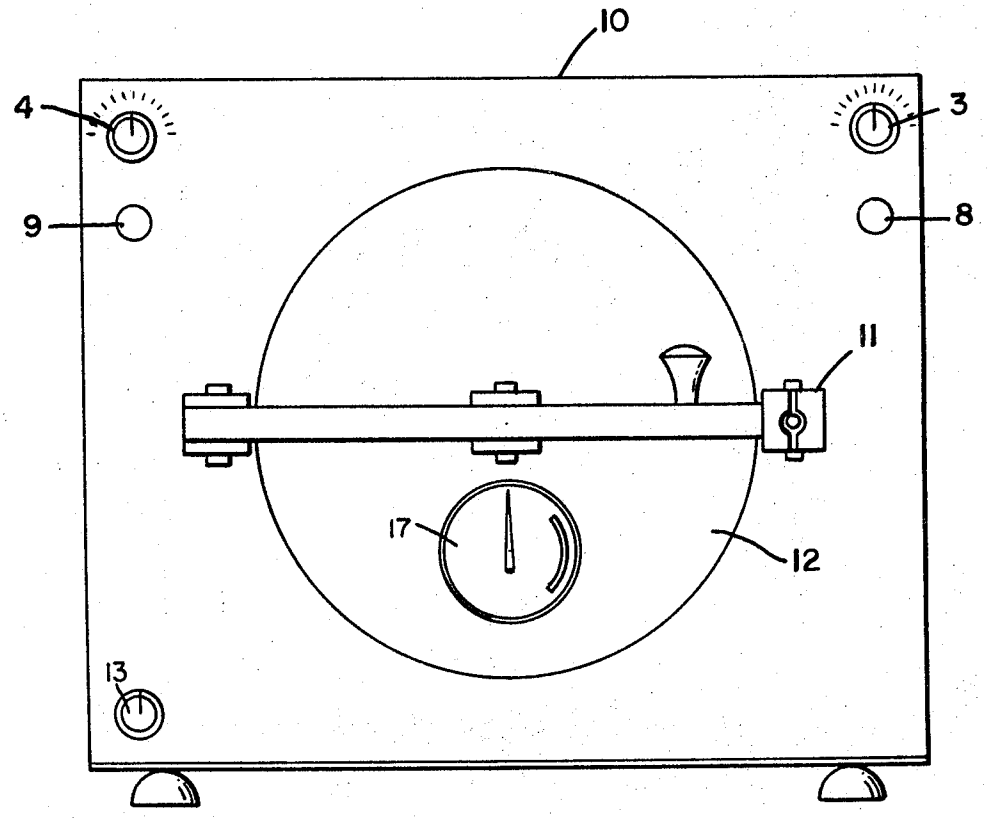


FIG_3

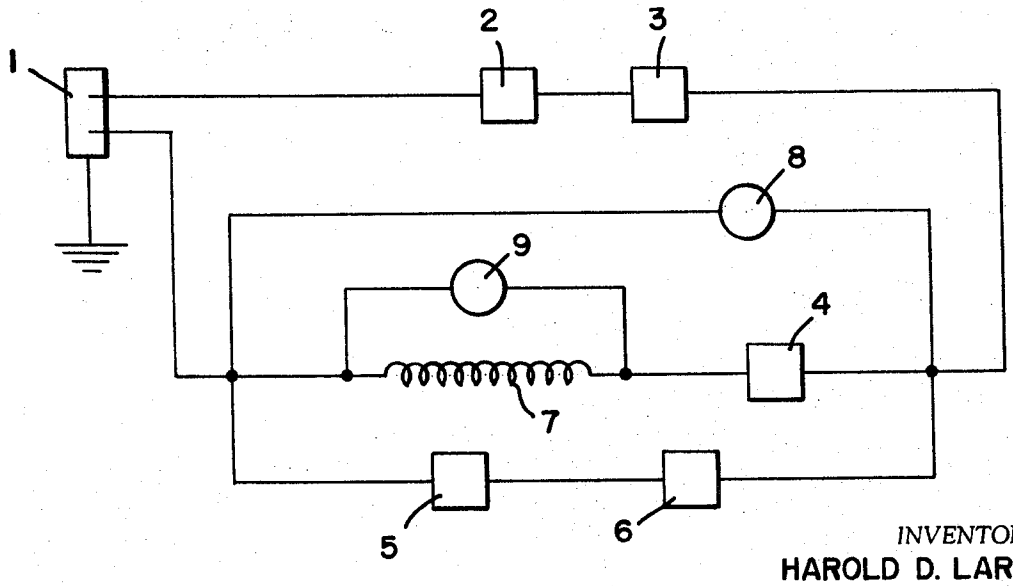


FIG_4

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April 13, 1971 H. D. LARRO 3,574,529

AUTOMATIC STERILIZING AUTOCLAVE

Filed Jan. 3, 1969 4 Sheets-Sheet 3

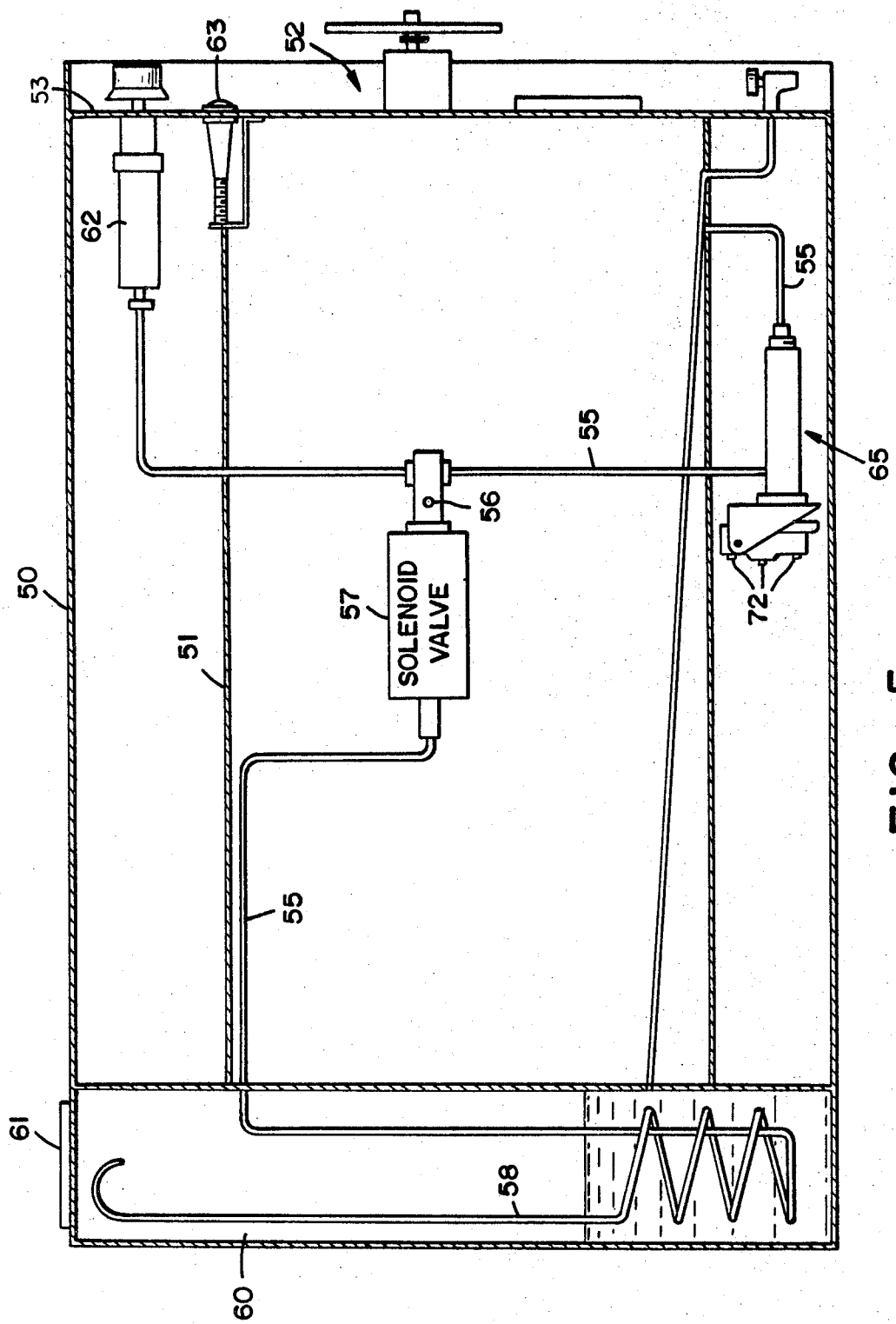


FIG_5

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April 13, 1971 H. D. LARRO 3,574,529

AUTOMATIC STERILIZING AUTOCLAVE

Filed Jan. 3, 1969 4 Sheets-Sheet 4

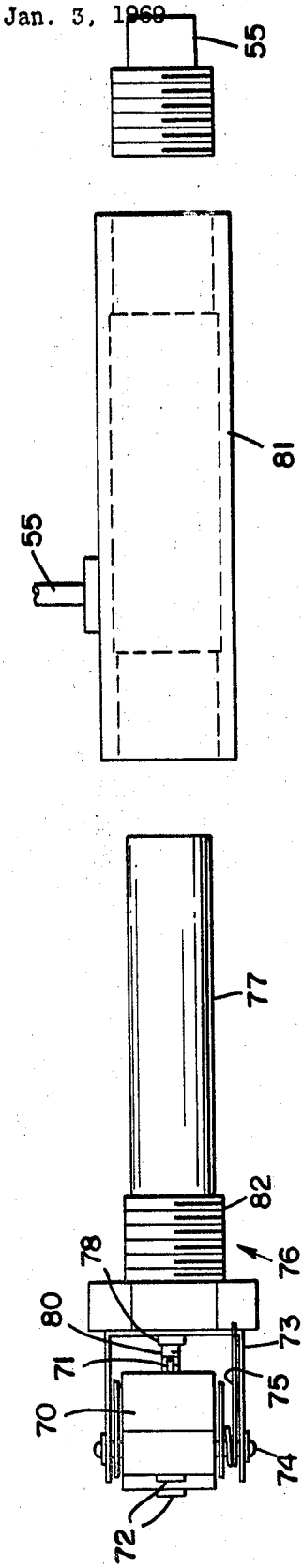


FIG_6

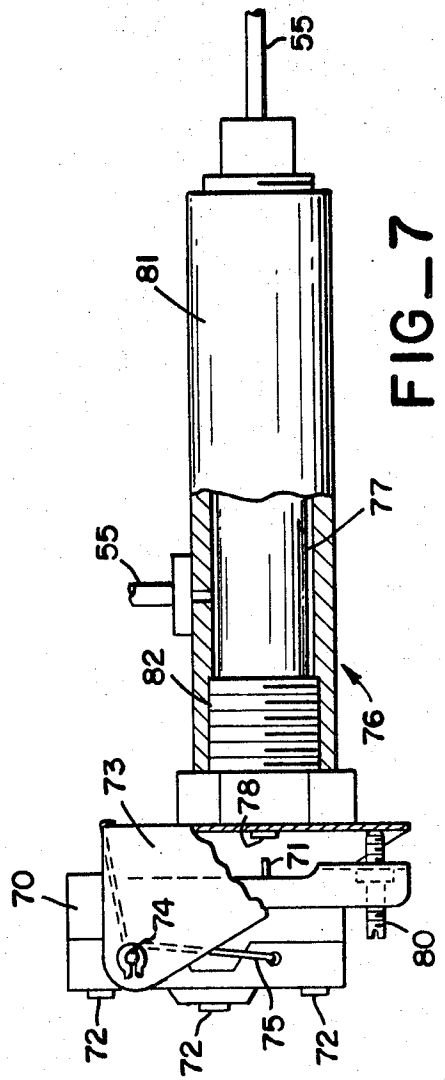


FIG_7

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United States Patent Office 3,574,529
Patented Apr. 13, 1971

3,574,529

AUTOMATIC STERILIZING AUTOCLAVE

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Continuation-in-part of abandoned application Ser. No. 449,541, Apr. 20, 1965. This application Jan. 3, 1969, Ser. No. 788,814

Int. Cl. A61l 3/00

U.S. Cl. 21—94 12 Claims

ABSTRACT OF THE DISCLOSURE

An autoclave for sterilizing articles by steam under pressure with fully automatic operation throughout a sterilizing cycle. An automatically controlled valve in the air-steam exhaust passageway from the autoclave pressure chamber closes the exhaust passageway only at a preselected temperature in order to first exhaust air from the pressure chamber at the beginning of the sterilizing cycle, and opens the exhaust passageway after a predetermined period at the end of the sterilizing cycle, at which time the heating element is also automatically cut off. During the sterilizing cycle, non-sterile pockets of air in the pressure chamber are automatically purged through the air-steam exhaust passageway by the automatic control valve.

This application is a continuation-in-part of United States patent application, Ser. No. 449,541, entitled "Sterilizing Autoclave," filed on Apr. 20, 1965 and abandoned on Jan. 30, 1969.

This invention relates to a new and improved sterilizing autoclave for sterilizing by heat under pressure, medical, surgical and dental instruments and other articles and appliances.

It is an object of the present invention to provide a new and improved sterilizing autoclave which provides fully automatic operation throughout a sterilizing cycle without attendance by an operator after the initial settings. A related object is to provide an autoclave with safety features which permit such fully automatic operation.

A further object of the invention is to provide a fully automatic sterilizing autoclave which continuously purges pockets of non-sterile air within the pressure chamber during a sterilizing cycle in order to maintain complete sterility throughout the autoclave pressure chamber.

In order to accomplish these results, the present invention contemplates providing an autoclave for sterilizing articles in which the air-steam exhaust passageway communicating with the autoclave sterilizing pressure chamber is controlled by an automatic valve for completely automatic operation during a sterilizing cycle. To this end, the valve is operatively coupled with a thermoswitch which operates the valve to close the air-steam exhaust passageway at a preselected air-steam temperature, so that as steam is produced at the beginning of the sterilizing cycle, residual air in the autoclave pressure chamber is expelled through the air-steam exhaust passageway before it is closed by the valve. The valve is also operatively coupled with a timer which operates the valve to open the air steam exhaust passageway after a predetermined period of sterilization at substantially constant temperature and pressure to vent steam in the pressure chamber into a condensing tank. At the same time the timer switch also shuts off the heating element which produces steam from water placed in the pressure chamber. In a preferred embodiment of the invention, the valve is a stainless steel solenoid valve. A feature and advantage of the present invention resides in a design

permitting reduced number of parts which may be formed of non-corrosive material to minimize maintenance and permit the use of tap water without deterioration.

According to another aspect of the invention, the automatically controlled valve in the air-steam exhaust passageway is operated during the sterilizing cycle to continuously purge pockets of non-sterile air or gas released from articles placed in the pressure chamber. To this end, the heat sensor for the thermoswitch which controls the valve is positioned coaxially within the air-steam exhaust passageway between the autoclave pressure chamber and valve. When a pocket of cool or non-sterile air or gas enters the exhaust passageway after the valve has closed the passageway at the beginning of a sterilizing cycle, the heat sensor detects the drop in temperature, and activates the thermoswitch to operate the solenoid valve and open the air-steam exhaust passageway until the pocket of cooler air has been released. As sterile steam again enters the exhaust passageway, the heat sensor of the thermoswitch detects the rise in temperature and activates the thermoswitch to operate the valve and close the air-steam exhaust passageway to thereby preserve the substantially constant temperature and pressure within the autoclave sterilizing chamber.

Other objects, features and advantages of the present invention will become apparent in the following specification and accompanying drawings.

In the drawings:

FIG. 1 is a fragmentary side view partially cut away of a sterilizing autoclave embodying the present invention.

FIG. 2 is a fragmentary side view partially cut away of the opposite side of the autoclave shown in FIG. 1.

FIG. 3 is a front view of the autoclave showing the indicator and control panel and door to the sterilizing chamber.

FIG. 4 is a schematic drawing of the electrical circuitry for the sterilizing autoclave.

FIG. 5 is a diagrammatic side view with the housing cut away of another sterilizing autoclave according to the present invention.

FIG. 6 is an exploded view of the thermoswitch and sensor for the autoclave shown in FIG. 5.

FIG. 7 is a side view partially cut away of the thermoswitch.

In the sterilizing autoclave shown in FIG. 1 there is provided a sterilizing pressure chamber **14** having an access door **12**. During sterilizing operations, the access door **12** is tightened by means of a door yoke **11** against a pressure sealing gasket **12***a* mounted on the chamber body **14**. The door **12** and yoke **11** are designed to retain steam within the chamber at a pressure of at least 27 pounds, that required to safely sterilize at normal altitudes. Leading from the bottom of pressure chamber **14** is a single air-steam exhaust passageway **19** which is coupled in series through a pressure release safety valve **18**, solenoid valve **6**, and condensing coil **16**. Distilled water condensed from steam in the pressure chamber collects in condenser tank **15** from which it may be removed through drain cock **13**. A thermoswitch **5** whose heat sensing element is positioned in the condensing tank **15** operates the solenoid valve **6** at a preselected temperature of air-steam exhausted into the condensing tank to close the air-steam exhaust passageway **19**.

Water is placed manually into the autoclave sterilizing chamber **14** through the access door **12** which is closed after the articles to be sterilized have also been placed in the chamber. Heating element **7**, positioned inside chamber **14** at the bottom, is energized as hereinafter described to produce steam from water placed in the chamber. As steam is produced, the cool air filling the

chamber is expelled through exhaust passageway **19** to the condensing tank **15**. As the cooler air has been completely exhausted, steam then passes through the exhaust passageway **19** to the condensing tank **15**. This increase in temperature is sensed by the heat sensor of thermoswitch **5** which operates the solenoid valve **6** to close the air-steam exhaust passageway **19**. Sterilization then takes place for a period determined by a timer switch **3**. When the preselected sterilization period has elapsed, timer switch **3** operates the solenoid valve **6** to open the air-steam exhaust passageway **19** and vent the steam in the pressure chamber **14**. At the same time, timer switch **3** de-energizes the heating element **7**. During the sterilizing cycle, the temperature in pressure chamber **14** is monitored by thermostat **4** through a tube communicating with air-steam exhaust passageway **19** between the solenoid valve **6** and the pressure chamber. Thermostat **4** regulates heating element **7** to maintain a constant preselected temperature in the range of, for example, 250 to 270 degrees. The pilot light **9** is lit only during periods when heating element **7** is energized. The pilot light **8** remains lit when the timer switch **3** is closed during a sterilizing cycle.

An integrated electrical circuit is provided for electrical control of solenoid valve **6** by thermoswitch **5** and timer switch **3** and for electrical control of the heating element **7** by thermostat **4** and timer switch **3** as hereinafter described. A boil-dry switch **2** is positioned at the bottom of pressure chamber **14** as a safety feature to cut out supply of power to the electrical circuit in the event that the quantity of water in the sterilizing chamber is insufficient. An additional safety feature of the autoclave is the pressure release safety valve **18**, a conventional spring-loaded safety valve which releases steam to the side of the autoclave when pressure exceeds a predetermined safe value and which reseals itself after safe pressure level is restored. Such conventional safety valves are described in U.S. Pat. No. 2,526,974 and U.S. Pat. No. 2,548,691.

Controls for setting the timer switch **3** and thermostat **4**, and pilot light indicators **8** and **9** are mounted on a control panel **10** at the front of the autoclave as shown in FIG. 3. A conventional pressure gauge **17** is also mounted on the front of the access door **12**. Drain cock **13** for draining distilled water from condensing tank **15** is provided at the bottom of the control panel.

A schematic diagram of the unitary electrical circuit for automatically controlling operation of the autoclave elements during a sterilizing cycle is shown in FIG. 4. The electrical circuit includes a three-pronged A.C. plug **1** for access to, for example, a 110–115 volt A.C. 50–60 cycle power source. All current through the electrical circuit passes through the conventional boil-dry switch **2** which is a thermostat type switch. In the event that insufficient water is present in the sterilizing chamber, overheating of heating element **7** operates the boil-dry switch to open the entire circuit and cut off power. All current through the circuit also passes through timer switch **3**, which is set on the control panel to close the electrical circuit for a preselected period of time of, for example, zero to 60 minutes. From timer switch **3**, the circuit is connected to provide several current loops. One current loop passes through the solenoid coil of stainless steel solenoid valve **6** and thermoswitch **5**. Thus, the valve, by means of a solenoid coil, is controlled by both the thermoswitch **5** and timer switch **3**. The solenoid valve is adjusted so that the seat of the valve is normally open thereby leaving the air-steam exhaust passageway **19** open to the condenser tank **15** which communicates with the atmosphere. When both the timer switch **3** and thermoswitch **5** are closed, permitting current to pass through the solenoid coil of the solenoid valve, the valve is operated to close the seat of the valve and thereby close the air-steam exhaust passageay **19** permitting pressure to build up within pressure chamber **14**. At the end of a sterilizing cycle when timer switch **3** opens the electrical circuit, the solenoid valve returns to its normally open position, thereby venting steam from the pressure chamber **14** through the air-steam exhaust passageway **19** to the atmosphere via condenser tank **15**.

A second current loop from timer **3** passes through the thermostat **4** and heating element **7** to permit control of the heating element **7** by the thermostat **4**. Thus, when timer switch **3** closes the circuit initiating a sterilizing cycle, the heat sensing element of thermostat **4** monitors the temperature in the sterilizing chamber through a tube communicating with the pressure chamber to open and close the circuit to the heating coil to thereby maintain a constant preselected temperature. The thermostat **4** is adapted to maintain temperature regulation in the sterilizing chamber of within, for example, ¼ of a degree. Heating element **7** can be positioned inside the sterilizing pressure chamber **14** at the bottom.

A third current loop from timer **3** passes through the pilot light **8** and back to the terminal strip **1**, the pilot light **8** thereby indicating when the complete electrical circuit is under operation, i.e., when timer switch **3** is closed. A final current loop from timer **3** passes through the thermostat **4**, a second pilot light **9** connected in parallel with the heating coil **7** and then back to the terminal strip **1**. Pilot light **9** thereby indicates when the heating element **7** is energized by thermostat **4**.

Another sterilizing autoclave embodying the present invention is illustrated in FIGS. 5 through 7. According to this embodiment, there is provided within a housing **50** a sterilizing pressure chamber **51** having an access door **52** and a control panel **53** similar to that illustrated in FIGS. 1 through 3. A single air-steam exhaust passageway **55** is connected to the bottom of pressure chamber **51** and passes in series adjacent a pressure release safety valve **56**, and through solenoid valve **57** and condensing coil **58**, which terminates in condensing tank **60**, communicating with the atmosphere through a hole **61** in the housing **50** of the autoclave.

According to this form of the invention, however, the thermoswitch **65**, which electrically controls solenoid **57** is positioned so that the heat sensor or sensing element **76** of the thermoswitch communicates with the air-steam exhaust passageway **55** intermediate the sterilizing chamber **51** and solenoid valve **57**. Thus, whereas in the embodiment of the present invention previously described the heat sensitive element of thermoswitch **5** was positioned in the condensing tank **15**, according to the form illustrated in FIGS. 5 through 7 the heat sensing element **76** monitors the temperature of air-steam in the pressure chamber **51** before it reaches solenoid valve **57**.

As in the previous embodiment described in FIGS. 1 through 4, there is provided an electrical timer switch, not shown, which also controls the solenoid valve **57** and a heating element positioned at the bottom of the sterilizing chamber **51**, not shown herein. A thermostat **62** regulates power to the heating coil as heretofore described to maintain a preselected constant temperature. Pilot light **63** is lit when the heating element is energized. An additional pilot light, not shown, indicates when the timer switch is closed in the manner heretofore described. Thus, the electrical circuitry for automatically controlling the solenoid valve **57** and heating element for the autoclave illustrated in FIGS. 5 through 7 is the same as that shown in FIG. 4 with the corresponding elements substituted.

A feature and advantage of the form of the invention shown in FIGS. 5 through 7 resides in a continuous purging of cooler non-sterile pockets of air developing in the pressure chamber during the sterilizing cycle. This continuous purging is accomplished by solenoid valve **57** under electrical control of the thermoswitch **65**. Solenoid valve **57** is adjusted so that the valve seat is normally open permitting a continuous passageway between the chamber **51** and the atmosphere through condensing tank **60**. Water is placed in the pressure chamber along with articles to be sterilized and access door **52** is sealed. The

timer switch is turned on and set for the predetermined sterilization period, thereby energizing the heating coil to generate steam in the pressure chamber. Cool air in the pressure chamber is displaced and vented through the air-steam exhaust passageway **55** through solenoid valve **57** until steam enters the passageway. The increase in temperature is sensed by the sensor of thermoswitch **65**, which closes the electrical circuit to the solenoid coil of valve **57** operating the valve to close the seat of the valve and thereby close the air-steam exhaust passageway **55**, permitting steam pressure to build up within the chamber **51**. The sterilizing cycle thereafter continues with temperature control maintained by thermostat **62** heretofore described.

During the sterilizing cycle, however, pockets of non-sterile cooler air may develop or emerge from articles in the chamber being sterilized. If such non-sterile pockets of air develop, being heavier they will move downward into the air-steam exhaust passageway **55**. The decrease in temperature is sensed by the heat sensing element **76** of thermoswitch **65** which opens the electrical circuit to the solenoid coil of valve **57**, so that the valve returns to its normally open seat position thereby opening the air-steam exhaust passageway **55** to vent the non-sterile air into condensing tank **60**. When steam at the sterilizing temperature again reaches the heat sensitive element of thermoswitch **65**, the solenoid valve is operated to close the seat of the valve and once again close the air-steam exhaust passageway. As non-sterile pockets of air develop during the sterilizing cycle, they are continuously purged in the manner described above.

A more detailed illustration of the configuration and placement of thermoswitch **65** is illustrated in FIGS. 6 and 7. The thermoswitch **65** consists of an electrical switch **70** actuated by a pushbutton **71** to open or close the electrical connections between terminals **72**. The switch is pivotally mounted on a frame **73** on an axis **74** and is biased by a spring **75** in the direction of a heat sensing element **76**, also rigidly mounted to frame **73**. The heat sensing element **76** consists of an elongate tubular housing **77** filled with an expandable heat sensitive material such as paracyeme. The heat sensitive material expands with increasing temperature and contracts with decreasing temperature to respectively extend and retract a small piston **78** mounted in juxtaposition to the pushbutton **71** which actuates electrical switch **70**. By means of an adjustable screw **80** the thermoswitch can be calibrated so that piston **78** depresses pushbutton **71** at a preselected temperature. Screw **80** adjusts the distance between the pushbutton **71** and piston **78** and operates against bias of spring **75**. In order to maintain the air-steam mixture from chamber **51** in intimate contact with the elongate tube **77** filled with a heat sensitive material, tube **77** is coaxially enclosed by a collar **81**, which is maintained in the air-steam exhaust passageway **55**. The tube **77** containing heat sensitive material is spaced coaxially within collar **81** by means of a threaded portion **82**, which engages internal threads at the end of collar **81**. Steam from pressure chamber **51** enters the air-steam exhaust passageway **55** which communicates with one end of the collar **81**. The air-steam mixture is distributed around the tubular container **77** and thereafter passes out the air exhaust steam passageway **55** from the other end of collar **81**. Thermoswitch **65** thereby maintains sensitive control over solenoid valve **57** for release or purging of pockets of non-sterile air developing during a sterilizing cycle and for closing the valve upon contact with steam of the preselected sterilizing temperature.

What is claimed is:

1. An autoclave comprising:

a pressure chamber having an access door to receive articles for sterilization and contain steam under pressure;

electrical heating means for producing steam from water placed in the pressure chamber;

a single air-steam exhaust passageway communicating with the inside of the pressure chamber and leading to the outside of the chamber;

a solenoid valve in the air-steam exhaust passageway adapted to open and close said passageway, said valve biased in a normally open position;

a thermoswitch electrically coupled with the solenoid valve to operate said valve and close the air-steam exhaust passageway only at and above a preselected air-steam temperature whereby air in the pressure chamber is expelled through the air-steam exhaust passageway by steam produced in the pressure chamber before the passageway is closed;

and a timer switch electrically coupled with said solenoid valve to operate said valve to open the air-steam exhaust passageway after a predetermined time, said timer switch also electrically connected to the heating means to simultaneously shut off said heating means at said predetermined time.

2. An autoclave comprising:

a pressure chamber adapted to receive articles for sterilization and contain steam under pressure;

electrical heating means for producing steam from water placed in the pressure chamber;

a single air-steam exhaust passageway communicating with the inside of the pressure chamber and leading to the outside of the chamber;

a solenoid valve in the air-steam exhaust passageway adapted to open and close said passageway, said valve biased in a normally open position;

a thermoswitch electrically coupled with the solenoid valve to operate said valve and close the air-steam exhaust passageway only at and above a preselected air-steam temperature whereby air in the pressure chamber is expelled through the air-steam exhaust passageway by steam produced in the pressure chamber before the passageway is closed;

a timer switch electrically coupled with said solenoid valve to operate said valve to open the air-steam passageway after a predetermined time, said timer switch also connected to the heating means to simultaneously shut off said heating means at said predetermined time;

a thermostat electrically coupled with the heating means to maintain a substantially constant temperature in the pressure chamber during the sterilization period;

a boil-dry switch electrically coupled with the heating means to prevent operation of the heating means when insufficient water is present in the pressure chamber;

and an electrical circuit controlling operation of said autoclave, said timer switch and boil-dry switch connected in said electrical circuit to open and close said circuit, said thermostat and heating means connected in series along a first parallel leg of the electrical circuit from the timer switch and boil-dry switch, said solenoid valve and thermoswitch connected in series along a second parallel leg from the timer switch and boil-dry switch.

3. An autoclave as set forth in claim **2** wherein there is also provided;

a first pilot light connected along a third parallel leg of the electric circuit from the timer switch and boil-dry switch to indicate when said switches are closed and when a sterilizing cycle is underway;

and a second pilot light, said second pilot light connected in parallel across the heating means in said circuit whereby said second pilot light indicates when the heating means is activated.

4. An autoclave comprising:

a pressure chamber having an access door to receive articles for sterilization and contain steam under pressure;

means for providing steam in the pressure chamber;

a single air-steam exhaust passageway communicating

with the inside of the pressure chamber and leading to the outside of the chamber;

a valve in the air-steam exhaust passageway adapted to open and close said passageway, said valve biased in a normally open position;

a thermoswitch operatively coupled with the valve to operate said valve and close the air-steam exhaust passageway only at and above a preselected air-steam temperature whereby air in the pressure chamber is expelled through the air-steam exhaust passageway by steam provided in the pressure chamber before the passageway is closed, said thermoswitch actuated by a heat sensitive element positioned within the air-steam exhaust passageway between the pressure chamber and the valve whereby pockets of air cooler than said preselected temperature are automatically purged from the pressure chamber through the air-steam exhaust passageway and valve during a sterilizing cycle;

and a timer switch operatively coupled with said valve to operate said valve to open the air-steam exhaust passageway after a sterilizing cycle of predetermined period, said timer switch also operatively coupled to the steam providing means to simultaneously shut off said means after said predetermined period.

5. An autoclave as set forth in claim **4** wherein said air-steam exhaust passageway communicates with the pressure chamber through the bottom of said pressure chamber.

6. An autoclave as set forth in claim **4** wherein the heat sensitive element of said thermoswitch is an elongate element mounted coaxially within and spaced from the walls of said air-steam exhaust passageway whereby the air-steam flow in the passageway is distributed around the heat sensitive element.

7. An autoclave comprising:

a pressure chamber adapted to receive articles for sterilization and contain steam under pressure;

electrical heating means for producing steam from water placed in the pressure chamber;

a single air-steam exhaust passageway communicating with the inside of the pressure chamber and leading to the outside of the chamber;

a solenoid valve in the air-steam exhaust passageway adapted to close said passageway, said valve biased in a normally open position;

a thermoswitch electrically coupled with the solenoid valve to operate said valve and close the air-steam exhaust passageway only at and above a preselected air-steam temperature whereby air in the pressure chamber is expelled through the air-steam exhaust passageway by steam provided in the pressure chamber before the passageway is closed, said thermoswitch actuated by a heat sensitive element positioned within the air-steam exhaust passageway between the pressure chamber and the solenoid valve whereby pockets of air cooler than said preselected temperature are automatically purged from the pressure chamber through the air-steam exhaust passageway and solenoid valve during a sterilizing cycle;

a timer switch electrically coupled with said solenoid valve to operate said valve to open the air-steam exhaust passageway after a sterilizing cycle of predetermined period, said timer switch also electrically connected to the heating means to simultaneously shut off said heating means at said predetermined period;

a thermostat electrically coupled with the heating means to maintain a substantially constant temperature in the pressure chamber during the sterilization period;

a boil-dry switch electrically coupled with the heating means to prevent operation of the heating means when insufficient water is present in the pressure chamber; and an electrical circuit controlling operation of said autoclave, said timer switch and boil-dry switch connected in said electrical circuit to open and close said circuit, said thermostat and heating means connected in series along a first parallel leg of the electrical circuit from the timer switch and boil-dry switch, said solenoid valve and thermoswitch connected in series along a second parallel leg from the timer switch and boil-dry switch.

8. An autoclave as set forth in claim **7** wherein said air-steam exhaust passageway communicates with the pressure chamber through the bottom of said pressure chamber.

9. An autoclave as set forth in claim **7** wherein the heat sensitive element of said thermoswitch is an elongate element mounted coaxially within and spaced from the walls of said air-steam exhaust passageway whereby the air-steam flow in the passageway is distributed around the heat sensitive element.

10. In an automatic autoclave of the type having a pressure chamber for receiving articles for sterilization and containing steam under pressure, means for providing steam in the pressure chamber; a single air-steam exhaust passageway communicating with the inside of the pressure chamber and leading to the outside of the chamber; a solenoid valve in the air-steam exhaust passageway adapted to open and close said passageway; and a thermoswitch electrically coupled with said solenoid valve to operate said valve and close the air-steam exhaust passageway only at and above a preselected air-steam temperature whereby air in the pressure chamber is expelled through the air-steam exhaust passageway by steam provided in the pressure chamber before the passageway is closed, said thermoswitch actuated by a heat sensitive element positioned within the air-steam exhaust passageway between the pressure chamber and the solenoid valve, said valve biased in a normally open position whereby pockets of air cooler than said preselected temperature are automatically purged from the pressure chamber through the air-steam exhaust passageway and valve during a sterilizing cycle.

11. An autoclave as set forth in claim **10** wherein said air-steam exhaust passageway communicates with the pressure chamber through the bottom of said pressure chamber.

12. An autoclave as set forth in claim **10** wherein the heat sensitive element of said thermoswitch is an elongate element mounted coaxially within and spaced from the walls of said air-steam exhaust passageway whereby the air-steam flow in the passageway is distributed around the heat sensitive element.

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MORRIS O. WOLK, Primary Examiner

B. S. RICHMAN, Assistant Examiner

U.S. Cl. X.R.

21—56, 96, 97, 98, 104