

April 15, 1952

R. L. JEWELL ET AL

2,592,705

STERILIZER

Filed Dec. 5, 1949

9 Sheets-Sheet 1

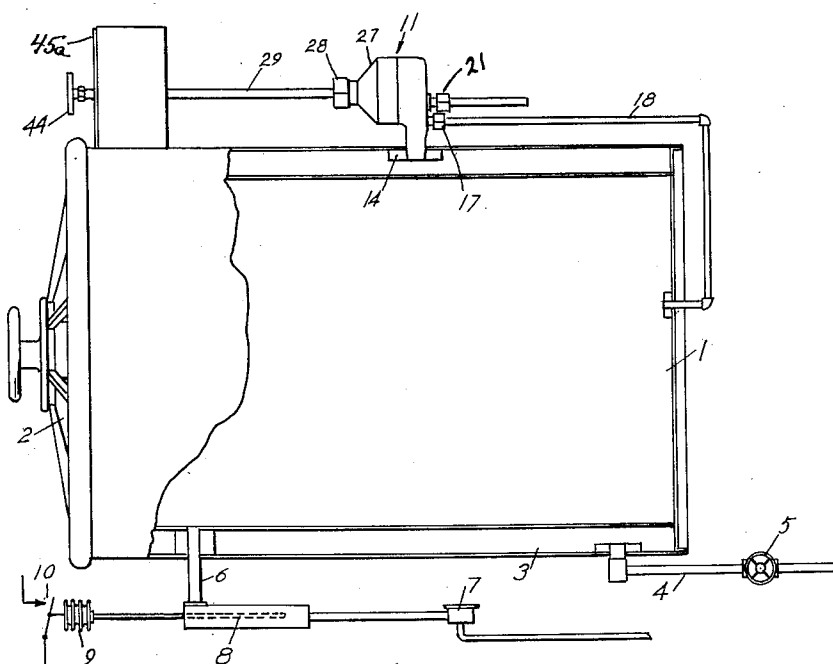


FIG. 1.

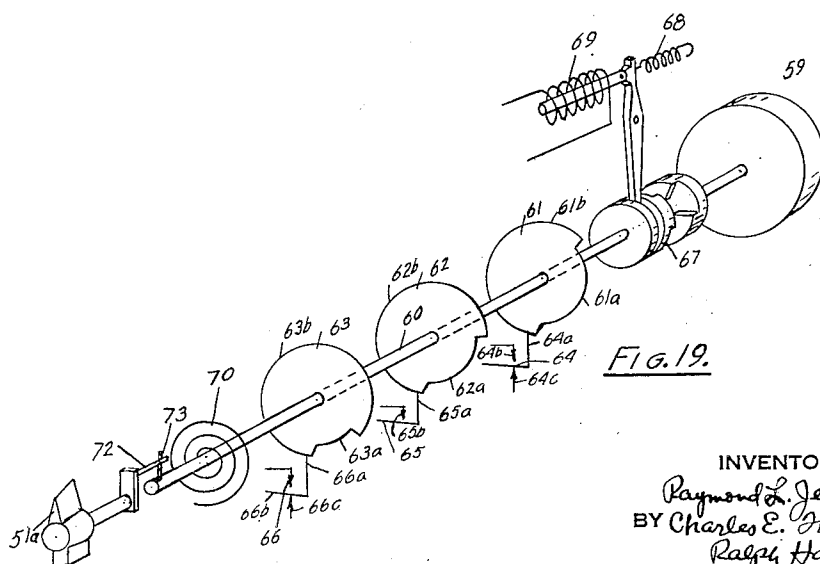


FIG. 19.

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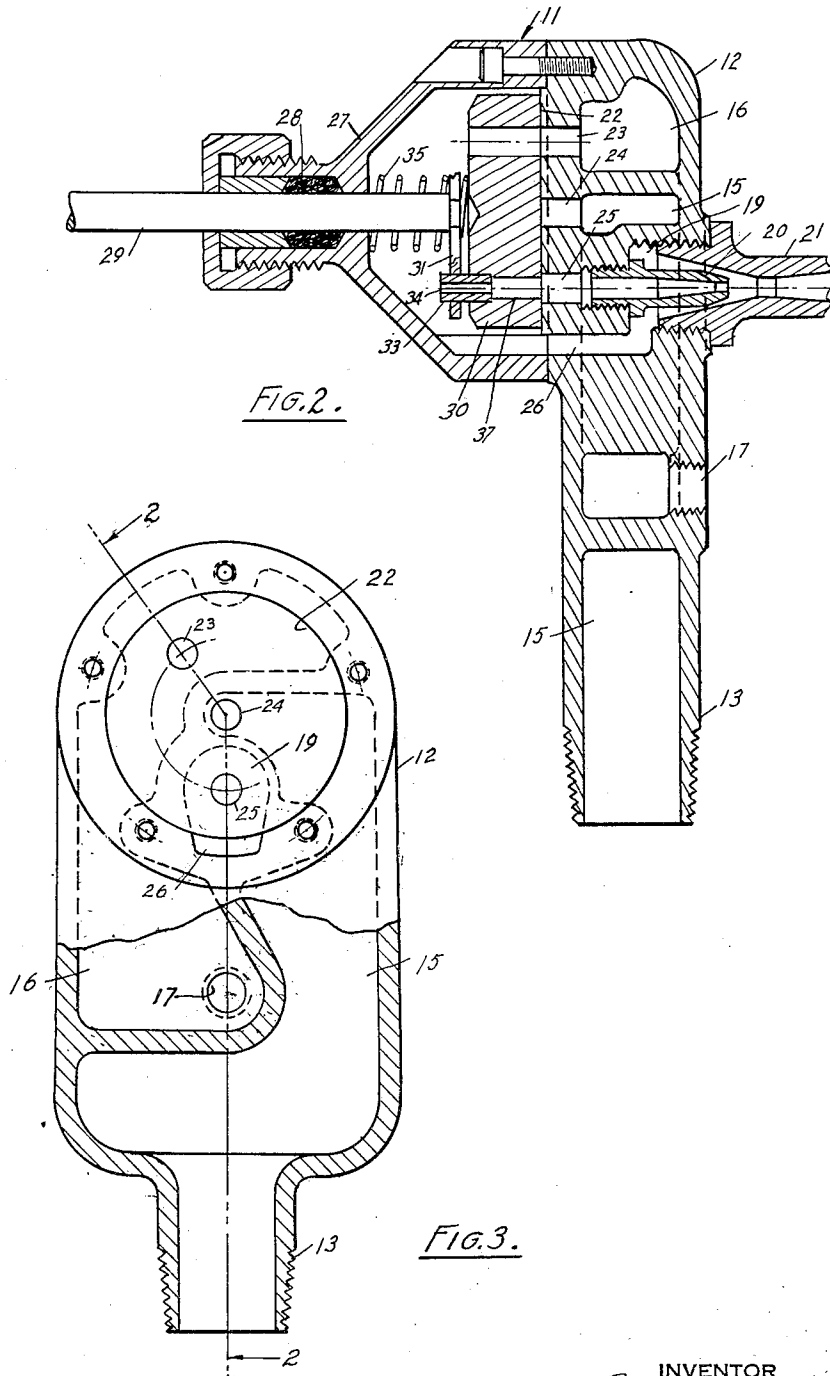
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9 Sheets-Sheet 2



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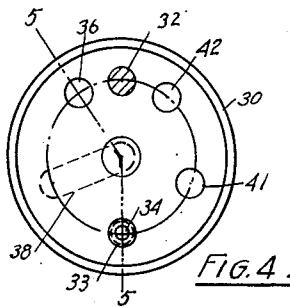


FIG. 4.

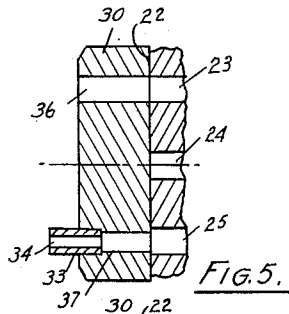


FIG. 5.

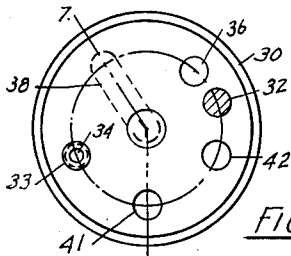


FIG. 6.

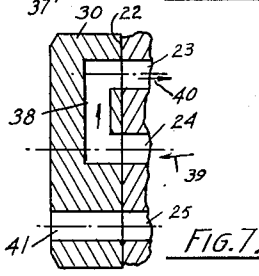


FIG. 7.

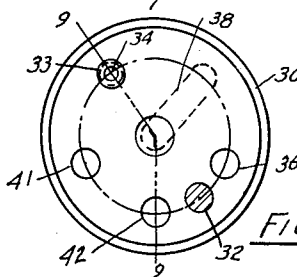


FIG. 8.

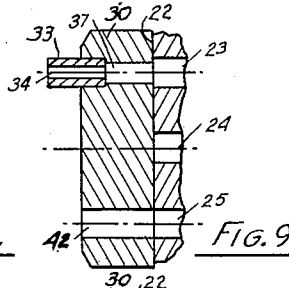


FIG. 9.

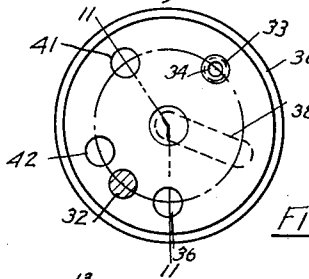


FIG. 10.

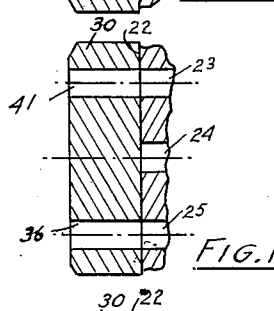


FIG. 11.

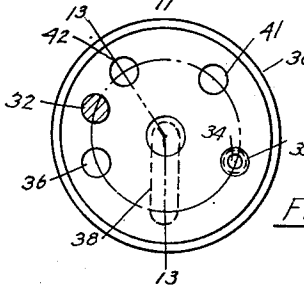


FIG. 12.

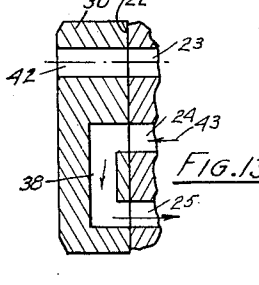


FIG. 13.

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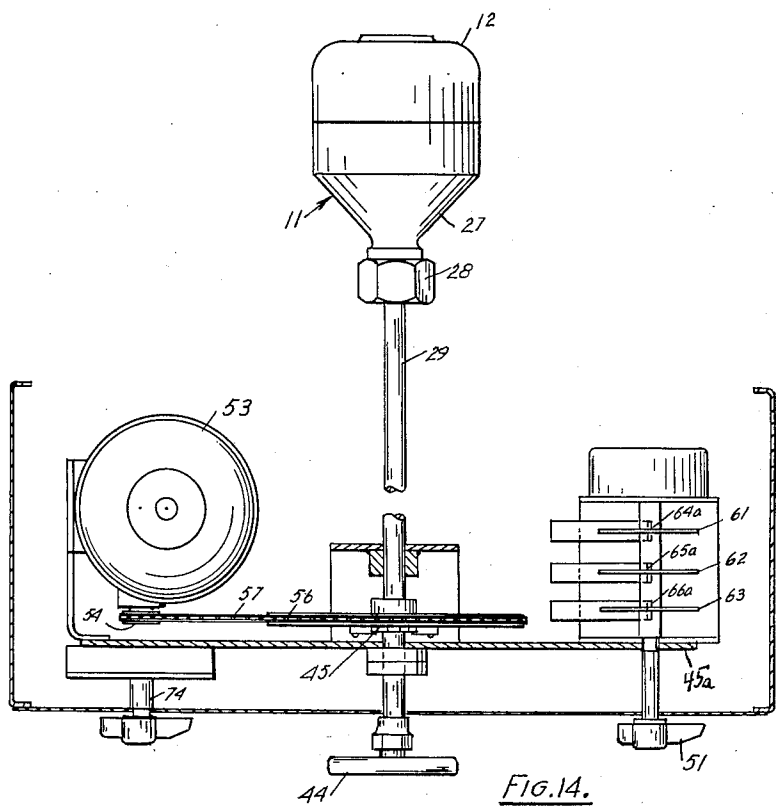
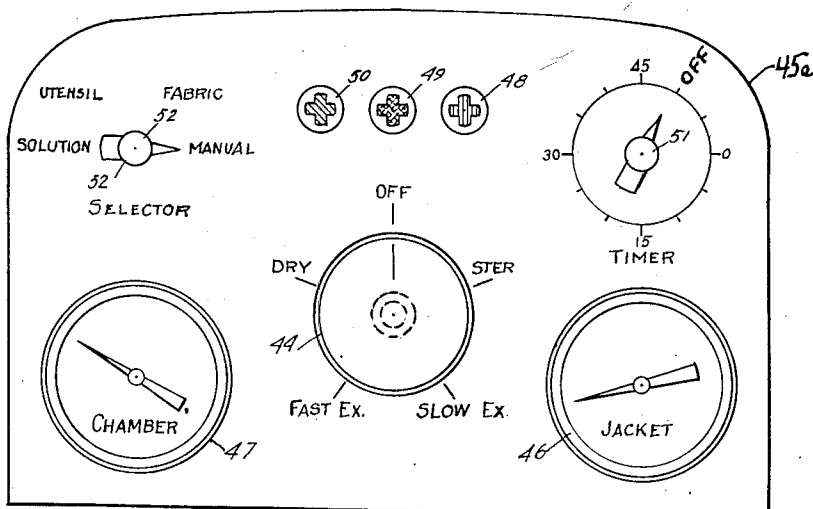


FIG. 15.

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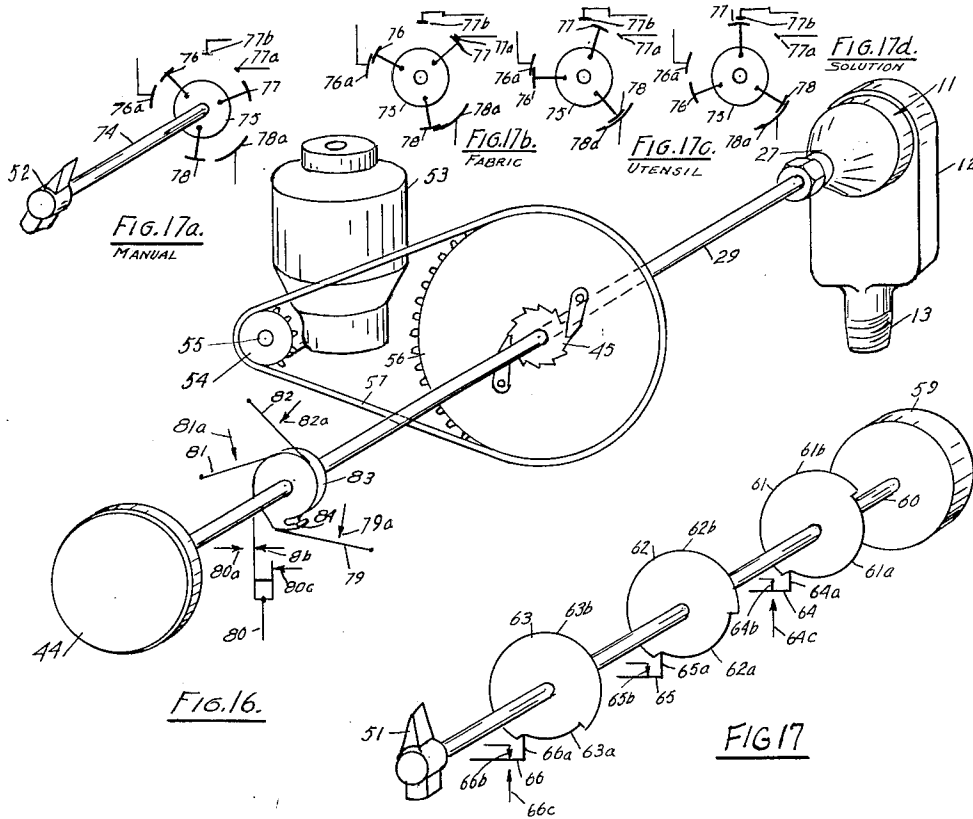
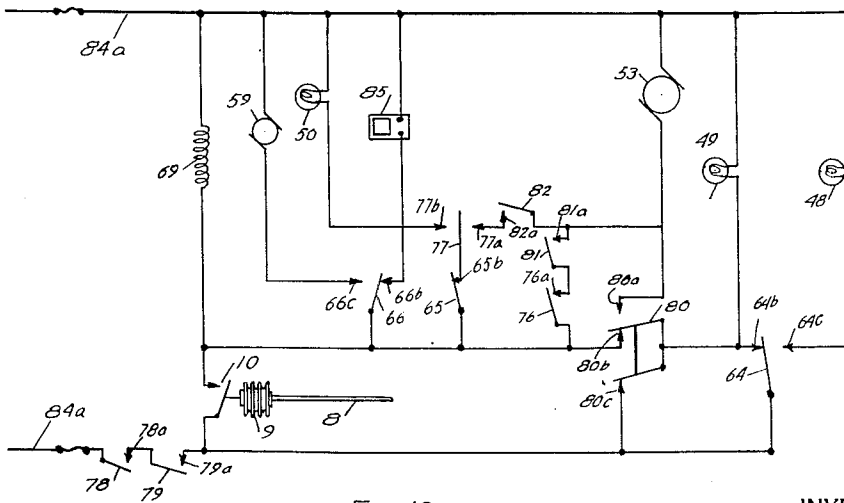
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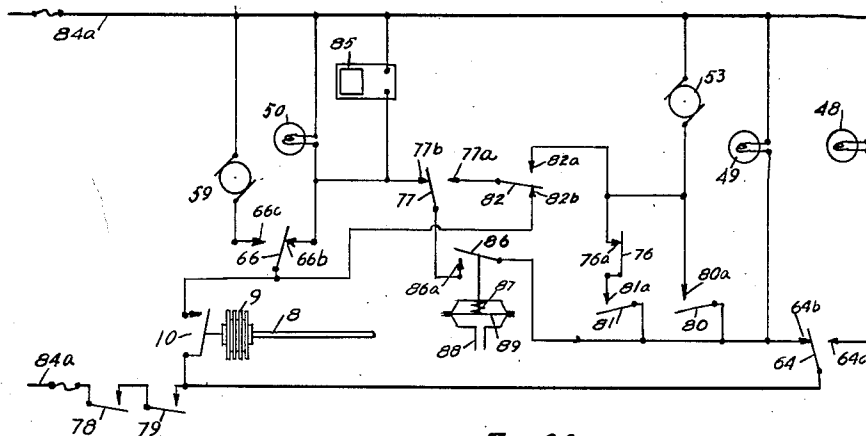


FIG. 20.

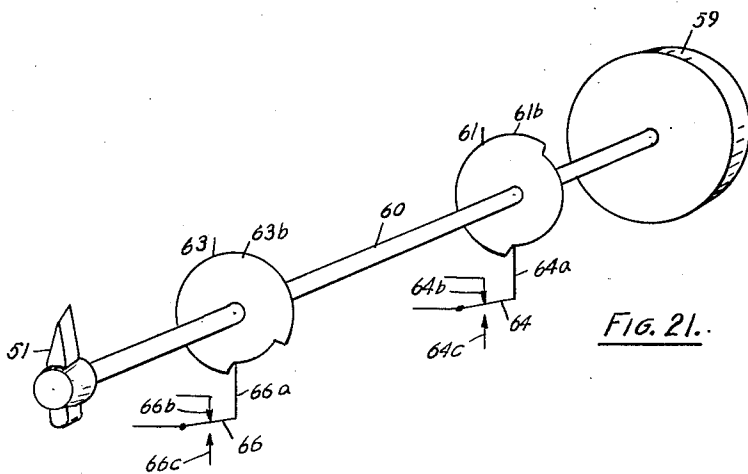


FIG. 21.

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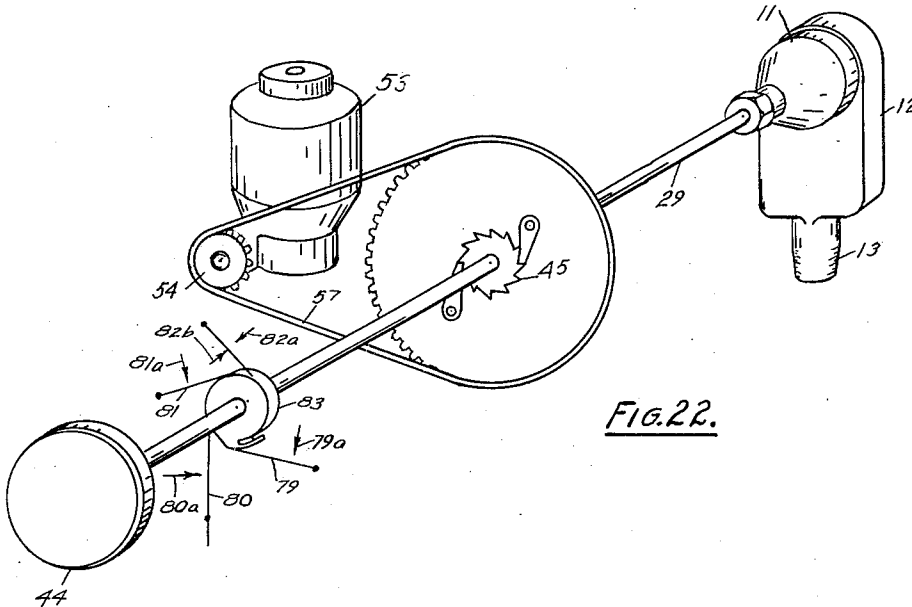


FIG. 22.

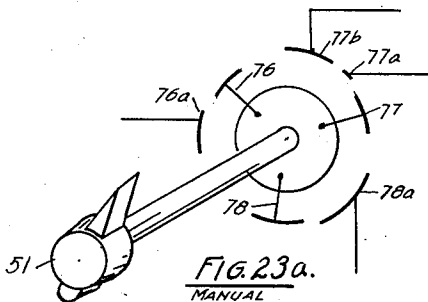


FIG. 23a.
MANUAL

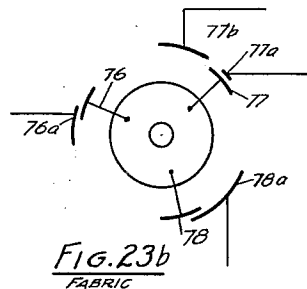


FIG. 23b.
FABRIC

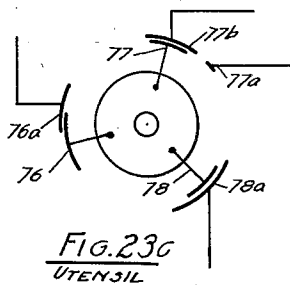


FIG. 23c.
UTENSIL

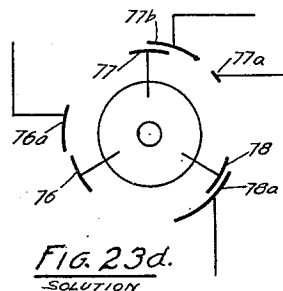


FIG. 23d.
SOLUTION

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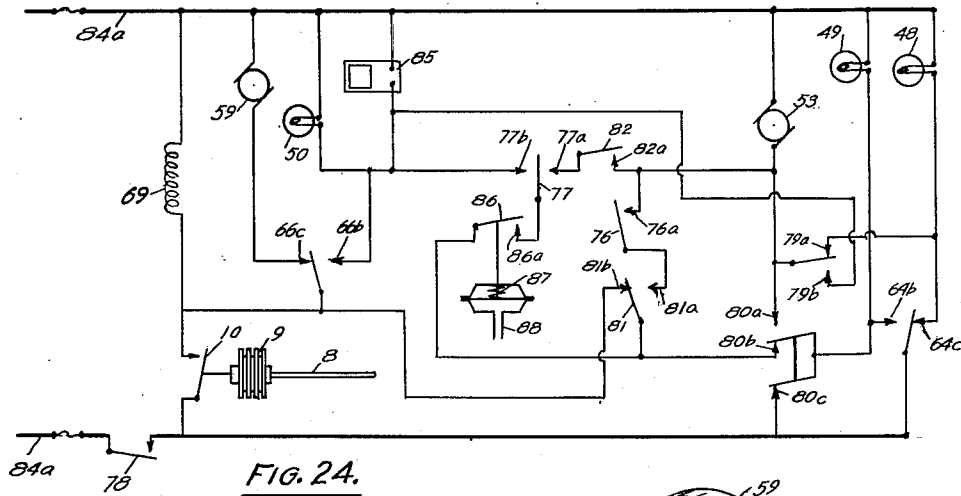
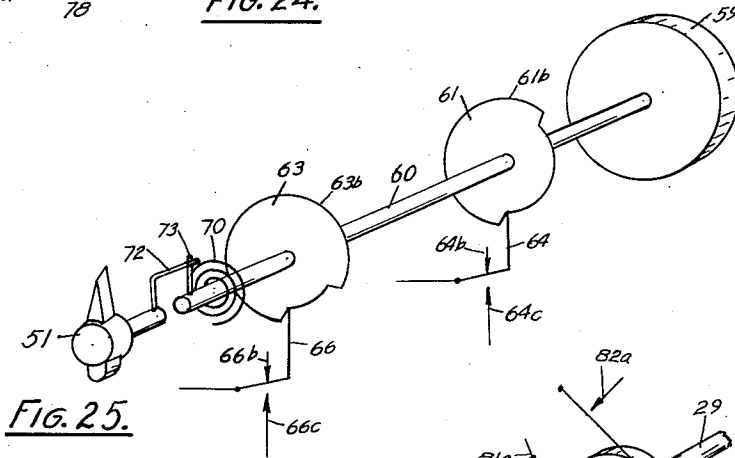
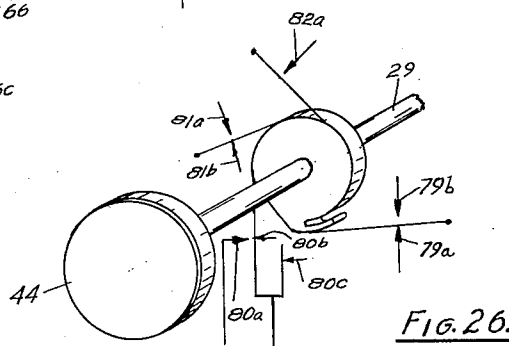
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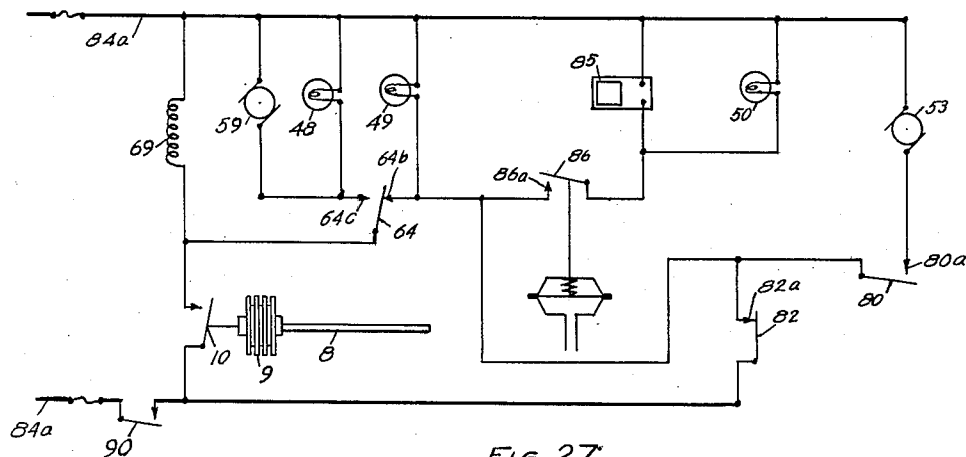


FIG. 27.

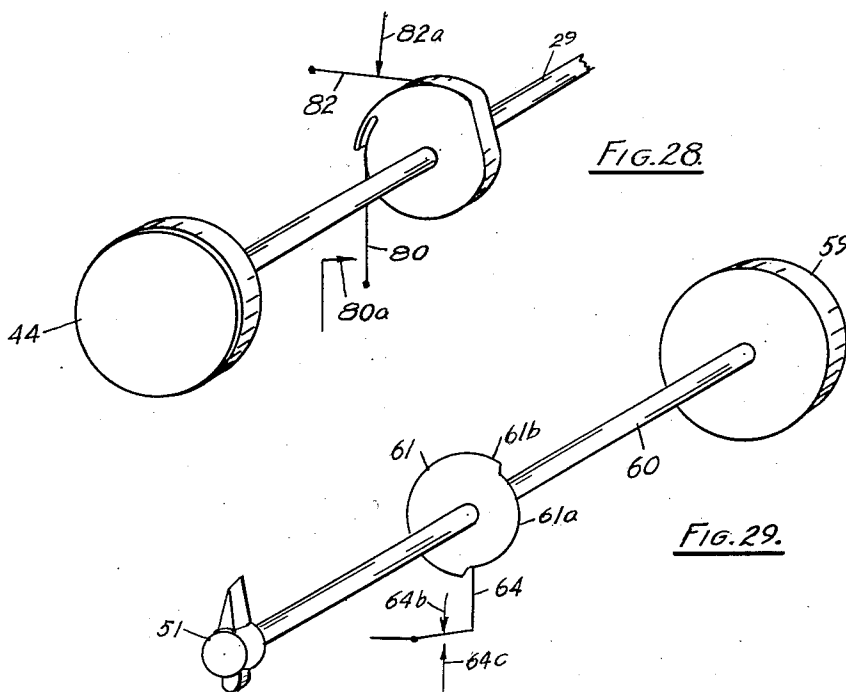


FIG. 29.

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2,592,705

STERILIZER

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Application December 5, 1949, Serial No. 131,236

14 Claims. (Cl. 161—7)

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In hospital sterilizers, operating requirements vary with the character of the material being sterilized. Metallic articles, such as surgical instruments require merely a definite sterilizing time. After sterilizing the instruments the sterilizer need only be exhausted as rapidly as possible so that the operator can remove the sterilized instruments. In the case of bandages or other cloth material, the sterilizing cycle is preferably followed by a fast exhaust to remove the steam and then a subsequent drying operation to remove any residual moisture in the fabric. In the case of solutions, the sterilizing cycle should be followed by a slow exhaust to prevent evaporation or boiling of the solution. It is also desirable that the sterilizer be subject to the control of the operator at all times so that special requirements may be met. This invention is intended to provide an automatic control meeting the various requirements of the materials to be sterilized. The control actuates a manually operable multiport valve so that the operation of the sterilizer can always be manually controlled. Further objects and advantages appear in the specification and claims.

In the drawings, Fig. 1 is a side elevation, partly broken away, of the sterilizer; Fig. 2 is a sectional elevation on line 2—2 of Fig. 3 of the valve controlling the sterilizing, exhausting and drying operations; Fig. 3 is a front view partly broken away of the valve; Fig. 4 is a plan view of the valve disc in the "off" position; Fig. 5 is a section on line 5—5 of Fig. 4; Fig. 6 is a plan view of the valve disc in the "sterilize" position; Fig. 7 is a section on line 7—7 of Fig. 6; Fig. 8 is a plan view of the valve disc in the "slow exhaust" position; Fig. 9 is a section on line 9—9 of Fig. 8; Fig. 10 is a plan view of the valve disc in the "fast exhaust" position; Fig. 11 is a section on line 11—11 of Fig. 10; Fig. 12 is a plan view of the valve disc in the "dry" position; Fig. 13 is a section on line 13—13 of Fig. 12; Fig. 14 is a top plan view of the control for the sterilizer; Fig. 15 is a front view of the control panel; Fig. 16 is a perspective view of the valve and the associated manual and motor drive therefor; Fig. 17 is a perspective of the timer; Fig. 17a is a perspective of the selector switch in the manual position; Fig. 17b is a view of the selector switch in the fabric position; Fig. 17c is a view of the selector switch in the "utensil" position; Fig. 17d is a view of the selector switch in the solution position; Fig. 18 is a control diagram, Fig. 19 is a perspective of an automatic reset timer for use in the Fig. 18 control diagram; Fig. 20 is a control diagram in which a pressure

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control responsive to the steam pressure in the sterilizing chamber terminates the sterilizing cycle in either the "fast" exhaust (utensil) or "slow" exhaust (solution) position. Fig. 21 is a perspective of the timer for the Fig. 20 control; Fig. 22 is a perspective of the cam operated contacts on the valve shaft; Figs. 23a, 23b, 23c, and 23d are perspectives of the selector switch for the Fig. 20 control; Fig. 24 is a control diagram for a fully automatic control in other respects similar to the Fig. 20 control; Fig. 25 is a perspective of the timer for the Fig. 24 control; Fig. 26 is a perspective of the cam operated contacts on the valve shaft; Fig. 27 is a control diagram for a sterilizer having a single exhaust position; Fig. 28 is a perspective of the valve and the associated drive therefor, and Fig. 29 is a perspective of a manual reset timer.

Referring to the drawings, 1 indicates the sterilizer chamber; 2 indicates the door through which the chamber is loaded and unloaded; 3 indicates a steam jacket around the sterilizer chamber, and 4 indicates the steam line through which the jacket is continuously supplied with steam under the control of a shut-off valve 5. In the lower part of the sterilizing chamber is a drain line 6 leading to a steam trap 7. In this drain line is a thermostatic bulb 8 which is associated with a bellows 9 controlling a switch 10 which is closed only after the temperature in the drain line reaches the desired sterilizing temperature. The thermostatic bulb 8 is, in effect, used to prevent the starting of the sterilizing cycle until after the temperature has reached the desired value.

The sterilizing chamber is controlled by a valve 11 conveniently mounted on top of the jacket. The valve has a casing 12 provided at its lower end with a fitting 13 threaded into a complementary fitting 14 on the jacket. As shown more clearly in Fig. 3, the casing is divided into a chamber 15 which is at all times connected to the steam jacket through the fitting 13, a chamber 16 which is at all times connected to the sterilizing chamber 1 through a fitting 17 connected to a line 18, and an exhaust chamber 19 at all times connected to an injector nozzle 20 and a Venturi ejector fitting 21. A sidewall of the casing 12 has a valve seat 22 provided with a port 23 leading to the chamber 16, a port 24 leading to the chamber 15, a port 25 leading to the exhaust chamber 19, and a port 26 outside the machined surface of the valve seat 22 leading to the ejector nozzle 21. The valve seat is enclosed by a bonnet 27 suitably bolted to the casing and hav-

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ing a stuffing box 28 for a shaft 29 for rotating a valve disc 30. The driving connection to the valve disc is effected through arms 31 fixed to the inner end of the shaft 29 and pins 32 and 33 fixed to the valve disc. Pin 32 is solid and is diametrically opposite the pin 33 which has a restricted bore 34. The valve disc 30 is biased against the valve seat 22 by a spring 35 diagrammatically indicated around the shaft 29.

As shown more clearly, Figs. 4-13, inclusive, the valve disc 30 has five equally spaced ports corresponding to the number of positions the valve disc occupies. In the "off" position of the valve disc shown in Figs. 4 and 5, a port 36 extending through the valve disc registers with the port 23 in the chamber 16 which leads through the fitting 17 and the line 18 to the sterilizing chamber 1. In this position a port 37 in the valve disc which carries the hollow pin 33 registers with the port 25 connected to the exhaust chamber 19. In the "off" position the sterilizing chamber 1 is accordingly vented to the atmosphere. In the "off" position, the port 24 leading from the jacket chamber 15 is blocked so that the steam within the jacket is shut off.

In the "sterilize" position of the valve disc shown in Figs. 6 and 7, a way 38 in the valve disc connects the ports 23 and 24. In this position steam from the jacket flows in the direction of arrow 39 into the port 24 through the way 38 and out through the port 23 in the direction of the arrow 40. This admits the sterilizing steam to the chamber 1. Also in the "sterilize" position a port 41 through the valve disc registers with the port 25 leading to the exhaust chamber 19. The port 41 merely vents the bonnet 27 to the atmosphere.

In the "slow exhaust" position of the valve disc shown in Figs. 8 and 9 the port 24 is shut off. This cuts off the flow of steam from the jacket. The port 23 leading from the sterilizing chamber is connected through the port 37 and the restricted passageway 34 to the valve bonnet 27. This permits a flow of steam from the sterilizing chamber 1 to the valve bonnet 27. The steam in the valve bonnet flows either through the passageway 26 or through a port 42 which registers with the port 25 leading to the exhaust chamber 19. The passageway 34 is sufficiently restricted so that the exhaust of steam from the sterilizing chamber 1 takes a sufficient length of time so that boiling or bubbling of sterilized solutions is prevented.

In the "fast exhaust" position shown in Figs. 10 and 11 the port 24 is closed, the port 23 is connected through the port 41 to the valve bonnet 27 and the exhaust chamber port 25 is connected to the valve bonnet through the port 36. The ports 36 and 41 are of such size that the steam from the sterilizing chamber is quickly exhausted. The fast exhaust will ordinarily be completed in less than two minutes. The fast exhaust is desirable for solid materials such as bandages and utensils.

In the "dry" position of the valve shown in Figs. 12 and 13 the port 23 leading from the sterilizing chamber 1 is connected through the port 42 to the valve bonnet 27. The port 24 leading from the jacket is connected through the way 38 to the port 25 leading to the injector nozzle 20. High pressure steam from the jacket accordingly flows into the vent port 25 and out through the nozzle 20 in the direction indicated by the arrows 43. As is more clearly shown in Fig. 2, the discharge of high pressure steam

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through the nozzle 20 has a Venturi action which produces a suction in the passageway 26. Since in this position the passageway 26 is connected to the sterilizing chamber, the suction results in a vacuum within the sterilizing chamber which tends to vaporize residual moisture in the sterilized material. This drying action is desirable in the case of fabrics. The degree of vacuum produced within the sterilizing chamber may be limited by a vacuum breaker.

The valve disc may be rotated sequentially through the position illustrated in Figs. 4-13, inclusive, manually by means of a knob 44 fixed to the shaft 29. An overrunning clutch indicated diagrammatically as a pawl and ratchet 45 allows manual operation and prevents reverse rotation of the valve disc. In sterilizing solutions the valve disc will ordinarily be turned first to the "sterilize" position, then to the "slow exhaust" position, and finally to the "off" position. In sterilizing metallic articles such as instruments, the knob will be turned first to the "sterilize" position, second to the "fast exhaust" position, and finally to the "off" position. There is no need for a slow exhaust in the sterilizing of instruments, nor is there any need for a final drying operation since the residual heat in the instruments quickly evaporates moisture. In the sterilizing of fabrics the valve is turned first to the "sterilize" position, second to the "fast exhaust" position, third to the "dry" position, and finally to the "off" position. The fast exhaust quickly removes the steam from the sterilizing chamber. The drying cycle follows the fast exhaust produces a vacuum within the sterilizing chamber which causes the evaporation of residual moisture within the fabric.

Figs. 14 through 19 illustrate a control by which the valve is automatically moved through the various positions. The control has a panel 45a which is conveniently mounted on top of the sterilizer. On the panel are temperature indicators 46 and 47 respectively indicating the temperature in the jacket and chamber, red, yellow and green signal lights, 48, 49, and 50 indicating the various stages of the sterilizing cycle, a timer setting knob 51 for setting the time of the sterilizing, and a selector knob 52 for selecting the cycle to be automatically carried out, or for cutting out the automatic control so that the sterilizer can be manually controlled. The valve control knob 44 is located in front of the panel 45a and the panel carries suitable markings around the knob to indicate the position of the valve.

During the operation of the automatic control the valve shaft 29 is driven by a gear motor 53 having a pinion 54 on its low speed shaft 55 which drives a sprocket 56 loose on the valve shaft 29 through a chain 57. The driving connection between the sprocket 56 and the valve shaft 29 is effected through the pawl and ratchet 45 which prevents reverse rotation of the valve shaft. The ratchet is fixed to the valve shaft and the pawls are shown fixed to the sprocket. The gear reduction in the motor 53 is sufficient to prevent reverse rotation of the motor shaft 55. Whenever the motor 53 is energized the valve shaft 29 is rotated in a clockwise direction as viewed in Fig. 16.

The timer for the control may be either of the resetting or non-resetting type. The non-resetting timer illustrated in Fig. 17 comprises a synchronous motor 59 driving a shaft 60 on which are fixed cams 61, 62, and 63 controlling

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switches 64, 65, and 66. The timer setting knob 51 is fixed directly to the shaft 60. In Fig. 17 the timer is shown in the "off" position in which cam followers 64a, 65a, and 66a rest respectively in lowered sections 61a, 62a, and 63a of the cams. In this position contacts 64b, 65b, and 66b are closed and contacts 64c and 66c are open. Upon turning the knob 51 in a counter-clockwise direction as viewed in Fig. 3, the cam followers 64a, 65a, and 66a are simultaneously moved to the raised portions 61b, 62b, and 63b of the cams, thereby simultaneously shifting the position of the contacts. When the cam followers are on the raised portions of the cams, the contacts 64b, 65b, 66b are opened and the contacts 64c and 66c are closed. The design of the timer motor is such that the cam shaft 60 may be advanced relative to the timer motor 59 by turning the knob 51. This permits the operator to select any length of timing cycle from the maximum down to the minimum. In the timer control illustrated, the maximum length of timing for operation of the switch 64 from 64c to 64b is forty five minutes. The operator may select any portion of this time.

In the automatic reset timer illustrated in Fig. 19, the motor 59 drives the cam shaft 60 through a timer clutch 67 normally biased to the open position by a coil spring 68 and closed by a solenoid 69. The cam shaft 60 is normally biased toward the maximum time position by a coil spring 70. Whenever the clutch 67 is disengaged the cam shaft 60 is rotated back toward the maximum time position. The cam shaft is stopped in the desired position by a knob 51a which serves solely to select the time. The knob 51a has a pin 72 which cooperates with a pin 73 on the cam shaft to limit the amount of reverse or resetting movement of the cam shaft. In other respects the operation of the resetting timer is the same as in the direct drive timer illustrated in Fig. 17. In the direct drive timer the knob 51 indicates the position of the timer. In the resetting timer the knob 51a does not indicate the position of the cam shaft 60 but merely indicates the maximum time for which the timer has been set. If it is desired that the position of the cam shaft be indicated, a separate indicator can, of course, be supplied on the cam shaft 60. This will indicate the remaining time of the time controlled operation.

The selector switch shown in Fig. 17a comprises a shaft 74 carrying the knob 52 and on which is fixed a disc 75 carrying switches 76, 77, and 78. In the "manual" position shown, the switches are all open. In the "fabric" position of the selector knob 52 the switch 76 is closed on contact 76a, the switch 77 is closed on contact 77a, and switch 78 is closed on contact 78a. In the "utensil" position of the selector knob 52, the switch 76 is closed on contact 76a, the switch 77 is open, and the switch 78 is still closed on the contact 78a. In the "solution" position of the selector knob 52, the switch 76 is open, the switch 77 is closed on contact 77b, and the switch 78 is still closed on the contact 78a.

The valve motor 53 is controlled by cam operated switches 79, 80, 81, and 82 controlled by a cam 83 on the valve shaft 29. The switches are illustrated in the "off" position of the valve. In this position a projection 84 on the cam 83 opens the switch 79 which is otherwise normally closed. As the cam 83 rotates the projection 84 successively cooperates with the switches 80, 81, and 82 and shifts the switches from the position illus-

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trated. For example, in the position illustrated the switch 80 has contact 80a open, and contacts 80b and 80c closed. When the projection 84 engages the switch 80 the switch is shifted to the position in which the contact 80a is closed and the contacts 80b and 80c are open. The switches 81 and 82 have contacts 81a and 82a which are normally open and which are closed when the projection 84 on the cam moves under the switches.

When the selector knob 52 is in the "manual" position, the switch 78 in series with the power line 84a is opened. This opens the circuit to the entire automatic control for the sterilizer and permits the operator to manually select any operation in the sterilizer cycle by turning the knob 44. Because of the pawl and ratchet 45 the operator can only turn the knob 44 in a clockwise direction as viewed in Figs. 15 and 16.

In the other positions of the selector knob 52, the switch 78, 78a, is closed and the operation of the sterilizer is controlled by the automatic control. Since the sterilizing cycle is somewhat different for each position of the selector knob 52, the complete cycle will be traced for each position of the selector knob.

In the "fabric" position of the selector knob 52, switch 76 is closed on contact 76a, switch 77 is closed on contact 77a, and switch 78 is closed on contact 78a. After loading the sterilizer chamber 1 and locking the door 2 to the closed position, the operator starts the sterilizing cycle by first turning the timer knob 51 to the desired sterilizing time and then turning the valve knob 44 to the "sterilize" position. If the valve knob 44 is turned to the "sterilize" position before the timer knob 51 has been set to the desired sterilizing time, the control automatically prevents the starting of the sterilizing cycle. The movement of the knob 44 to the "sterilize" position actuates the switch 80 from the position illustrated in which the contacts 80b and 80c are closed, to a position in which the contact 80a is closed and the contacts 80b and 80c are open. Since in the "off" position of the timer knob 51, the switch 64 is closed on the contact 64b, the yellow signal light 49 lights and the valve motor is energized through the contact 80, 80a, causing rotation of the valve past the "sterilize" position. As soon as the valve moves past the "sterilize" position the contacts 80, 80a, open and the contacts 80b and 80c close. The closing of these contacts energizes a circuit to a buzzer 85 and to the green light 50 through the contacts 66, 66b. A failure of the operator to set the timer knob 51 before turning the valve knob 44 to the sterilizing cycle accordingly results in almost simultaneous lighting of the yellow and green signal lights 49 and 50 and the sounding of the buzzer 85 which ordinarily comes in only at the end of the sterilizing cycle.

If the timer is of the automatic resetting type, illustrated in Fig. 19, of course the operator need not reset the timer knob 51a unless the length of the sterilizing cycle is to be changed. With the automatic reset timer the timer cam shaft 60 automatically returns to the position selected by the timer knob 51a whenever the timer clutch solenoid 69 is de-energized, thereby causing the opening of the timer clutch 67. With the automatic reset timer of Fig. 19, the operator starts the sterilizing cycle by turning the knob 44 to the "sterilize" position.

If the timer has been set to the desired sterilizing time, either manually or automatically,

the turning of the valve knob to "sterilize" causes the lighting of the red signal light 48 because the switch 64 is closed on contact 64c. In the set position of the timer, the contact 65b is open, and the switch 66 is closed on the contact 66c, closing the circuit to the timer motor. The timer motor starts when the temperature in the exhaust line 6 from the sterilizing chamber 1 rises to the desired temperature. At this point the bellows 9 expands and closes the switch 10, thereby supplying power to the timer motor through contact 66c. The thermostatic switch 10 insures the proper sterilizing time. At the end of the timing period selected, the timer knob 51 points to 0 and the timer shaft 60 has turned to the position in which the cam follower 64a drops off the raised portion 61b of the cam 61 onto the lowered portion 61a. This moves the switch 64 from the contact 64c to the contact 64b and energizes the yellow signal light 49. The closing of the contact 64b also completes the circuit through the switch 80 and contact 80a to the valve motor 53 causing rotation of the valve motor from the "sterilize" position. Upon reaching the "slow exhaust" position the switch 81 closes on contact 81a and the switch 80 moves away from contact 80a and closes contacts 80b and 80c. Because the selector switch 76 in the "fabric" position is closed on the contact 76a the valve motor continues rotating past the "slow exhaust" position until it reaches the "fast exhaust" position in which the switch 81 opens contact 81a and the switch 82 is closed on contact 82a. In the "fast exhaust" position the valve occupies the position shown in Figs. 10 and 11 in which the steam within the sterilizing chamber is exhausted through the port 41 to the valve bonnet and through the port 36 and passageway 26 to the atmosphere. At the end of the fast exhaust cycle, which is ordinarily timed for the order of two minutes, the cam follower 65a moves from the raised portion 62b of the cam 62 onto the lowered portion 62a and effects the closing of switch 65 on contact 65b. Since the selector switch 77 in the "fabric" position is closed on the contact 77a and the switch 82 is closed on the contact 82a, a circuit is completed to the valve motor through the switch 64, contact 64b, switch 80, contact 80b, switch 65, contact 65b, switch 77, contact 77a, switch 82, contact 82a to the motor 53. This causes the driving of the motor 53 until the valve has turned to the "dry" position illustrated in Figs. 12 and 13. The valve stops at this position because at this position the cam switch 82 is moved away from the contact 82a. In the "dry" position steam from the jacket is fed to the injector nozzle 20 and the suction produced by the discharge of the high pressure steam into the throat of the ejector Venturi nozzle 21 draws a vacuum in the sterilizing chamber which evaporates residual moisture. The drying cycle continues until the cam follower 66a drops from the raised portion 63b of the cam 63 onto the lowered portion 63a. When this happens, which may ordinarily be from five to eight minutes after the end of the fast exhaust cycle, the switch 66 is moved away from the contact 66c to the contact 66b. This closes a circuit to the buzzer 85 and also to the green signal light 50 which signals to the operator the end of the sterilizing cycle. At this time the operator manually turns the knob 44 to the "off" position, thereby cutting off the steam supply to the injector nozzle 20 and opening the switch 79 to de-energize the buzzer and lights.

When the selector knob 52 is in the "utensil"

position the start of the sterilizing cycle is the same as in the "fabric" position. The turning of the knob 44 to the "sterilize" position after the timer knob 51 has been set for the desired sterilizing time causes the closing of the switch 79, the closing of the switch 64 on contact 64c, and the closing of switch 80 on contact 80a and the opening of switch 80 from contacts 80b and 80c. At the end of the pre-selected time for the sterilizing cycle which is indicated when the knob 51 comes opposite zero on the time dial, the switch 64 moves away from the contact 64c and closes on the contact 64b, lighting the yellow signal light 49 and energizing a circuit to the valve motor 53 through the contacts 80, 80a. Because in this position of the selector switch, contact 75 is closed on contact 76a, the valve motor continues to drive the valve shaft 29 until the switch 80 is opened from the contact 80a, and the switch 81 is opened away from the contact 81a, and the switch 82 is closed on the contact 82a. In this position the valve is in the "fast exhaust" position illustrated in Figs. 10 and 11. At the end of the time for the "fast exhaust," the cam follower 65a drops off the high portion 62b of the cam 62 onto the lower portion 62a and closes the switch 65 against the contact 65b. Since the selector switch 77 is closed on the contact 77b, this completes a circuit from one side of the line through switch 64, contact 64b, switch 80, contact 80b, switch 65, contact 65b, switch 77, contact 77b to the buzzer 85 and green light 50. This signals to the operator the end of the sterilizing cycle. The operator shuts off the buzzer by manually turning the dial knob 44 to the "off" position in which the switch 79 is open, thereby breaking the circuit buzzer and light.

When the selector knob 52 is in the "solution" position the sterilizing operation starts in the same manner as in the other positions by the turning of the knob 44 to the "sterilize" position after the timer knob 51 has been set for the desired sterilizing time. At the end of the sterilizing time, when the cam follower 64a drops off the raised portion 61b of the cam 61 onto the lowered portion 61a and closes the switch 64 onto the contact 64b, the yellow signal light 49 lights and the valve motor 53 is energized through the switch 80 and contact 80a. In this position of the selector switch the switch 76 is open. Accordingly, the valve motor merely turns the valve from the "sterilize" position to the "slow exhaust" position. In the "slow exhaust" position illustrated in Figs. 8 and 9, the switch 80 is closed on contacts 80b and 80c. Because switch 76 is open, no further energizing of the valve motor 53 is possible. At the end of the "slow exhaust" time which occurs when cam follower 66a drops from the raised portion 63b of cam 63 onto the lowered portion 63a, the switch 66 is moved from contact 66c to contact 66b, thereby breaking the circuit to the timer motor and closing a circuit to the buzzer 85 and green light 50. The operator opens the circuit to the buzzer by manually turning the valve knob 44 to the "off" position in which the switch 79 is open.

So far the control has been described for a direct drive timer such as illustrated in Fig. 17. With the automatic resetting timer such as is illustrated in Fig. 19, the operation is the same as that previously described. With the direct drive timer the solenoid 69 controlling the closing of the timer clutch 67 obviously will be omitted. When the automatic resetting timer is used the timer motor is energized through the thermo-

static switch 10 and the switch 66 which is closed on contact 66c until the timer reaches the "off" position. There are only two conditions on which the operation of the automatic reset timer is different from the direct drive timer. The first condition in which the automatic resetting timer has a different operation is upon failure of the steam pressure during the sterilizing cycle. Under these conditions the thermostatic switch 10 opens and de-energizes the timer clutch solenoid 69. The timer clutch 67 is then opened by the coil spring 68 and the timer cam shaft 60 is rotated back to the beginning of the sterilizing cycle selected by the position of the knob 51a. Another condition in which the operation of the automatic resetting timer is different from the direct drive timer is upon failure of the power supply. Failure of the power supply de-energizes both the timer motor 59 and the timer clutch solenoid 69 causing the resetting of the timer back to the beginning of the sterilizing cycle. These are safety features. Another advantage of the automatic resetting timer is that upon manually turning the valve knob 44 to the "off" position the timer solenoid 69 is de-energized, thereby causing the resetting of the timer cam shaft 60 back to the position selected by the knob 51a. This means that with the automatic resetting timer the operator need not first pre-select the sterilizing time before turning the knob 44 to the "sterilize" position.

The control illustrated in Figs. 20 through 23d, inclusive, makes use of a number of parts which have been previously described and which are indicated by the same reference numerals. The principal differences in the Fig. 20 control are the omission of contacts 85b and 85c in the cam operated switch 80, the omission of the cam 62 and the associated switch 65, 65b, the addition of a normally closed contact 82b to the cam operated switch 82, the extension of the selector switch contact 17b so that the contact 17, 17b is closed in both the "fast" exhaust (utensil) and "slow" exhaust (solution) positions, and the addition of a normally closed pressure switch 86 having a contact 86a normally held in the closed position by a spring 87. Steam pressure from the sterilizing chamber is admitted through a conduit 88 to the underside of the pressure diaphragm 89. Whenever the steam pressure is less than a low value, for example, 1/2 lb. per square inch, the contact 86a is closed by the spring.

As in the previously described control, in the "manual" position the switch 18 is open so that none of the parts of the control is operated.

In the "fabric" position the selector switch contact 18 is closed, the selector switch contact 17 is closed on contact 17a and the selector contact 76 is closed on contact 76a. The operator starts the sterilizing cycle by first turning the timer knob 51 to the desired sterilizing time and then turning the knob 44 from the "off" to the "sterilize" position. Setting the timer knob 51 to the sterilizing time moves the contact 64 from the contact 64b to the contact 64c and also moves the contact 65 from the contact 66b to the contact 66c. Upon turning the knob 44 from the "off" position to the "sterilize" position, steam is admitted to the sterilizing chamber and the switch 19 is closed on contact 19a and the switch 80 is closed on contact 80a. As soon as the temperature in the sterilizing chamber reaches the desired value the switch 10 is closed by the thermostatic bulb 8 and bellows 9 and the timer motor 59 is energized through switch 66 and

contact 66c, starting the rotation of the cams 61 and 63 which determine the time of the sterilizing cycle. At the end of the sterilizing time the cam follower 64a drops off the raised portion 61b of the cam 61 and moves the switch 64 from the contact 64c to the contact 64b. This energizes the amber light 49, signaling the end of the sterilizing operation and also energizes the valve motor 53 through the closed contact 80, 80a. When the valve shaft 29 reaches the "slow" exhaust position, the switch 80 moves away from the contact 80a and the switch 81 closes on the contact 81a. Since the selector switch 76 is closed on contact 76a the valve motor 53 continues its rotation and moves the valve shaft 29 through the "slow" exhaust position to the "fast" exhaust position where the switch 81 opens and the switch 82 moves from the contact 82b to the contact 82a. In the "fast" exhaust position, the pressure in the sterilizing chamber is rapidly reduced and on reaching a safe low value the switch 86 is closed on the contact 86a by the spring 87 which overcomes the pressure exerted on the diaphragm 89. The drop in pressure is accompanied by opening of the thermostatic switch 10 de-energizing the timer and stopping the rotation of the cams 61, 63. The time required for exhaust is controlled by the pressure switch and not by the timer. The closing of the switch 86 completes a circuit to the valve motor 53 extending through contacts 64, 64b, contacts 86, 86a, contacts 17, 17a, and contacts 82, 82a. This causes the rotation of the valve shaft 29 from the "fast" exhaust position to the "dry" position where steam is supplied to the injector nozzle 20. In the "dry" position the switch 82 moves away from contact 82a and is closed on contact 82b which energizes the timer motor 59 through the pressure switch contacts 86, 86a and the selector switch contacts 17, 17a. Rotation of the timer continues independent of the thermostatic switch 10 until the cam follower 66a drops off the elevated portion 63b on the cam 63 and moves the switch 66 from the contact 66c to the contact 66b. The closing of the contact 66b energizes the green light 50 and the buzzer 85 which signals the end of the sterilizing cycle to the operator.

In the "utensil" position on the selector switch the operation is the same as in the "fabric" position up to the point at which the pressure in the sterilizing chamber drops to a point at which the contact 86 closes on the contact 86a. At this time, since the selector switch 77 is closed on contact 17b, the signal light 50 and buzzer alarm 85 are energized signaling the end of the sterilizing cycle to the operator.

In the "solution" position of the selector switch the operation starts the same as in the "fabric" position. However, since the selector switch contact 76 is not closed on the contact 76a, the valve shaft 29 cannot move past the "slow" exhaust position. In the "slow" exhaust position the steam in the sterilizing chamber is slowly exhausted through the restricted port 34 so that the temperature of solutions drops at the same rate as the temperature in the sterilizing chamber. The timer 59 continues its rotation until the thermostatic switch 10 is opened by the drop in temperature. This occurs before the cam follower 66a drops off the elevated portion 63b of the cam 63, so that the timer does not control the duration of the "slow" exhaust. The duration of the "slow" exhaust cycle is controlled by the pressure switch 86 which closes on contact 86a when the pressure reaches the desired low

value at which it is safe to open the sterilizing door. The closing of the pressure switch 36 on the contact 86a energizes the green signal light 50 and the buzzer alarm 85 through the selector switch contacts 77, 77b. Having the duration of the exhaust cycle determined by pressure rather than by time permits a more accurate control. In the "fast" exhaust position the pressure control saves time since it is no longer necessary to allow sufficient time to take care of all loads. In the case of solutions, this is particularly advantageous as with large loads the time required for exhausting the sterilizing chamber is much greater than with small loads.

The control illustrated in Figs. 24-26 makes use of a number of parts which have been previously described and which are designated by the same reference numerals. The principal difference in the Fig. 24 control is the use of an automatic reset timer as illustrated in Fig. 19, the omission of the cam 62 and the associated switch 65, 65b, the change in position of the contact 79a and the addition of a contact 79b so the circuit to the valve motor may be closed at the end of the cycle; the addition of a contact 81b to prevent resetting of the timer after the end of the sterilizing operation, the extension of the selector switch contact 77b so the contact 77, 77b is closed in both the "fast" and "slow" exhaust position, and the addition of the normally closed pressure switch 86 having a contact 86a normally held in the closed position by a spring 87.

In the Fig. 24 control, the selector switch is that illustrated in Figs. 23a-23d. Before starting any cycle of operations, the selector switch is in the "manual" or "off" position. In this position the circuit to the timer clutch 69 is broken and the spring 70 returns the cam shaft to the "start" position determined by the knob 51a which selects the sterilizing time.

In the sterilizing of fabrics, after the sterilizer has been loaded and the door closed, the operator turns the selector switch from "manual" to "fabric." This closes the switch 76 and causes the lighting of the red light 48 through the contacts 64; 64c which are closed due to the resetting by the spring 70. The valve motor 53 is now energized through contacts 79, 79a and rotates the valve shaft 29 from the "off" to the "sterilize" position. Upon reaching the "sterilize" position, contacts 79a, 80b, 80c open and contacts 80a, 79b close. The rise in temperature accompanying the admission of steam causes the closing of the switch 10 and starting the timer. If at any time during the sterilizing operation the temperature drops below the desired sterilizing temperature, the switch 10 opens and the timer is reset to the starting point. This insures continuous sterilizing at or above the desired sterilizing temperature for the full interval selected by the knob 51a.

At the end of the sterilizing time, the cam follower 64a drops off the raised portion 61b of the cam 61 and moves the switch 64 from contact 64c to contact 64b. This energizes the amber light 49 signaling the end of the sterilizing operation and also energizes the valve motor 53 through the closed contacts 80, 80a. When the valve shaft 29 reaches the "slow" exhaust position, the switch 80 moves away from the contact 80a and the switch 81 moves away from contact 81b and closes on contact 81a. Since the selector switch 76 is closed on contact 79a, the valve motor 53 continues its rotation and moves the shaft 29 through the "slow" exhaust position to the "fast" exhaust position in which the switch 81 moves

away from the contact 81a and closes on the contact 81b and the switch 82 closes on contact 82a. The closing of the switch 81 on the contact 81b establishes a circuit to the timer motor 59 and to the timer clutch solenoid 69 so that upon opening of the thermostatic switch 10 due to the rapid reduction in temperature in the sterilizing chamber, the timer is not de-energized and reset by the spring 70. Upon reduction in pressure in the sterilizing chamber to the value at which the door 2 may be safely opened, the pressure switch 86 closes on contact 86a and since the selector switch 77 is closed on contact 77a, the valve motor 53 is energized through contacts 80, 80b, 86, 86a, 77, 77a, 82, and 82a causing rotation of the valve shaft from the "fast" exhaust position to the "dry" position. In the "dry" position contacts 82 and 82a are opened. Rotation of the timer continues until the cam follower 65a drops off the raised portion 63b on the cam 63 and moves the switch 66 from the contact 66c to the contact 66b. The closing of the contact 66b energizes the green light 50 and the buzzer 85 and also energizes the valve motor 53 through the closed contact 79b. The valve motor turns until the valve is moved from the "dry" to the "off" position in which the contact 79b is opened and the contact 79a is closed. The turning of the valve to the "off" position cuts off the supply of steam but does not stop the buzzer or de-energize the green light 50. The buzzer and green light are de-energized by turning the selector switch to the "manual" position in which the switch 78 is opened. This de-energizes all of the signal lights and buzzer and also de-energizes the timer clutch solenoid 69 permitting resetting of the timer cam shaft to the position illustrated in Fig. 25 in which the contact 66 is closed on contact 66c and the contact 64 is closed on contact 64c.

In the "utensil" position the operation is the same as in the "fabric" position up to the point at which the pressure in the sterilizing chamber drops to the value at which the door 2 can be opened resulting in the closing of the contact 88 on the contact 86a. At this time, since the selector switch 77 is closed on contact 77b, the signal light 50, the buzzer alarm 85, and the valve motor 53 are energized. The valve motor rotates the valve to the "off" position at which time the contact 79b is open and the contact 79a is closed. The operator shuts off the buzzer by returning the selector switch to the "manual" position.

In the "solution" position of the selector switch the operation starts the same as in the "fabric" position. However, since the selector switch contact 76 is not closed on the contact 76a, the valve shaft 29 cannot move past the "slow" exhaust position in which contact 81 is closed on contact 81a and is moved away from contact 81b. As soon as the temperature in the sterilizing chamber drops below the sterilizing value, the thermostatic switch 10 opens, de-energizing the timer clutch solenoid 69 and also de-energizing the timer motor 59. The spring 70 returns the timer cam shaft to the starting position in which the contacts 64, 66 are closed on the contacts 64c and 66c. The resetting of the timer cam shaft has no effect upon the operation of the sterilizer. Nothing happens until the temperature within the sterilizing chamber drops to the value at which the door 2 can safely be opened. At this time the switch 86 closes on contact 86a and energizes the green signal light 50, the buzzer alarm 85, and the valve motor 53 through the contact 77b and switch 79. The valve motor turns until the valve

shaft 29 is moved to the "off" position at which the contact 79b is open and the contact 79a is closed. The operator shuts off the buzzer alarm by turning the selector switch to the "manual" position.

In the control shown in Figs. 27 to 29, inclusive, the sterilizer has two positions, namely "sterilize" and "exhaust." The valve may be the same as that illustrated in Figs. 4 to 13, inclusive, where the ports 25, 33, 34, 36, and 42 are plugged. With these changes the valve will have only the "sterilize" position illustrated in Figs. 6 and 7 and the "fast" exhaust position illustrated in Figs. 10 and 11. With the elimination of the additional sterilizing operations, the number of switches operated by the cam 83 is also decreased. It is only necessary to have a switch 80 closed on contact 80a in the "sterilize" position and a normally open switch 82 which closes on contact 82a in the "fast" exhaust position simultaneously with the opening of the switch 80. The timer is also simplified since it is only necessary to have the cam 61 which controls the length of the sterilizing operation to the time selected by the knob 51. In the case of a manually reset timer the switch 64 is normally closed on the contact 64b. The switch 64 is closed on the contact 64c when the knob 51 is turned to select the timed duration of the sterilizing operation. In the case of the automatic reset timer the switch 64 can be normally closed on the contact 64c since that is the position to which the timer cam shaft would be returned by the resetting spring 70. In other respects the control is similar to the previously described controls, corresponding parts being indicated by the same reference numerals.

To start the sterilizing cycle, the operator, if the timer is of the manually reset type, turns the knob 51 to the desired time duration of the sterilizing cycle and then turns the valve knob 44 to the "sterilize" position. If the timer is of the automatic reset type and the knob 51a is already set at the correct sterilizing time, the operator need only turn the valve knob to the "sterilize" position. When the valve knob is in the "sterilize" position the switch 82 is away from the contact 82a and the switch 80 is closed on the contact 80a. The operator starts the sterilizing cycle by closing the switch 90. As soon as the temperature within the sterilizing chamber rises to the sterilizing value, the switch 10 closes energizing both the timer motor 59 and the timer clutch solenoid 69 if the timer is of the automatic resetting type. This energizes the red signal light 48 indicating that the sterilizing operation is in progress. At the end of the sterilizing time selected by the knob 51 (or the knob 51a if the timer is of the automatic resetting type) the cam follower 64 drops off the elevated portion 61b of the cam 61 and falls onto the depressed portion 61a thereby opening the switch contact 64c and closing the switch contact 64b. This completes a circuit to the valve motor 53 through the contacts 64, 64b, and 80, 80a. The valve motor rotates until the cam 83 strikes the contact 82 and moves it against the contact 82a. Simultaneously the switch 80 is moved away from the contact 80a thereby de-energizing the valve motor. The yellow signal light comes on simultaneously with the closing of the switch 64 on the contact 64b. If the timer is of the automatic resetting type, the opening of the thermostatic switch caused by the drop in temperature due to the exhaust of steam de-energizes the timer clutch solenoid 69 and causes the resetting of the timer. The reset-

ting of the timer however, has no effect upon the operation. The opening of the contact 64b does not extinguish the yellow signal light 49 since a circuit to the yellow signal light has been completed through the switch 82 and contact 82a by the rotation of the valve shaft 29 to the "exhaust" position. When the pressure within the sterilizing chamber reaches a value low enough so that the door 2 can be opened, the switch 86 closes on the contact 86a completing a circuit to the green light 50 and the buzzer alarm 85. This signals to the operator that the sterilizing operation has been completed and that the load can be removed. To de-energize the buzzer, the operator opens the manually controlled switch 90 which cuts off the power supply.

What we claim as new is:

1. In a sterilizer having a rotary multiport valve movable in sequence to sterilize, slow exhaust, fast exhaust and dry positions, a manually operable control shaft for operating the valve, a motor for driving the shaft in the direction to advance the shaft, an overrunning clutch between the motor and shaft permitting manual movement of the shaft relative to the motor only in the direction to advance the control shaft, motor circuits for energizing the motor for rotating the shaft from each of the positions to a succeeding position, limit switches in the respective circuits operated in each position of the shaft to condition a motor circuit for rotation of the shaft to a succeeding position, time controlled contacts in the motor circuits interrupting the circuits until the lapse of the desired time intervals, and a selector switch having contacts for bridging selected limit switches for the positions to be skipped and other contacts for interrupting the motor circuits for the positions to be eliminated.

2. In a sterilizer, a timer having contacts operated at the end of the sterilizing operation and other contacts respectively operated sequentially at intervals thereafter, a manually operable control shaft sequentially movable to sterilize and to a number of different succeeding positions, a motor in circuit with the timer contacts for driving the shaft in the direction to advance the control, an overrunning clutch between the shaft and motor allowing manual movement forward and preventing backward movement of the shaft relative to the motor, motor control switches opening a motor circuit at each position and conditioning the motor for rotation to a succeeding position, a selector switch in circuit with the timer and control switches for selectively bridging one or more of the control switches to skip the selected position of the control shaft.

3. In a sterilizer, a control shaft manually movable to sterilize, slow exhaust, fast exhaust, dry, and off positions, a motor for advancing the control shaft through said positions, an overrunning clutch between the shaft and motor allowing manual operation and preventing reverse rotation of the shaft, motor control switches operated in the sterilize, slow exhaust, and fast exhaust positions to condition the motor for rotation to a succeeding position, time controlled contacts operated respectively at the end of the sterilizing time to close the motor circuit to cause rotation from the sterilize position and other time controlled contacts operated at the end of the time required for fast exhaust and dry, a signal indicating the end of the sterilizing operations, and a selector switch having alter-

natively operable (1) contacts interrupting the motor circuit at slow exhaust and connecting the "dry" time controlled contacts to the signal, (2) contacts conditioning the motor for operation from slow exhaust to fast exhaust and connecting one of the other time controlled contacts to the signal and (3) contacts conditioning the motor for operation from slow exhaust to fast exhaust and connecting the "fast exhaust" from contacts in the motor circuit to cause operation of the motor to dry and the "dry" time contacts to the signal.

4. In a sterilizer, a rotary valve connected to the sterilizer and having steam admission and exhaust positions, a shaft for rotating the valve, a motor for advancing the shaft from the steam admission to the exhaust positions, a power circuit to the motor including contacts closed in the admission and open in the exhaust position of the valve shaft and time controlled contacts open during and closed after the selected sterilizing time whereby the shaft is advanced to the exhaust position at the end of the sterilizing time, a signal device, and a pressure switch responsive to the steam pressure in the sterilizer actuating the signal upon drop in pressure to a value safe for unloading the sterilizer.

5. In a sterilizer, an electrical resetting timer having a device preventing resetting when energized, valve means controlling the supply of steam for sterilizing and the exhaust of steam at the end of sterilizing, contacts actuated by the timer for controlling actuation of the valve means to sterilize and exhaust conditions, a first power circuit to said device closed through a thermostatic switch closed in response to sterilizer temperature above a safe value whereby upon dropping of the sterilizer temperature below said safe value during sterilize the timer is reset, a second power circuit to said device and a switch in said second power circuit closed in exhaust and open in sterilize whereby resetting of the timer is prevented during exhaust.

6. In a sterilizer, an electrical resetting timer having a device for preventing resetting when energized, a rotary multiport valve for the sterilizer having steam admission, exhaust, and dry positions, a manually operable shaft for operating the valve, a motor for driving the shaft in the direction to advance the shaft, an overrunning clutch between the motor and shaft permitting manual movement of the shaft relative to the motor only in the direction to advance the control shaft, motor circuits for energizing the motor for rotating the shaft from each of the positions to a succeeding position, limit switches in the respective circuits operated in each position of the shaft to condition a motor circuit for rotation of the shaft to a succeeding position, time controlled contacts in the motor circuits interrupting the circuits until the lapse of the desired time intervals, a selector switch having contacts for bridging selected limit switches for the positions to be skipped and other contacts for interrupting the motor circuits for the positions to be eliminated, a first power circuit to said device through a thermostatic switch closed in response to sterilizer temperature above a safe value whereby upon dropping of the sterilizer temperature below said safe value during sterilize the timer is reset, and a second power circuit to said device having a switch therein open in sterilize and closed during exhaust whereby resetting of the timer is prevented during exhaust.

7. In a sterilizer having a rotary multiport valve having steam admission, exhaust, and off

positions, a manually movable shaft for operating the valve, a motor for advancing the shaft, means controlling the rotation of the motor to the steam admission and exhaust positions and the length of time the valve remains in such positions to carry out the desired operations forming the sterilizing cycle, a signal energized at the completion of the sterilizing cycle, and a circuit to the valve motor energized from the signal to cause rotation of the valve to the off position through a switch opened when the valve reaches the off position.

8. In a sterilizer having a rotary multiport valve having steam admission, exhaust, and off positions, a manually movable shaft for operating the valve, a motor for advancing the shaft, means controlling the rotation of the motor to the steam admission and exhaust positions and the time the valve remains in such positions to carry out the desired operations forming the sterilizing cycle, said means including an electrical resetting timer having a device effective when energized to prevent resetting, a circuit to said device through a thermostatic switch closed at sterilizer temperatures above a desired value whereby the timer resets if the temperature during sterilizing drops below the desired value, another circuit to said device through a switch open during the steam admission position of the valve and closed after the steam admission position of the valve, a signal energized at the completion of the sterilizing cycle, and a circuit to the valve motor energized from the signal through a switch opened when the valve reaches the off position.

9. In a sterilizer, a control shaft manually movable to sterilize, slow exhaust, fast exhaust, dry, and off positions, a motor for advancing the control shaft through said positions, an overrunning clutch between the shaft and motor preventing reverse rotation of the shaft, motor control switches operated in the sterilize, slow exhaust, and fast exhaust positions to condition the motor for rotation to a succeeding position, time controlled contacts operated at the end of the sterilizing time to close the motor circuit to cause rotation from the sterilize position, steam pressure controlled contacts operated upon drop in pressure to a value safe to open the sterilizer and other time controlled contacts operated after the pressure contacts, a signal indicating the end of the sterilizing operations, and a selector switch having alternatively operable (1) contacts interrupting the motor circuit at slow exhaust and connecting the pressure controlled contacts to the signal (2) contacts conditioning the motor for operation from slow exhaust to fast exhaust and connecting the pressure controlled contacts to the signal and (3) contacts interrupting the motor at fast exhaust and connecting the pressure controlled contacts to the motor circuit, and connecting the other time controlled contacts to the signal.

10. In a sterilizer, valve means having a control shaft movable to steam admission, exhaust, and off positions, a motor for advancing the shaft, means controlling the rotation of the motor to the steam admission and exhaust positions and the length of time the valve means remains in such positions to carry out the desired operations forming the sterilizing cycle, a signal energized at the completion of the sterilizing cycle, and a circuit to the motor for advancing the shaft to the off position, said circuit being energized from the signal through a switch opened when the shaft reaches the off position.

11. In a sterilizer, a control shaft manually

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movable to steam admission and exhaust positions, a motor for advancing the shaft from the steam admission to the exhaust positions, a power circuit to the motor including contacts closed in the admission and open in the exhaust position of the shaft and time controlled contacts open during and closed after the selected sterilizing time whereby the shaft is advanced to the exhaust position at the end of the sterilizing time, a signal device, and a pressure switch responsive to the steam pressure in the sterilizer actuating the signal upon drop in pressure to a value safe for unloading the sterilizer.

12. In a sterilizer, a control shaft sequentially movable to sterilize, slow exhaust and fast exhaust positions, a motor for advancing the control shaft through said positions, motor control switches operated in the sterilize and slow exhaust positions to condition the motor for rotation to a succeeding position, time controlled contacts operated at the end of the desired sterilizing time to close the circuit to the motor to cause rotation from the sterilize position, and a selector switch selectively interrupting or closing a circuit to the motor through the motor control switch for the slow exhaust position whereby the motor stops in the slow exhaust position when the selector switch interrupts the motor circuit and whereby the motor continues through slow exhaust to fast exhaust when the selector switch closes the motor circuit.

13. In a sterilizer, a control shaft sequentially movable to sterilize, slow exhaust and fast exhaust positions, a motor for advancing the control shaft through said positions, motor control switches operated in the sterilize and slow exhaust positions to condition the motor for rotation to a succeeding position, time controlled contacts operated at the end of the desired sterilizing time to close the circuit to the motor to cause rotation from the sterilize position, a selector switch selectively interrupting or closing a circuit to the motor through the motor control switch for the slow exhaust position where-

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by the motor stops in the slow exhaust position when the selector switch interrupts the motor circuit and whereby the motor continues through slow exhaust to fast exhaust when the selector switch closes the motor circuit, a signal device, and a pressure switch responsive to steam pressure in the sterilizer in the exhaust positions actuating the signal upon a drop in pressure to a value safe for unloading the sterilizer.

14. In a sterilizer, a control having contacts operated at the end of the sterilizing operation and other contacts operated sequentially at a plurality of intervals thereafter, a control shaft movable to sterilize and to a number of different succeeding positions, a motor in circuit with the contacts for rotating the shaft in the direction to advance the control, motor control switches opening a motor circuit at each position and conditioning the motor for rotation to a succeeding position, a selector switch in circuit with the control contacts and motor control switches for bridging the motor circuits for the positions to be skipped and for interrupting the motor circuits for the positions to be eliminated.

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