Sept. 27, 1966 J. B. KLINGEL 3,275,724

METHOD OF AUTOCLAVING CONCRETE BLOCKS

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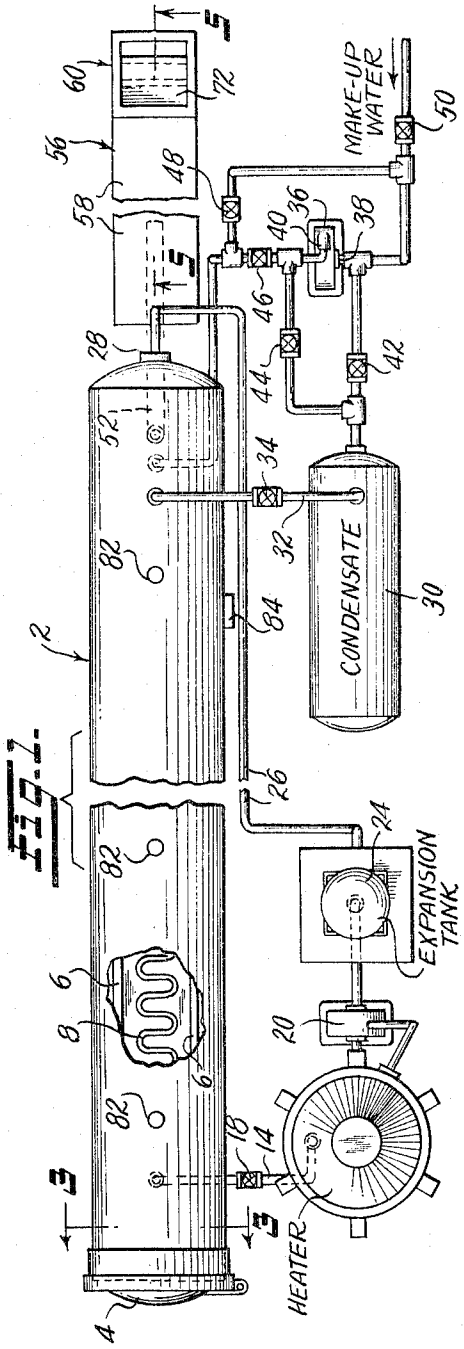


Fig. 1.

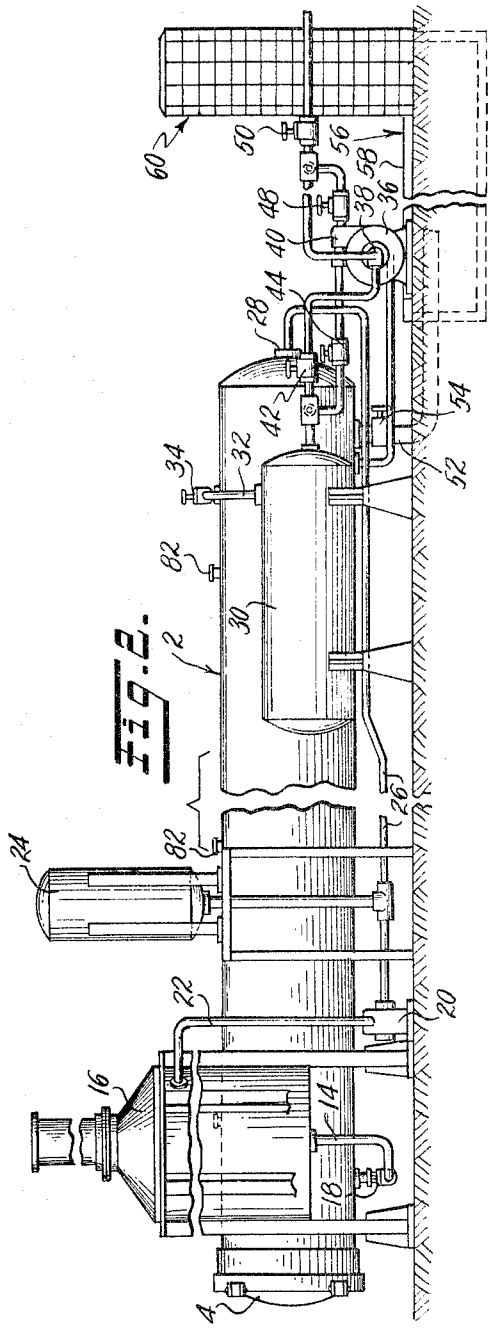


Fig. 2.

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Fig. 3.

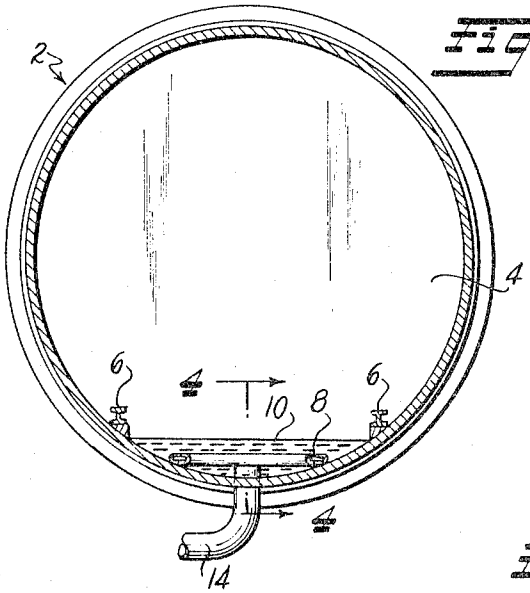


Fig. 4.

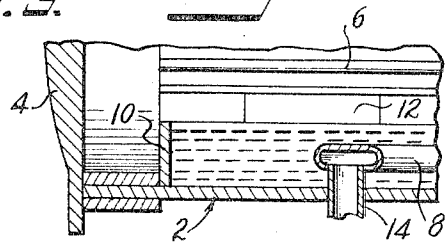


Fig. 5.

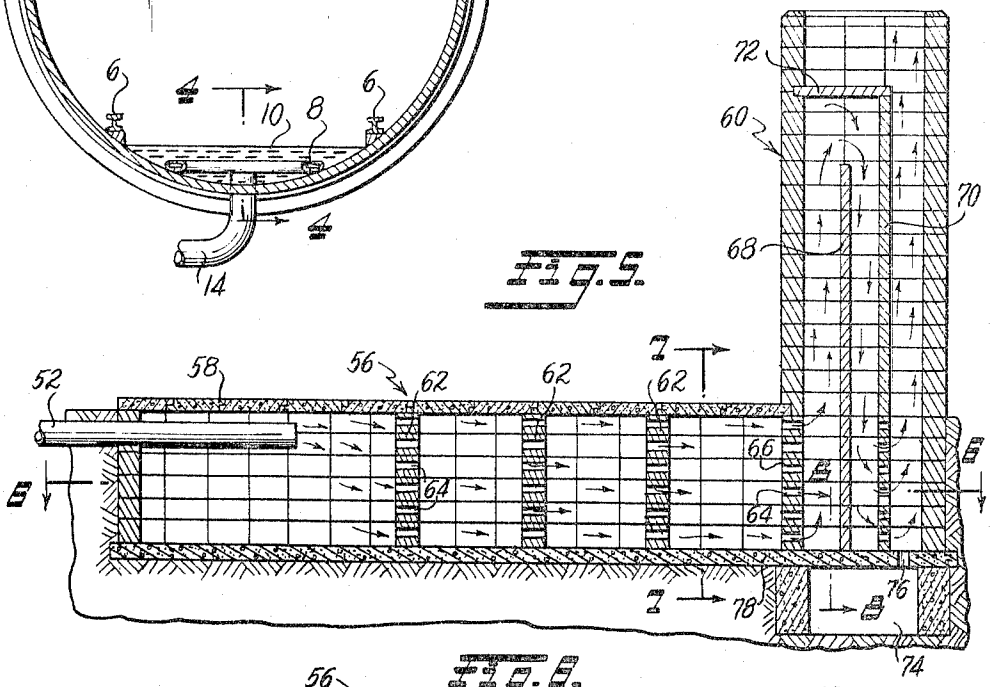


Fig. 6.

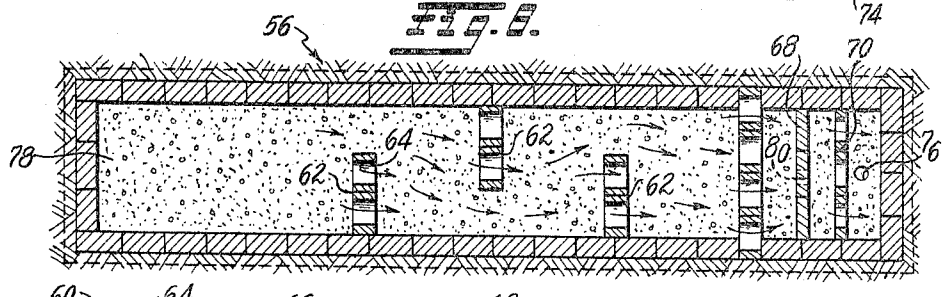


Fig. 7.

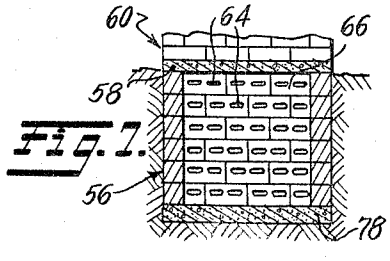
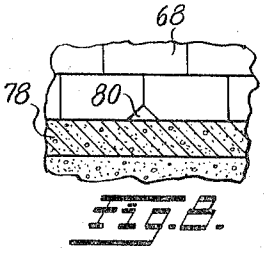


Fig. 8.



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METHOD OF AUTOCLAVING CONCRETE BLOCKS

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Continuation of application Ser. No. 300,129, Aug. 2, 1962, which is a division of application Ser. No. 37,343, June 20, 1960. This application Apr. 2, 1965, Ser. No. 445,181

7 Claims. (Cl. 264—82)

This application is a continuation of my co-pending application Serial No. 300,129, filed August 2, 1962, for Fired Heater Autoclave System, which is in turn a division of application Serial No. 37,343, filed June 20, 1960, and now abandoned.

This invention relates to autoclaves, and to a method of operating the same. The invention is of particular utility in the curing of concrete blocks, and the description herein will refer specifically to such articles; but it is to be understood that the invention is not so limited. The essential features of the invention may be employed in the steam treating of other articles.

In general the invention comprises both method and apparatus, and wherein an autoclave system is provided with a storage tank adjacent the autoclave. The autoclave itself is provided with a dam at the door end, to retain water in the bottom thereof of sufficient depth to cover pipe coils also in the bottom of the autoclave chamber. These coils are supplied with hot oil or other fluid medium, heated at some external location, whereby the water in the bottom of the autoclave is heated and vaporized to build up the desired steam pressure, and to hold that pressure for the predetermined cycle time for the particular articles being treated or cured. During the holding cycle, steam condenses on the sides of the autoclave and on the equipment and material therein, and merely runs down to the bottom thereof where it is again vaporized by the heating coils. At the end of the cycle time, a valve is opened providing communication between the upper portion of the autoclave and the storage tank previously mentioned. This equalizes the pressure in the autoclave and the storage tank, which in the case of curing concrete blocks is of the order of 150 p.s.i. The water in the bottom of the autoclave is at a temperature of about 365° F. When the pressure is equalized in the autoclave and storage tank, a pump is operated to pump the hot pressurized water from the autoclave into the storage tank, and the previously described valve is then closed to seal the storage tank and retain pressure therein. A vent valve communicating with the autoclave is then opened to relieve pressure and exhaust the remaining steam therefrom. The vented steam is directed into a novel muffler tunnel which will be described in greater detail later.

After the pressure in the autoclave is reduced to atmospheric, the door thereof is opened and the cured blocks removed. The autoclave is then charged with a fresh batch of blocks to be cured, and again closed. The pump previously referred to is then operated to pump hot pressurized water from the storage tank into the autoclave; and, since the water is at a high temperature and pressure, when it enters the autoclave at atmospheric pressure, it immediately flashes into steam. Circulation of the heating medium through the water in the bottom of the autoclave is again started, and the previously described cycle is repeated.

In the curing of concrete blocks a substantial amount of water is introduced into the system by evaporation from the blocks themselves. This water also collects in the bottom of the autoclave where it overflows a level control dam and is discharged or collected for reuse. A

suitable liquid level control is provided in the autoclave to replenish the water therein if it should fall below the desired value.

The novel system described briefly above offers many advantages. The fired heater for heating the oil or other heat transfer medium operates at a low pressure; and, since the autoclave itself is an unfired pressure vessel, a licensed fireman or stationary engineer is not required. No high pressure boiler is used. In localities where water is expensive a considerable savings results in the recovery and reuse of condensate and there is no need for feed water treatment or preheating since any scale collects on the outside of the heating coils or the inside of the autoclave and such scale cracks due to differential expansion and contraction and is easily removed. However, the water may be economically treated chemically, which would otherwise be too expensive, and thus eliminate or minimize rack corrosion. The recovery and reuse of condensate permits a very substantial heat conservation with subsequent savings. If desired, blowdown steam can also be condensed and recovered.

It is therefore an object of this invention to provide a method of operating an autoclave system which results in the conservation of heat and water and a substantial acceleration of the cycling time.

Another object of the invention is to provide a method of operating an autoclave system that is highly economical and reliable in operation.

Still another object of the invention is to provide a method and apparatus in an autoclave system whereby hot condensate is stored for reuse in a subsequent cycle.

A further object of the invention is to provide, in an autoclave system, a novel muffler device to eliminate undue noise and disturbance upon blowdown.

Still further and additional objects and advantages will become apparent to those skilled in the art as the description proceeds with reference to the accompanying drawings, wherein:

FIG. 1 is a diagrammatic plan view of an autoclave system according to the present invention;

FIG. 2 is a diagrammatic side view of the apparatus shown in FIG. 1;

FIG. 3 is an enlarged transverse sectional view taken substantially along the line 3—3 of FIG. 1;

FIG. 4 is a further enlarged fragmentary sectional view taken along the line 4—4 of FIG. 3;

FIG. 5 is a vertical sectional view through the muffler tunnel and taken along the line 5—5 of FIG. 1;

FIG. 6 is a horizontal sectional view taken along the line 6—6 of FIG. 5;

FIG. 7 is a fragmentary sectional view taken along the line 7—7 of FIG. 5; and

FIG. 8 is an enlarged fragmentary section taken along the line 8—8 of FIG. 5.

With reference particularly to FIGS. 1 and 2, a more or less conventional autoclave 2 is shown which comprises a tank-like structure defining a pressure chamber having an openable sealing door 4 at one end thereof. Inside the chamber 2 are tracks 6 (see also FIG. 3) upon which cars or carts may be rolled to load and unload the autoclave with the articles to be treated. A pipe 8 is arranged along the bottom of the autoclave chamber and, as shown, is sinuously arranged therein but may be arranged in parallel lengths connected to common headers at their ends. Any other suitable arrangement, however, could be employed and applicant will herein use the term "coil" to refer to the pipe 8.

As shown in FIGS. 3 and 4, the autoclave is provided with a transverse dam 10 defined by an upright plate of steel or the like at the end thereof near the door 4. The dam 10 extends to a sufficient height to retain water in the bottom of the autoclave to a level sufficient to cover

the coil 8. It is to be noted that the water level is below the level of the tracks 6. The tracks 6 are mounted on spaced blocks or the like 12 providing a space therebetween to permit condensate to run down the inside surface of the autoclave to the bottom thereof.

The forward end of the coil 8 is connected through a conduit 14 to a suitable heater 16. The conduit 14 is provided with a valve 18 therein. As diagrammatically shown in FIGS. 1 and 2, the heater 16 is fed by a pump 20 through a conduit 22 from a supply of oil or other heating medium in an expansion or supply tank 24. The expansion tank 24 is connected, through conduit 26, to a fitting 28 at the rear end of the autoclave and an internal conduit (not shown) connects the fitting 28 to the rear portion of the coil 8, thus defining a closed circulation system. It is obvious that, with valve 18 open and pump 20 operating, oil is pumped into the heater where it is heated to the high temperature necessary and thence through the coil 8 where it heats the water held in the autoclave by the dam 10. The oil circulates through the coil 8 and fitting 28, thence through conduit 26 back to the pump 20, the inlet side of which is in communication with the expansion tank 24.

A condensate storage tank 30 is provided adjacent the autoclave chamber 2 and the upper portion of tank 30 is connected through conduit 32 to the upper portion of the autoclave 2. A selectively operable valve 34 is provided in the conduit 32.

A pump 36 having an inlet 38 and an outlet 40 (see FIG. 1) is connected through the piping shown to the tank 30, the bottom portion of autoclave 2 and to a source of makeup water, not shown. By manipulating the valves 42, 44, 46, 48 and 50, in a manner to be described, the pump 36 may be operated to pump condensate from autoclave 2 into tank 30, to pump the water from tank 30 into autoclave 2, or to pump water from a source of makeup water either into the autoclave 2 or into the condensate tank 30, all as will be described in greater detail.

A vent conduit 52 communicates with the interior of the autoclave, at the bottom thereof, and is provided with a vent valve 54. The vent conduit 52 terminates in one end of a muffler tunnel indicated in FIGS. 1 and 2 generally by the numeral 56.

Referring now to FIGS. 5 through 8, the muffler tunnel comprises an elongated passageway having transverse dimensions quite large relative to the transverse dimension of the vent pipe 52. The tunnel comprises a generally horizontal portion 58 and a generally vertical or stack portion 60. The horizontal portion 58 is provided with a plurality of transverse baffles 62 therein. The baffles 62 extend from alternate sides of the passageway and each terminates short of the opposite side, as clearly shown in FIG. 6. Each of the baffles 62 may be constructed of concrete blocks having their usual core openings 64 extending horizontally to define somewhat restricted passageways through the baffles. Adjacent the juncture of the horizontal portion 58 and the stack portion 60, a transverse partition wall 66 is provided to support a wall portion of the stack 60 thereover. The wall 66, however, may be formed of concrete blocks having their core openings 64 extending horizontally to provide a flow path for exhaust steam from the horizontal portion into the stack portion. Within the stack portion 60 a transverse imperforate partition wall 68 is provided terminating some distance below the upper end of the stack. Spaced from the partition wall 68 is a further vertical partition 70 which is imperforate throughout its upper portion but formed of concrete blocks at least at its lower end, the concrete blocks thereat being arranged with their core openings extending horizontally to define a flow path through the bottom portion of the partition 70. The partition 70 extends upwardly within stack 60 to a greater height than the partition 68 and a cap plate 72 spans the space from the upper end of partition 70 to the forward wall of the stack 60 and is in overlying but spaced relation to the upper end of partition 68. As will be evident from the above description and inspection of the drawings, the horizontal portion of the muffler passageway having the baffles therein defines generally sinuous flow paths for exhaust steam. The steam then passes through the wall 66 and along the sinuous flow path indicated by the arrows in FIG. 5 to the upper end of the stack where it exhausts to atmosphere. The sinuous flow path within stack 60 has upwardly and downwardly extending portions, whereas the flow path in the portion 58 is a horizontally undulating flow path.

Due to the nature of the flow path provided within the muffler passageway, the restricted openings through which the steam must pass, and the fact that the transverse dimensions of the passageway are quite great relative to the diameter of conduit 52, a highly efficient muffling of the exhaust is achieved. It is well known that pressurized steam, when exhausted directly to the atmosphere, expands rapidly and creates very loud noise which may be highly disturbing, and in some instances dangerous, to all within the vicinity thereof. By means of the muffler tunnel herein described, the autoclave 2 may be vented quite rapidly without creating an undue disturbance.

Below the stack portion 60 a drain pit or channel 74 is formed. A drain opening 76 is formed in the floor or bottom 78 of the muffler tunnel whereby moisture condensed within the tunnel may be drained away. FIG. 8 shows an enlarged detail of the bottom portion of the imperforate partition wall 68 and shows a drain opening 80 formed therein to permit flow of any condensate from the horizontal portion 58 or from the space between partition 68 and the adjacent stack wall to drain toward drain opening 76. If desired, the bottom 78 may be formed to slope toward drain opening 76.

In first starting the system for its initial cycle of operation, the heater 16 is fired to start heating the oil therein. Valves 42, 44 and 48 are closed, as are the valves 18 and vent valve 54 along with equalizer valve 34. The pump 36 is then started with valves 46 and 50 being open, to pump an initial supply of water into the autoclave 2. It is assumed that the autoclave has been charged with concrete blocks to be cured and the door 4 remains open. When the level of the water reaches the top of the dam 10, as determined visually, valves 46 and 50 are closed, pump 36 is stopped, and door 4 is closed and locked. It is further contemplated that a suitable level control device (indicated schematically at 84 in FIG. 1) be provided to detect lowering of the water level in the autoclave, during a cycle of operation, to too low a level. Any overflow from the dam 10, due to gain in water by evaporation from the blocks being cured, is discharged through any suitable trap of well-known design (not shown).

When the autoclave 2 has thus been charged with the required amount of starting water, the valve 18 is opened and pump 20 started in operation to commence circulating hot oil through the coil 8. The hot oil heats the water in the autoclave to produce steam. The air trapped in the autoclave upon charging the same with the articles to be cured, is vented through suitable thermostatic vent devices 82. The vent devices 82 are of conventional construction and are well known in the art. They remain open as long as air flows therethrough but close when the flow of air stops and steam begins to flow out. Thus all of the air is exhausted from the autoclave by the initially produced steam and the autoclave is then sealed so that steam pressure can build up to the required level. In curing concrete blocks it has been found desirable to heat the oil in heater 16 to a temperature of about 550° F. It is further contemplated that pressure control means be provided to limit the steam pressure in the autoclave to about 150 p.s.i., the water in the bottom thereof then being at a temperature of about 365° F.

When the curing pressure has been attained automatic valves (not shown) function to permit flow of only the amount of oil necessary to revaporize condensate within the autoclave, the only heat loss from the system being by radiation and condensation. All the steam that condenses within the autoclave flows to the bottom thereof and is continuously re-evaporated during the holding or curing cycle.

After the predetermined cycle time has elapsed and the concrete blocks completely cured, flow of hot oil through the coil **8** is stopped by closing valve **18** and stopping pump **20**. Thereafter equalizer valve **34** is opened, which permits high pressure steam from the autoclave to enter the condensate storage tank **30** and to equalize the pressure in the two enclosures. After the pressure is thus equalized, valve **48** is opened to provide communication between the bottom of the autoclave and the inlet to pump **36**. Valve **44** is also opened and pump **36** is started to pump all of the hot pressurized water from the autoclave **2** into the condensate storage tank **30**. After all of the water has been thus pumped into the tank **30**, the valves **48** and **44** are closed, as is valve **34**, to seal the tank **30** and retain the water therein at the high pressure of 150 p.s.i. At this time nothing but steam is left in the autoclave **2**. The vent valve **54** is now opened to exhaust steam from the autoclave into the muffler tunnel already described and to reduce the pressure in the autoclave to atmospheric. Thereafter the door **4** is opened and the cured blocks are removed for use. The autoclave is then recharged with a new supply of blocks to be cured and the door **4** is closed and sealed before water is introduced. The vent valve **54** is then closed and valves **42** and **46** are opened. Pump **36** is then started and pumps the stored hot pressurized water from storage tank **30** into the autoclave **2**. The level control device previously referred to may be in control of the pump **36** at this time to stop the same when the desired water level is reached. Under the temperature and pressure conditions described, entry of the hot pressurized water into the autoclave results in immediate flashing of the same into steam, due to the reduction in pressure thereon from 150 p.s.i. to atmospheric. Any air in the autoclave is exhausted through the thermal valves **82** previously described and when the required level of water is achieved in the autoclave, pump **36** is stopped and valves **42** and **46** are again closed. Valve **18** is then opened and pump **20** is started and the previously described cycle is repeated.

It is to be understood that, while manually operated valves have been shown and described for the sake of simplicity, a completely automatic control system of any well-known type could be employed to cause the sequence of operations herein described to be performed automatically. It is also to be understood that the tank **30**, shown separate from the autoclave **2**, may be an integral part thereof in the form of a compartment therein.

It is obvious that, since the heat required to hold the autoclave to the required curing pressure is quite small, a series or bank of similar systems may be served by the same heater **16**. Such a series of systems would have their cycles staggered so that only one of them would be starting its cycle at a time, the remaining autoclaves being in the holding portion of their cycle and thus requiring only a small amount of heat. The horizontal portion **58** of the muffler tunnel **56** would then be arranged to extend in such direction as to be accessible to all of the autoclaves in the series and would serve as a muffler for each of them.

While a single specific embodiment of the invention has been shown and described herein, it is to be understood that the same is merely illustrative, that the invention is not limited thereto but embraces all forms and modifications falling within the scope of the appended claims.

I claim:

1. A method of autoclaving articles adapted to undergo chemical transformation upon subjection thereof to high temperatures and pressures, comprising the steps of:

(1) supporting said articles out of contact with liquid water within a closed chamber provided therein with a reservoir of water;

(2) heating by indirect heat within the chamber and thereby vaporizing at least a portion of said water for the development of steam pressure within said chamber and for the effecting of chemical transformation of said articles;

(3) relieving said steam pressure within said chamber; and

(4) maintaining any unvaporized portion of said water against substantial loss of heat.

2. The method of claim **1**, wherein said water is heated to a temperature of approximately 365° F., and said steam pressure is maintained at a pressure of approximately 150 p.s.i.

3. A method of autoclaving articles adapted to undergo chemical transformation upon subjection thereof to high temperatures and pressures, comprising the steps of:

(1) supporting said articles out of contact with liquid water within a closed chamber provided therein with a reservoir of water;

(2) bringing a preheated oil heating medium into indirect heat transfer relationship with said reservoir of water by providing a heat exchange coil submerged within said reservoir, and thereby vaporizing at least a portion of said water for the development of steam pressure and for the effecting of chemical transformation of said articles;

(3) relieving said steam pressure within said chamber; and

(4) maintaining the unvaporized portion of said water against loss of heat and for re-use in a subsequent and separate autoclaving operation.

4. A method of autoclaving articles adapted to undergo chemical transformation upon subjection thereof to high temperatures and pressures, comprising the steps of:

(1) supporting said articles out of contact with liquid water within a first closed chamber provided therein with a reservoir of water;

(2) heating indirectly by an indirect preheated source of heat submerged in said reservoir and thereby vaporizing at least a portion of said water for the development of steam pressure and for the effecting of chemical transformtion of said articles;

(3) exhausting steam from said first chamber and into a second closed chamber, thereby relieving said steam pressure within said first chamber; and

(4) transferring any unvaporized portion of said water into said second closed chamber, thereby maintaining said transferred water against loss of heat and for re-use in a subsequent autoclaving operation.

5. A method of autoclaving articles adapted to undergo chemical transformation upon subjection thereof to high temperatures and pressures, comprising the steps of:

(1) supporting said articles out of contact with liquid water within a closed chamber provided therein with a reservoir of water;

(2) heating indirectly by an indirect preheated source of heat submerged in said reservoir and thereby vaporizing at least a portion of said water for the development of steam pressure and for the effecting of chemical transformation of said articles;

(3) condensing steam within said chamber and revaporizing the condensate for the maintenance of said steam pressure;

(4) relieving said steam pressure within said chamber; and

(5) maintaining any unvaporized portion of said water against loss of heat and for re-use in a subsequent and separate autoclaving operation.

6. In a method of autoclaving concrete blocks adapted to undergo chemical transformation upon subjection thereof to high temperature and pressures, the steps of:

(1) supporting said blocks out of contact with liquid water within a closed chamber provided therein with a reservoir of superheated water;

(2) heating by an indirect preheated source of heat submerged in said reservoir and thereby vaporizing at least a portion of said water from the development of steam pressure within said chamber and for the effecting of chemical transformation of said blocks;

(3) relieving said steam pressure within said chamber; and

(4) maintaining any unvaporized portion of said water

against substantial loss of heat and for reuse in a subsequent and separate autoclaving operation.

7. The method of claim **6** wherein said water is heated to a temperature of approximately 365° F. and said steam pressure is maintained at a pressure of approximately 150 p.s.i.

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