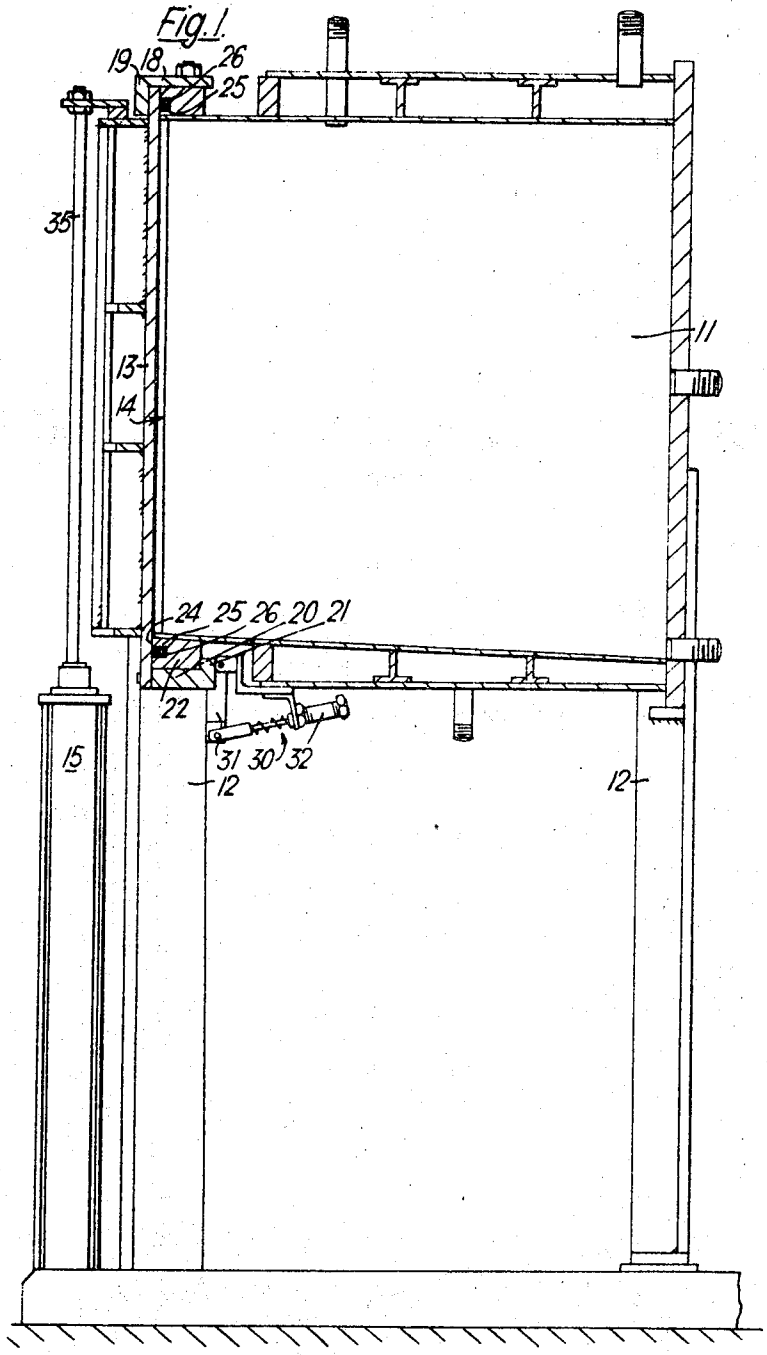
Jan. 6, 1970 W. C. COOPER 3,488,142

AUTOCLAVES

Filed July 14, 1965 5 Sheets-Sheet 1

Fig. 1



William Charles Cooper INVENTOR

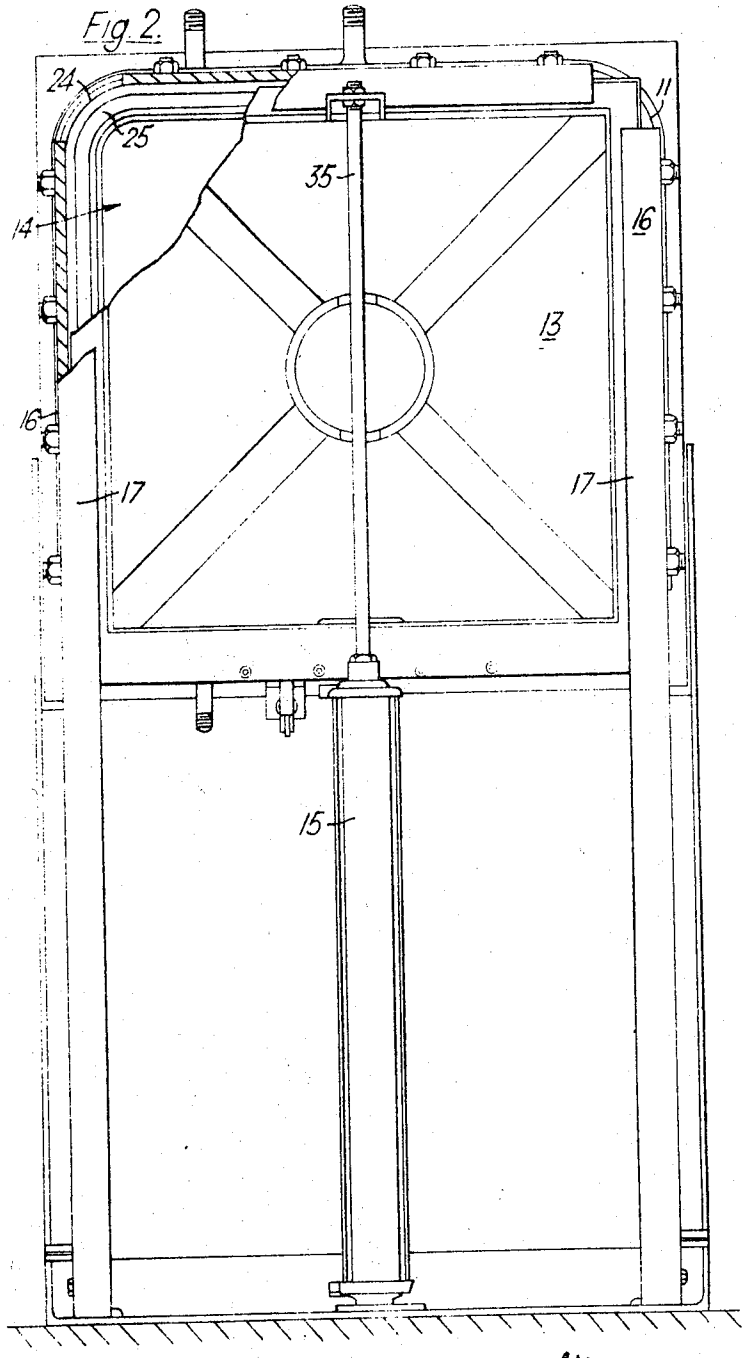
Dowell & Dowell ATTORNEYS

Jan. 6, 1970 W. C. COOPER 3,488,142

AUTOCLAVES

Filed July 14, 1965 5 Sheets-Sheet 2

Fig. 2.



INVENTOR
William Charles Cooper

Donald N. Dowell
ATTORNEYS

Jan. 6, 1970 W. C. COOPER 3,488,142

AUTOCLAVES

Filed July 14, 1965 5 Sheets-Sheet 3

Fig. 3.

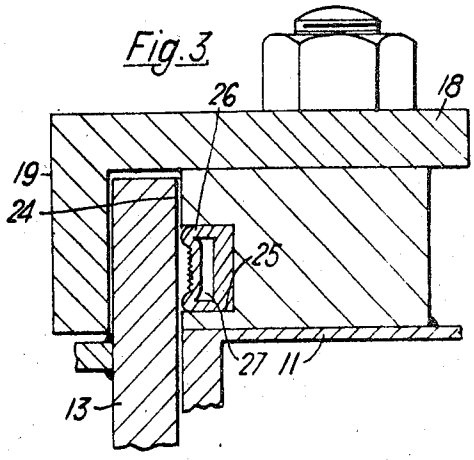
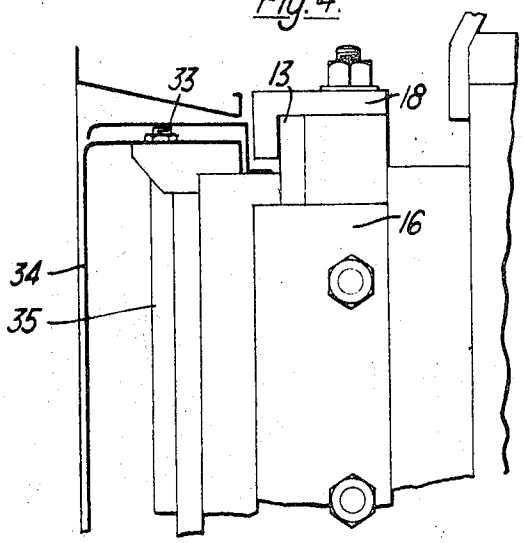


Fig. 4.



INVENTOR
William Charles Cooper

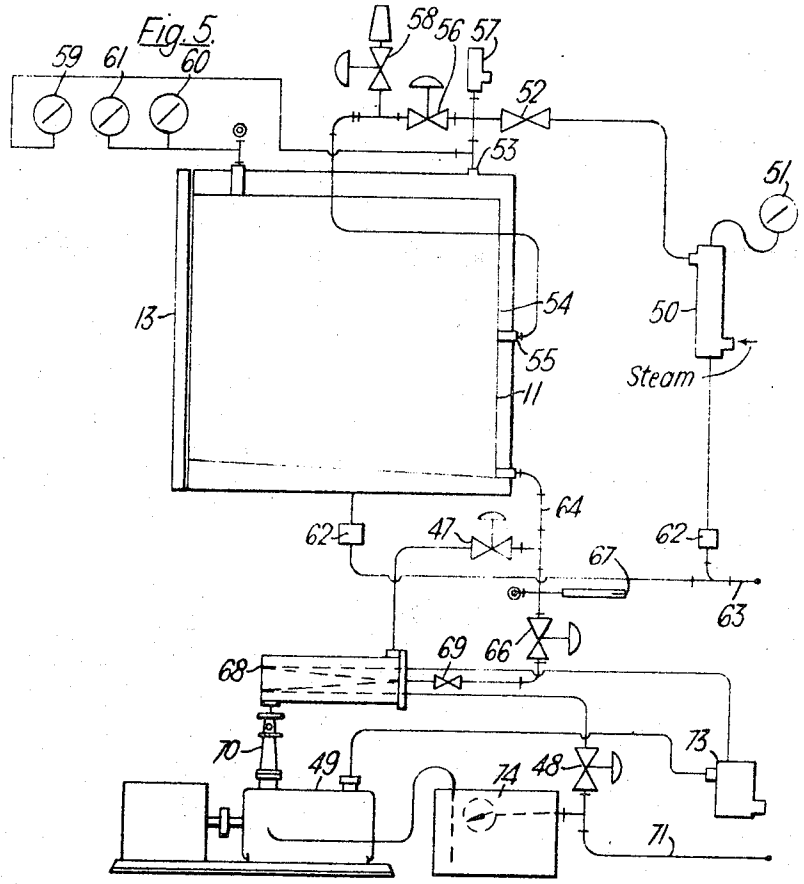
Dowell Howard
ATTORNEYS

Jan. 6, 1970 W. C. COOPER 3,488,142

AUTOCLAVES

Filed July 14, 1965 5 Sheets-Sheet 4

Fig. 5.



INVENTOR
William Charles Cooper

Dowell Hargett
ATTORNEY

Jan. 6, 1970 W. C. COOPER 3,488,142

AUTOCLAVES

Filed July 14, 1965 5 Sheets-Sheet 5

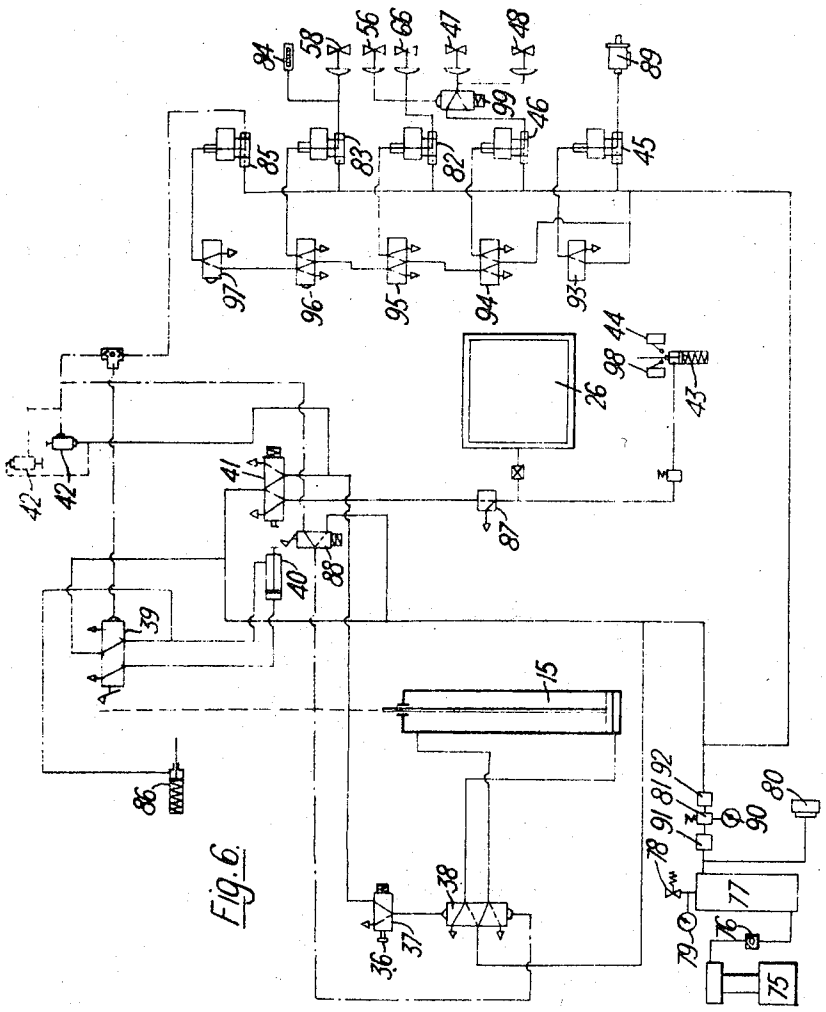


Fig. 6.

William Charles Cooper INVENTOR

Dowell & Dowell ATTORNEYS

United States Patent Office

3,488,142

Patented Jan. 6, 1970

3,488,142

AUTOCLAVES

William Charles Cooper, Nottingham, England, assignor to Manlove, Alliott, & Co. Limited, Nottingham, England

Filed July 14, 1965, Ser. No. 471,894
Claims priority, application Great Britain, July 14, 1964, 29,027/64
Int. Cl. A61l 3/02
U.S. Cl. 21—93 12 Claims

ABSTRACT OF THE DISCLOSURE

A sterilizing autoclave having a power-operated vertically sliding door plate to open and close an opening giving access to the sterilizing chamber at one end of the autoclave body. The operation of the door is interlocked with an automatic steam sterilizing cycle within the chamber so that the door cannot be unlocked and opened when the chamber is at other than atmospheric pressure, nor can sterilizing steam be admitted until the door is locked closed and sealed. The door has an air pressure-operated seal which is also interlocked with the sterilizing cycle so that it cannot be pressurized until the door is closed, nor can it be de-pressurized until the chamber is at atmospheric pressure. Vertical guide flanges sustain the door against the outward pressure of the seal and the sterilizing steam in the chamber.

This invention relates to autoclaves. More particularly, it is concerned with the closing and sealing arrangements of autoclaves.

The conventional way of locking an autoclave door is by means of a door mechanism of the central closing type embodying a centre screw, capstan handwheel and radial locking bolts. The door can be manually or power operated but in either case it is ordinarily of heavy construction and carried on side hinges. A hinged door of this type constitutes something of an impediment to loading and unloading of the autoclave and this disadvantage becomes particularly acute when it is desired to use mechanical handling equipment for loading and unloading. It is therefore an object of the invention to provide a door arrangement that is more convenient in this respect.

According to the present invention, an autoclave is provided with a sliding door which is sealed when closed by means of an inflatable seal to which internal fluid pressure is applied, and the guides for the sliding door incorporate flanges that overlie the margins of the outer face of the door so as to sustain the door against the internal pressure when the autoclave is in operation. Thus the door may slide freely into place when the seal is deflated but will become locked in the guides when fluid pressure is admitted to the seal, the door being even more firmly locked when the autoclave chamber is under pressure.

While a vertically-sliding door will normally be the most convenient, a laterally sliding door, or a door sliding in a substantially horizontal plane to cover and uncover a top opening in a vertical autoclave, are further useful possibilities.

The fluid for pressurising the door seal may be any pressure fluid that can be used satisfactorily at the elevated temperature to which it will be subjected while the autoclave is in operation. These include high temperature oils, steam, air and even water if the pressure is sufficient to prevent boiling at the working temperature. But an arrangement that has particular merit is one in which the fluid is the same as the working fluid employed in other equipment associated with the autoclave. In particular, the pressure fluid may be air from the same compressed air system as is connected to a pneumatic piston and cylinder unit or ram that opens and closes the door. And this can be extended to the case in which the autoclave is arranged to perform part or the whole of its cycle of operations automatically under the command of pneumatic control equipment, there then being a comprehensive air pressure system involving the control equipment, the pneumatic door operator and the door seal.

One autoclave construction in accordance with the invention will now be described by way of example and with reference to the accompanying drawings, in which:

FIGURE 1 is a side elevation, in section, of the autoclave,

FIGURE 2 is a front elevation with parts broken away,

FIGURE 3 illustrates the door seal,

FIGURE 4 illustrates a safety switch flap at the top of the door,

FIGURE 5 is a steam piping diagram of the autoclave, and

FIGURE 6 is a pneumatic circuit diagram.

In the arrangement shown in FIGURES 1 and 2 the autoclave **11** stands up above the floor on a frame **12**, and the door **13** associated with the front access opening **14** of the autoclave opens by sliding vertically downward. The door is essentially a robust flat mild steel plate stiffened on the outer face and having a protective coating of phenolic resin on the inner face. A long stroke pneumatic cylinder **15** raises and lowers the door. Vertical machined door guides **16** are provided at each side of the autoclave on the front end of the body thereof; these guides have flanges **17** that overlie the side margins of the outer face of the door **13**. A bar **18** across the top of the autoclave front has a depending flange **19** behind which the upper edge of the door **13** enters when the door is closed. A bar **20** across the inner face of the door at the bottom thereof has a shallow upturned flange **21** that engages behind a bar **22** across the underside of the front of the autoclave body when the door is closed. Thus, by reason of the flanges **17**, **19** and **21** the door **13**, when closed, is sustained along all four sides against internal pressure of the autoclave, and the pressure of the door seal to be hereinafter described.

In the forward face **24** of the front end of the autoclave body, that is the face across which the door plate **13** slides, there is a continuous channel **25** in which lies a hollow joint ring or gasket **26** of flexible material, as shown best in FIGURE 3. The natural size of this ring and the depth of the channel **25** are such that the ring does not protrude from the channel when it is not subjected to internal pressure. But when a suitable liquid or gaseous medium under pressure is admitted to its interior **27** by way of a pressurizing connection (not shown) it is expanded into contact with the inner face of the door plate, all around the margin thereof, to effect a pressure and vacuum tight seal.

Interlocks are required to prevent the joint ring **26** being pressurised before the door is fully closed, to prevent the autoclave chamber having its pressure raised before the joint ring is pressurised, and to prevent the joint pressure being released or the door opened before the autoclave chamber pressure has been exhausted. This being so, it is convenient to employ the same fluid pressure medium in the door-operating cylinder and the joint ring, i.e. air, and, in the case of an automatic autoclave with which there is associated process control equipment to carry through the desired autoclave cycle of operations, to make the control system a pneumatic system using the same compressed air supply as the door operator and the joint ring.

To prevent the door **13** from opening when there is pressure in the joint ring **26**, a safety catch **30** is provided

at the underside of the autoclave. The safety catch comprises a pivotally mounted spring-urged latch member **31** which automatically latches under the bar **20** at the bottom of the door as the door closes and which is retractable to unlock the door by means of an air cylinder **32**.

At the top of the door is a movable safety flap **33** (FIGURE 4) for operating an air valve to trip the door-closing cylinder if there should be anything in the path of the door, for example the operator's hand or arm, as it rises. The flap **33** overlies the upper end of a door cover **34** which encloses the front face of the door plate proper, and the rod **35** of the door-operating cylinder **15**, and rises and descends with the door. The safety flap valve is sensitive so that only very light pressure on the safety flap **33** will suffice to check the closing of the door.

FIGURES 5 and 6 show the steam piping and pneumatic control circuit arrangements, and the normal automatic cycle of operation of the autoclave will be described with particular reference thereto.

As shown in FIGURE 5, the steam supply to the autoclave **11** passes via a separator **50**, fitted with a steam pressure gauge **51**, a reducing valve **52** and connections **53**, **55** into the autoclave jacket **54** and the autoclave chamber there being an air-operated steam valve **56** in the steam line to the chamber. A safety valve **57**, an air-operated air admission valve **58**, a jacket pressure gauge **59**, and chamber pressure and vacuum gauges **60** and **61** are also provided. The separator **50** and the jacket **54** have steam traps **62** leading to a condensate line **63**. The autoclave chamber has an outlet line **64** leading to an air-operated exhaust valve **47** and an air-operated drain valve **66**, the line connection to the drain valve having a thermocouple fitting **67**. The exhaust valve **47** opens to the air/steam side of a condenser **68**; the drain valve **66** also leads to the condenser via a drain regulator valve **69**. An air ejector **70** and a liquid ring vacuum pump **49** are coupled to the condenser **68**. Cooling water from a mains line **71** is supplied to the condenser **68** via an air-operated water valve **48** and is discharged into a drain tundish **73**. The vacuum pump **49** also draws cold water from a storage tank **74**.

The air supply to the pneumatic system (FIGURE 6) is provided by a compressor **75** delivering through a non-return valve **76** to an air receiver **77** fitted with a relief valve **78** and pressure gauge **79**. A switch **80** responsive to the pressure in the receiver **77** controls the operation of the compressor. The control system obtains its air from the receiver through an assembly comprising a pressure regulating circuit **81** and pressure gauge **90**, a filter **91** and a lubricator **92**.

On pressing a start button **36** on a spool valve **37** a pilot air supply is passed to an air valve **38** delivering air under pressure to the bottom of the door cylinder **15**. Cylinder **15** then extends and lifts the door into the closed position. As the door reaches the fully closed position a trip valve **39** is actuated by the door thereby passing air to the left hand end connection of a delay cylinder **40**. Delay cylinder **40** extends and engages with a seal valve **41** to cause air to be supplied to the door seal **26**. If movement of the door into the closed position is interrupted by pressure on the door flap valve **42** then this passes air pressure back to the cylinder control valve **38** so as to switch it back to its original setting and thereby reverse the motion of the cylinder **15** opening the door.

When the door seal **26** is pressurised air is fed also to a cylinder **43** which provides a slight time lag before striking a micro switch **44** that supplies an electrical impulse to a solenoid valve **45**. Solenoid valve **45** opens and closes giving an air pulse to an indexing cylinder **89** to operate a 30 position electrical rotary switch in a timer unit. This is the commencement of the sterilising programme and each time a pulse is supplied via a solenoid valve **45** to this electrical switch the programme moves on to a further stage. There are altogether five similar solenoid valves **45**, **46**, **82**, **83**, **85** each associated with a respective spool valve **93**, **94**, **95**, **96**, **97**.

Vacuum pump **49** is started up at the commencement of the sterilizing cycle and runs continuously throughout the entire process. Solenoid valve **46** opens passing operating air to the autoclave exhaust valve **47** and to the cold water valve **48** opening both these valves. Air is evacuated from the autoclave chamber down to a vacuum of 25" Hg at which point a vacuum switch is made and the chamber is given a pulse of steam which causes the pressure in the chamber to rise to a slight positive pressure. Evacuation is then repeated down to 25" Hg and the pulse of steam is repeated twice more. Then the rotary switch in the timer unit moves to the sterilizing stage. The solenoid valve **46** closes and solenoid valve **82** opens passing air to the steam valve **56** and the drain valve **66**. Steam is admitted to the chamber via the reducing valve **52** allowing a set pressure of 32 lbs. p.s.i. When the sterilizing temperature of 134° F. is reached this is registered by the drain line thermocouple **67**. A temperature control switch makes contact and the sterilizing holding time begins. This time will normally be set at 3 minutes but a switch on the timer unit enables this time to be adjusted from ½ minute to 5 minutes in ½-minute stages.

A monitor timer is set to allow two minutes in which to reach sterilizing temperature during the sterilizing stage and if the sterilizing temperature is still low at the end of this time a flashing warning indicator comes on and remains on to the end of the process.

After sterilization the rotary switch in the timer unit moves on to the drying stage. Solenoid valve **82** closes and solenoid valve **46** opens passing air to the exhaust valve **47** and cold water valve **48** opening both these valves. Chamber pressure is rapidly reduced and the duration of this drying vacuum may be adjusted for a period of between ½ minute and 5 minutes, the time being normally in the region of 3–4 minutes.

At the end of the drying stage the rotary switch in the timer unit moves on to the release stage. Solenoid valve **46** closes and solenoid valve **83** opens allowing air to pass to the release valve **58** which opens and admits filtered air to the chamber. At the same time the process counter unit **84** is moved on by one unit to record the completed operation. As air fills the chamber and the chamber is restored to atmospheric pressure, a switch is made which signals the timer unit on to the door release position and a lamp indicating "cycle complete" comes on. Solenoid valve **85** opens passing air to cylinder control valve **39** which switches over and supplies air to the right hand end of delay cylinder **40** and to the door safety catch cylinder **86** causing it to be withdrawn. Delay cylinder **40** withdraws from seal valve **41** which is spring-loaded to return to the exhaust position. Air pressure is relieved from the quick exhaust valve **87** which immediately allows the escape of air pressure from the door seal **26**.

The delay cylinder **40** in retracting strikes a cylinder reverse valve **88** passing air to the cylinder control valve **38** which switches over and passes an air supply to the top end of the main door cylinder **15** bringing the door down into the open position.

It will be noted that an automatic interlock is provided between the steam valve **56** and the exhaust valve **47** by means of a spool valve **99**. If the door seal pressure should fail this is sensed by a microswitch **98** that can be employed to initiate the necessary precautionary measures.

The arrangement described is particularly suited for use in an installation, for example a hospital sterilising plant, in which the autoclave is loaded and unloaded by means of a conveyor since the sliding door does not require the same clearance volume in front of the autoclave in which to operate as does a hinged door and it is easier to bring the conveyor up to the autoclave. If there is to be, in effect, a conveyor line passing right through the autoclave then a similar sliding door is needed at the back end.

Modifications of the arrangement described are possible without departing from the scope of the invention. For instance, instead of being operated by a long stroke cylinder at the front of the autoclave the door could be opened and closed by a short stroke cylinder situated elsewhere and coupled thereto by a system of levers. While in the drawing the channel housing the sealing gasket is shown to be in a separate ring member bolted on to the autoclave end ring it is to be understood that there will ordinarily be only a single integral end ring.

I claim:

1. An autoclave, comprising a body having a sterilizing chamber therein and further having an end wall with an opening in a vertical plane giving access to the chamber at one end thereof, a flat door plate sliding rectilinearly against said end wall in a vertical plane to open and close said access opening, side guides for said door plate on said body and having flanges associated therewith to sustain the door plate against outward pressure thereon, a top flange on said body above the access opening behind which the upper margin of the door plate engages when the door is in closed position, a bottom flange on said door which engages behind a lower portion of said body when the door is in closed position, a fluid-pressure-responsive flexible door seal member carried by said body and extending around said access opening, fluid-pressure applying means operable to force said door seal member by fluid pressure into sealing engagement when the door plate is in the closed position, and power-operated means coupled to said door plate to cause it to slide between the open and closed positions.

2. An autoclave according to claim **1**, wherein said door plate is arranged to slide vertically, and said power-operated means comprises a long stroke pneumatic cylinder disposed with its axis vertical.

3. An autoclave according to claim **1**, wherein the seal pressurizing fluid is air.

4. An autoclave according to claim **1**, further comprising a lock to hold the door plate closed, and automatic interlock means whereby the lock is not released unless the autoclave is open to atmospheric pressure and the door seal is unpressurized.

5. An autoclave according to claim **1**, further comprising a movably mounted safety member across the edge of the door plate that leads during closing, and safety control means arranged to respond automatically to light pressure on the safety member by initiating substantially instantaneous reversal of said power-operated door-sliding means.

6. An autoclave according to claim **1**, wherein said flexible seal member is lodged in a channel in said end wall surrounding the access opening.

7. An autoclave according to claim **6**, wherein said seal member is hollow and inflatable and has internal fluid pressure applied to it for sealing, the seal member protruding outwardly from the channel in which it is lodged when so inflated but lying wholly within the channel when not inflated.

8. A sterilizing autoclave according to claim **1**, further comprising valve means to admit and exhaust sterilizing medium to and from said chamber to perform a sterilizing cycle, and fluid-operated control means for said valve means, and wherein the same working fluid is used in said control means and for pressurizing the door seal.

9. An autoclave according to claim **8**, wherein said fluid-operated control means is automatic and controls both said valve means and said power-operated door-sliding means.

10. A sterilizing autoclave, comprising a body containing a sterilizing chamber and having an access opening at a front end thereof, a flat door plate arranged to slide vertically against said front end to open and close the access opening, vertical guides on the body guiding the door plate at the side edges thereof, vertical flanges associated with said guides to sustain said door plate against outward pressure thereon, a top flange on said body extending horizontally above the access opening and behind which the top margin of the door plate enters when in the closed position, a bottom bar on said body extending horizontally below the access opening, a flanged bar extending horizontally across the bottom margin of the door plate and the flange of which engages behind said bottom bar when the door plate is in closed position, a channel in the front end of the body extending all around the access opening, a flexible joint ring lodged in the channel, means for applying fluid pressure to the joint ring in the channel thereby to force it into sealing contact with the door plate when the door plate is in the closed position, and power-operated means for raising and lowering the door plate.

11. An autoclave according to claim **10**, further comprising interlock means preventing the door seal from being pressurized when the door plate is not fully closed, and preventing the power operated means from acting to open the door when the door seal is pressurized.

12. A sterilizing autoclave, comprising a body containing a sterilizing chamber, a sliding substantially rectangular door assembly to open and close an access opening to said chamber, door-retaining members on said body extending along four sides of a rectangle containing said access opening and interengaging with portions of said door assembly when closed to sustain said door assembly against pressure within the chamber along all four margins of said door assembly, powered means coupled to operate said door assembly, a fluid-pressure-operated seal member on said body to seal said door assembly when closed, means for applying fluid pressure to said seal to cause it to effect door sealing engagement, and automatic control means controlling both the sterilizing operations in the autoclave chamber and the operation of the door assembly and door seal in an integral cycle of sequential operations.

References Cited

UNITED STATES PATENTS

1,752,265	3/1930	Schwarzkopf	21—108 XR
2,208,552	7/1940	Walter	21—98
3,136,007	6/1964	Maher et al.	
3,147,068	9/1964	Castle et al.	21—93 XR
3,371,986	3/1968	Brown	21—98

FOREIGN PATENTS

747,356	4/1956	Great Britain.

MORRIS O. WOLK, Primary Examiner

B. S. RICHMAN, Assistant Examiner

U.S. Cl. X.R.

21—94, 96, 103; 23—290