April 10, 1951 E. V. SMITH 2,548,403

LUMBER KILN

Filed Nov. 1, 1944 3 Sheets-Sheet 1

Fig. 1.

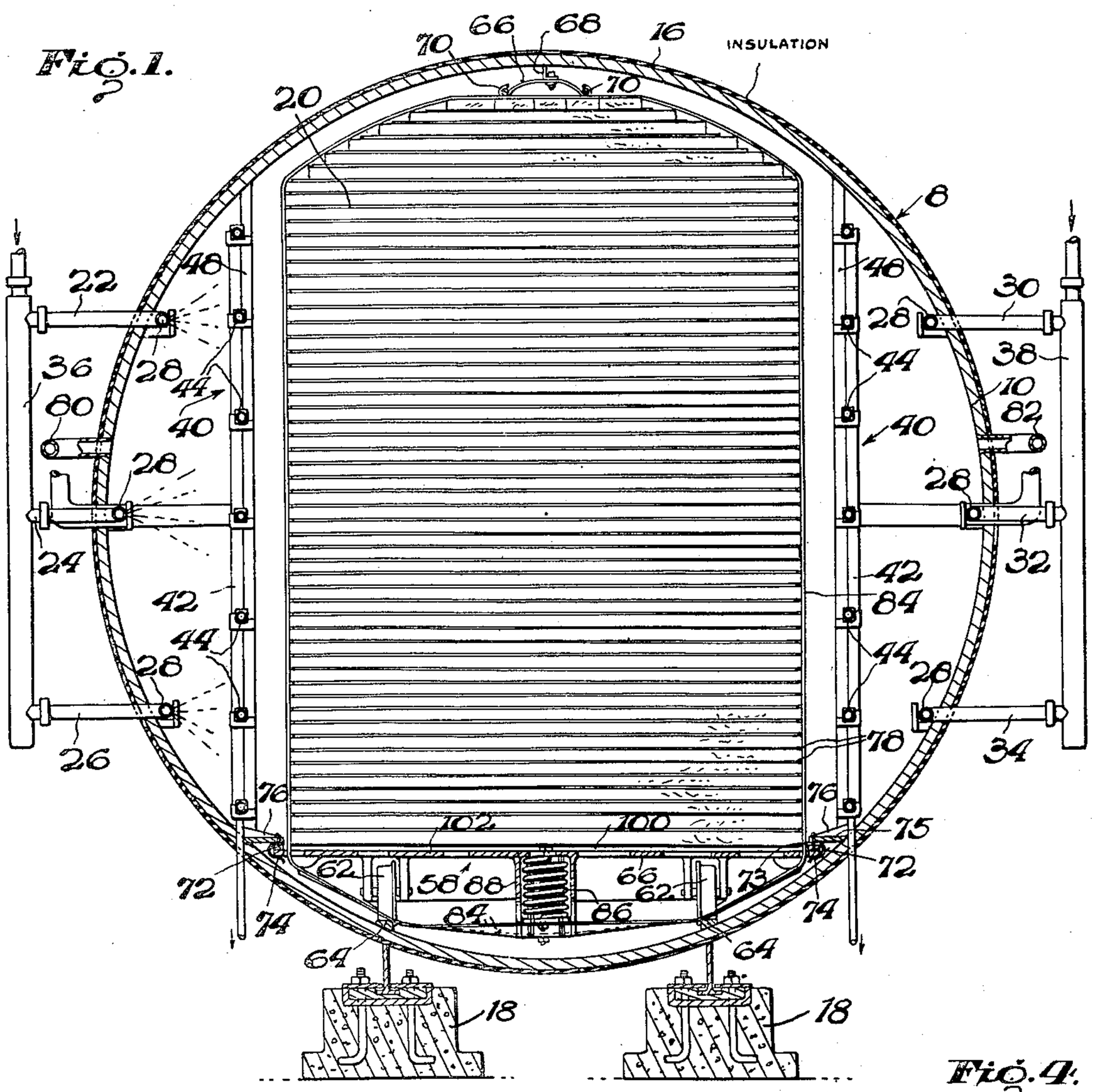


Fig. 3.

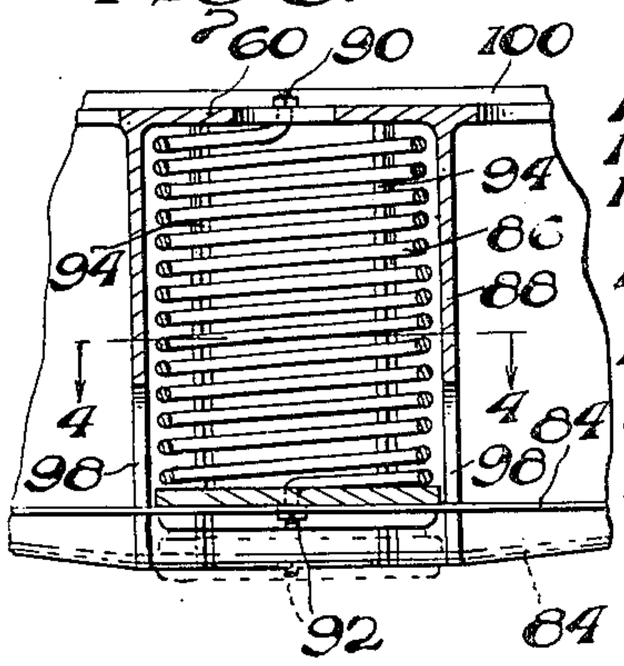


Fig. 6.

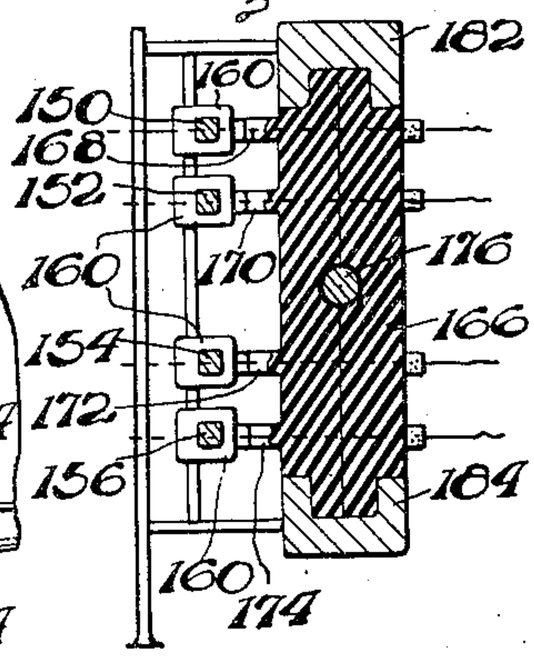
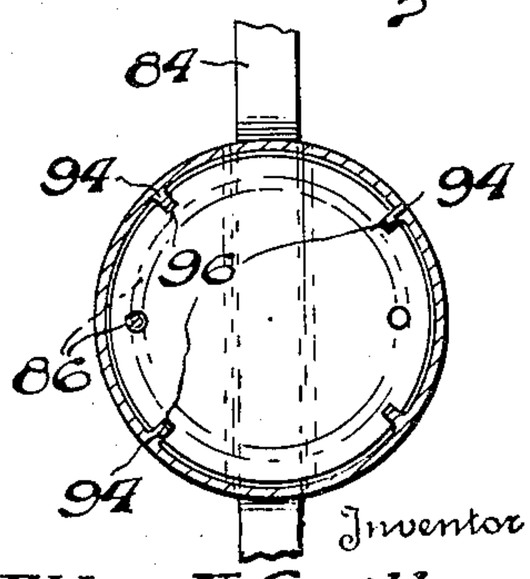


Fig. 4.



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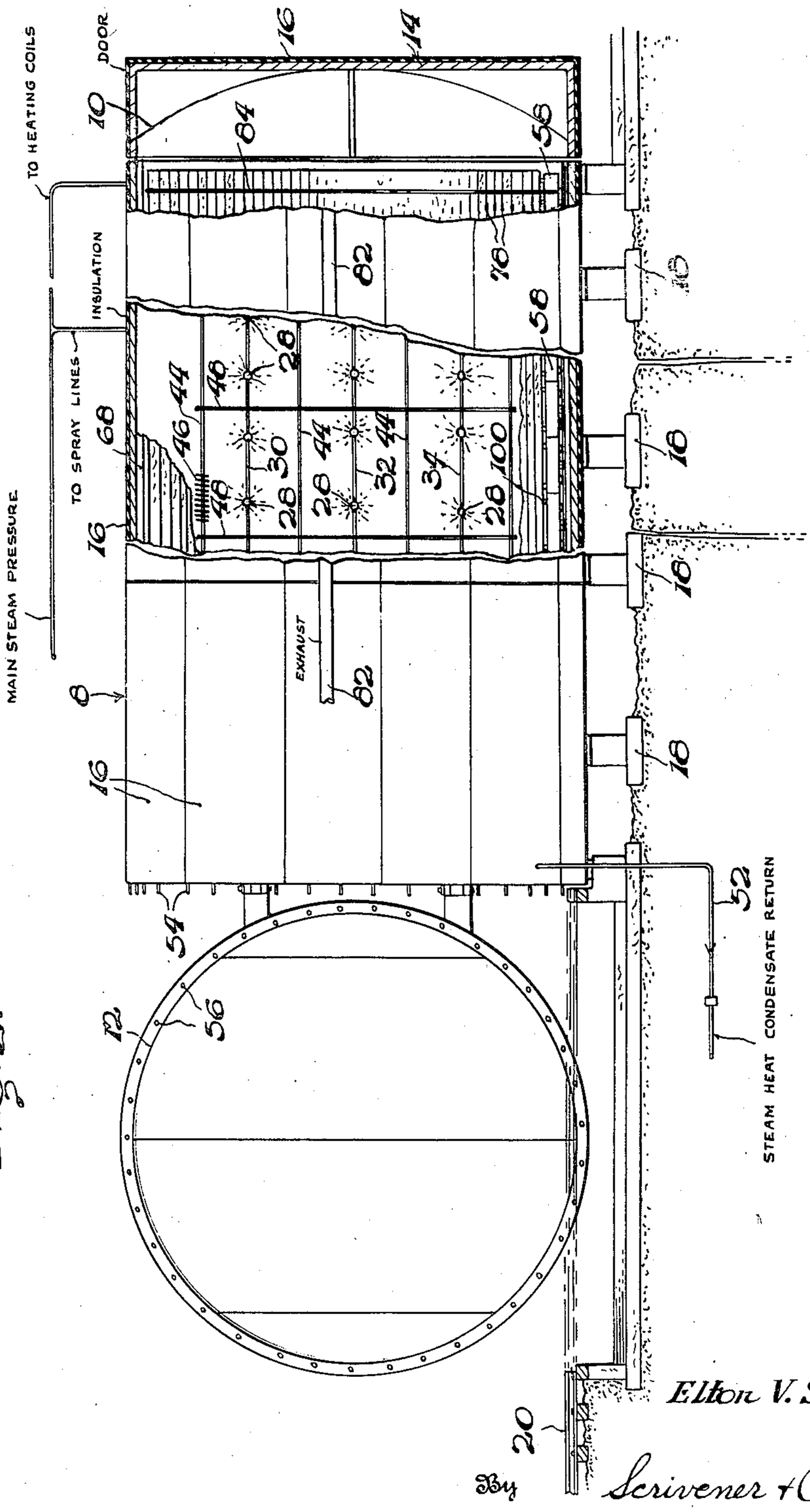

Fig. 2.

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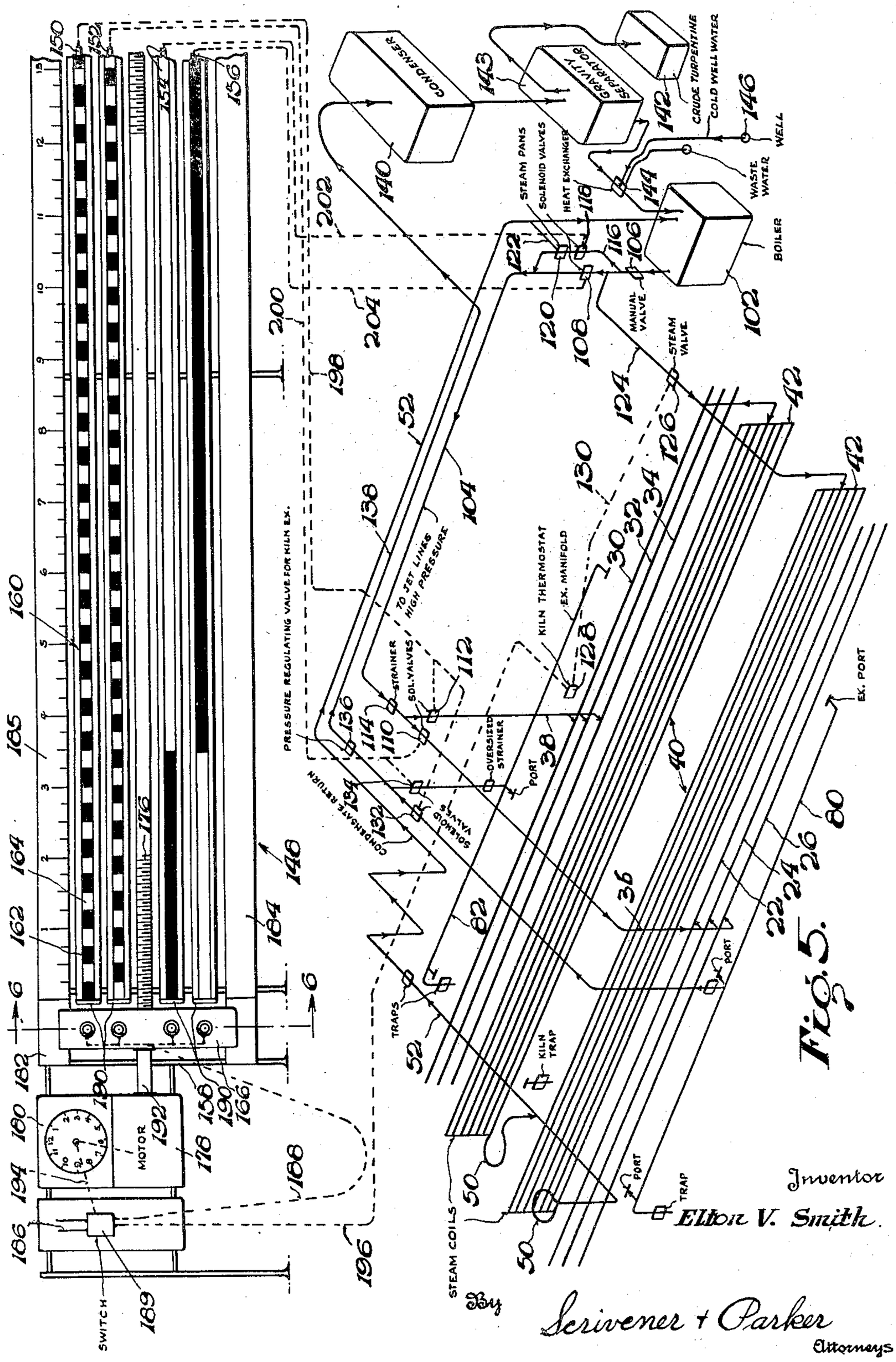

Fig. 5.

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Patented Apr. 10, 1951 2,548,403

UNITED STATES PATENT OFFICE

2,548,403

LUMBER KILN

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Application November 1, 1944, Serial No. 561,402

2 Claims. (Cl. 34—191)

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This invention relates to lumber kilns and methods of drying lumber, and more particularly to a novel arrangement employing the use of wet steam as the conditioning medium and dry steam as the drying medium, together with the complete recovery of by-products, such as turpentine and wood oils from the exhaust steam.

Wet steam may be defined as steam with a relative abundance of water vapor co-mingled with the steam while dry steam may be defined as superheated steam in which there is little or no water vapor co-mingled with the steam.

Various arrangements have heretofore been proposed for the drying of lumber and in certain of these, the use of steam has been resorted to, in order to reduce the moisture content of the lumber to a value acceptable to industry. In prior devices of this character, however, it has been found that an exceptional amount of steam has been required to effect a drying to the minimum moisture requirements so that such installations resulted in high operating costs as well as a relatively low efficiency. Attempts have also been made to effect a recovery of the wood oils resulting from the treatment of the lumber, but as far as at present known, the results have not been satisfactory, due to the lack of appreciation of all the problems involved.

It is accordingly one of the objects of the present invention to provide a novel method and arrangement for the conditioning and drying of lumber, which is so constituted as to avoid the disadvantages of the devices of the prior art and which on the contrary, serves to rapidly condition and efficiently dry the lumber, while at the same time securing a maximum yield of by-products such as turpentine and wood oils.

Another object is to provide a novel lumber kiln of the pressure-retort type which is so constructed and arranged as to be especially adapted for use with wet steam as the conditioning medium and superheated steam as a drying medium, and which may easily and quickly be filled to maximum capacity with lumber to be treated, thus resulting in a highly efficient plant.

A further object resides in the utilization of a novel series of steps in conditioning the lumber and including the use of wet steam and superheated or dry steam in a selected manner and time cycle, in order to achieve a thorough seasoning of the lumber in a short time and at minimum expense of operation.

Still another object comprehends a novel method of stacking the lumber prior to treatment including the use of spacer members or

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stickers of such nature and size that a considerable saving in space is secured, while effecting a sufficient spacing of the lumber so that all surfaces thereof will be subjected to the drying medium.

A still further object includes a novel construction for maintaining a substantially constant tension on each lumber stack, irrespective of the variation in volume thereof due to shrinkage during the drying process.

Another object is to provide a novel method of treating lumber which includes the use of wet steam and superheated steam in alternate cycles for selected time periods in order to effect a highly efficient drying of the lumber without causing it to check or crack.

Still another object resides in the employment of steam as the drying medium in an all-metal kiln, thus eliminating fire hazards.

Other objects and novel features of the invention will appear more fully hereinafter from the following description when taken in connection with the accompanying drawings wherein one embodiment of the invention is illustrated. It is to be expressly understood, however, that the drawings are employed for purposes of illustration only, and are not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawings wherein similar reference characters refer to similar parts throughout the several views;

Fig. 1 is a transverse sectional view of a kiln constructed in accordance with the present invention and illustrates one phase of the operation thereof, with a stack of lumber positioned therein for treatment;

Fig. 2 is a side view, partly in section, of the kiln of Fig. 1;

Fig. 3 is an enlarged sectional view of a portion of a kiln car and illustrates the spring construction which cooperates with the lumber bands;

Fig. 4 is a sectional view taken on line 4—4 of Fig. 3, with the spring removed;

Fig. 5 is a diagrammatic view of a timer construction and the piping layout of the complete system, and

Fig. 6 is a sectional view of a contact block of the timer, taken substantially along lines 6—6 of Fig. 5.

Referring more particularly to Figs. 1 and 2, a lumber kiln 8 embodying the principles of the present invention is illustrated therein as including a cylindrical steel shell 10 having front and

rear doors 12 and 14 respectively, the entire assembly being heat insulated, as by means of Alfol insulating panels 16, and being securely mounted on concrete piers or supports 18 so that a plurality of loaded kiln cars may be transferred from tracks 64, into the kiln for treatment, and thereafter removed from the kiln by way of the rear door 14, and suitable tracks, not shown. It is desired to particularly emphasize that the kiln of the present invention is a pressure-tight retort device capable of being fabricated from relatively light-gauge steel, while the use of insulation, in panels or otherwise, serves to materially conserve the heat within the kiln during operation.

One of the features of the present invention resides in a novel method of treating a stack of lumber within the kiln 8, by the use of wet steam and superheated or dry steam, and recovering from the exhaust, a maximum amount of turpentine and wood oils, abstracted from the lumber during the drying process. In order to provide a construction for alternately subjecting a lumber stack 20 to the action of the steam a plurality of pipes 22, 24 and 26 are positioned along one side of the interior wall of the kiln and each pipe is provided at spaced intervals with suitable spray jets 28, in the form of petcocks, through which the steam issues at high velocity, directed upon the adjacent side of the stack 20. A similar set of pipes 30, 32 and 34 are positioned along the opposite side of the wall of the kiln, and these are likewise provided with similar jets 28 for directing steam toward the opposite side of the stack 20. The group of pipes 22, 24 and 26 are connected to a header 36 while pipes 30, 32 and 34 communicate with a header 38, steam being supplied to these headers alternately, in a manner which will appear more fully hereinafter, so that opposite sides of the stack 20 will be subjected to periodic steam flow in opposite directions.

In order to maintain the temperature within the kiln at a selected value and also to impart to the steam issuing from jets 28 sufficient heat to compensate for the heat loss in expansion through the jets, a steam heating coil 40 is positioned on either side of the stack 20, between the latter and the respective groups of jets 28. As shown, each coil comprises headers 42, arranged at each end of the kiln, and a plurality of pipes 44 extending the entire length thereof, all of these pipes being preferably provided with fins 46 as indicated in Fig. 2, in order to increase the effective heat radiation, and being supported along the kiln wall as by means of a plurality of spaced standards 48. As shown in Fig. 5, one end of each coil is provided with an expansion loop 50, of well-known construction, and these are connected to a common return line 52. It is desired to point out that since the maintenance of a steam-tight atmosphere within the kiln is one of the features of the invention, all openings in the wall for the passage of pipes and other fittings, are securely welded. Moreover both the front and rear doors are tightly sealed when closed, and may include any suitable construction for this purpose, such as a plurality of bolts 54 on the kiln, adapted to be received within openings 56 in the door 12, and thereafter sealed in well-known manner.

While the steam issuing from the opposite sets of jets 28 is automatically cycled to secure an alternate flow, additional heat is provided by the heating coils 40 charged with steam. Due

to this feature, the interior of the kiln is automatically maintained at a uniform temperature regardless of which jets are in operation. Preferably, the steam flow to the coils 40 is governed in accordance with the kiln temperature desired so that a constant temperature is secured throughout the entire conditioning cycle.

Means are provided for supporting the lumber so that it may be readily moved along the track 64 and into the kiln, and as shown such means include a plurality of cars 58, each having a base 60 for supporting the lumber, and a plurality of wheels 62 cooperating with tracks 64. As illustrated in Fig. 2, the cars are arranged in tandem and constitute an efficient mobile support for the heavy weight of the lumber stack.

A novel construction is provided by the present invention for insuring that the steam from the sets of jets 28 will pass through the lumber stack rather than over or under the same. Such an arrangement is one of the major factors contributing to the high efficiency resulting from the use of this invention, inasmuch as all the steam from the jets is used to condition and dry the lumber stack rather than to merely flow around the exterior of the stack. As shown, such construction includes a baffle 66, preferably of thin, spring metal, extending along the top of the kiln from one end to the other and supported by a bracket 68 also extending from end to end of the kiln. The ends of the baffle are formed to receive longitudinally extending rods 70 which are of sufficient weight as to cause the two arms of the baffle to contact the top of the stack 20, the construction thus preventing steam flow over the top of the stack.

In order to prevent any substantial flow of steam beneath the stack 20, the kiln is provided with a pair of bottom baffles 72 cooperating with opposite sides of the kiln cars. Since both of these baffles are of similar construction, it is believed only necessary to describe one in detail. As shown, the baffle 72 comprises a spring arm 74, bent into U-shaped form and embracing the side edge of the base 60 of each kiln car, and being interposed between flat strips 73 and 75, the arm and strips extending from one end of the kiln to the other. Strip 75 is preferably welded to the kiln wall and spaced-apart brackets 76 serve to strengthen the baffle assembly. With this arrangement, passage of steam through the lumber stack is assured.

In stacking lumber for kiln-drying purposes, it is quite common in practice to employ wooden strips or stickers between each layer, in order to separate adjacent layers so that the drying medium may more effectively flow around the lumber. Stickers heretofore used, however, have been of substantial thickness for giving the required separation to insure adequate circulation of the slow-moving drying medium, and hence occupy considerable space in the kiln. By the present invention, due to the high velocity of the steam used for the drying medium, the space between layers may be considerably reduced at the same time that the open, vertical flues up through the stack may be completely eliminated. A further important feature resides in the use of stickers 78 made of rust-resistant metal and of a thickness of the order to ⅛ inch, for separating adjacent layers. Thus, a considerably saving in space is effected, so that a greater amount of lumber may be processed. At the same time, the stickers are indestructible and are moreover not subject to warping, twisting, bending or

breaking as in the case of wooden type heretofore utilized.

It is desired to point out here, that by an arrangement which will be referred to more in detail hereinafter, the pressure within the kiln is maintained at a value slightly above atmospheric, as for example up to about two pounds maximum per square inch. During the treatment of the lumber, the wood oils will vaporize and the kiln exhaust is conducted from the kiln as steam, holding liquid vapors in suspension by exhaust pipes **80** and **82**, opening into the interior of the kiln adjacent the sides thereof, Fig. 1, and adapted to be opened in the same timed sequence as the sets of jets **28**. Preferably the arrangement is such that when the left hand set of jets is in operation, the right hand exhaust line **82** is open and when this time cycle is completed, the right hand set of jets and the exhaust line **80** come into operation. In this manner the flow of steam is periodically reversed through the lumber stack and thence to exhaust, resulting in a highly efficient operation.

Means are provided for insuring that the lumber stack will be bound securely together as a unit for resisting tendencies of certain pieces to twist or warp during drying, and as shown, such means comprising a relatively thin metal band **84** which passes completely around the stack and beneath each kiln car. The ends of the band may be provided with any suitable type of quick-detachable connection, or crimped seal. The arrangement provided, also insures that substantially the same tension will be secured in the bands when the stack shrinks during the drying process. This desirable advantage is achieved by utilizing one or more springs **86** interposed between the band **84** and the base of each kiln car, Fig. 3, the spring serving to move the band **84** from its full line position, when the lumber is green, to its dotted line position, when the lumber is dried, thus exerting a substantially constant force on the band to tension the latter. More particularly, the car **58** is provided with a centrally-disposed depending housing **88** for receiving the spring, one end of the latter being secured to the base **60** at **90**, and the opposite end being attached at **92** to a suitable plate, Fig. 3. The latter is non-rotatably mounted in the housing in such a manner as to move longitudinally thereof, this result being secured by providing the interior of the housing with a plurality of spaced ribs **94** received within notches **96** in the periphery of the plate. The housing **88** is provided with cutaway portions **98** for reception of the band **84**. It will be understood that the side edges of each base **60** of the kiln cars, are provided with openings through which the bands **84** may be passed in assembling the stack of lumber. Preferably, each base **60** is provided with a pair of longitudinally extending spaced ribs **100** to position a bottom sticker of wood. The bases are moreover provided with a plurality of openings **102** in order to decrease weight.

Referring more particularly to Fig. 5, a flow diagram is shown therein which is illustrative of the preferred form of piping arrangement which may be employed. As shown therein, a boiler **102** is connected to the high pressure jet headers **36** and **38** by way of a pipe **104** which includes a manual valve **106**, solenoid valves **108**, **110** and **112**, a strainer **114** of any suitable type being inserted at a convenient point in the line **104**. A pipe **116** serves to by-pass the steam around the valve **108** and through a solenoid valve **118** and

steam pans **120**, the latter serving to impart the desired amount of wetting to the dry superheated steam from the boiler during the preliminary treating stage only. Water for the steam pans **120** is obtained from a connection **122** with the return pipe **52** which serves to conduct hot condensate from coils **40** back to the boiler. Headers **42** of the coils **40** are supplied with dry steam through pipe **124** having a control valve **126** therein, which serves to vary the steam flow in such a manner that the temperature within the kiln may be maintained constant throughout the cycle of operation. As shown a thermostat **128**, responsive to kiln temperature is adapted to control the valve **126** through an electrical connection **130**.

In order to recover the turpentine and wood oils from the exhaust steam issuing from the ports positioned in the sides of the kiln and which communicate with the exhaust pipes **80** and **82**, the latter are connected through solenoid valves **132** and **134**, pressure regulating valve **136**, and pipe **138**, with a condenser **140**, the latter being connected to a suitable apparatus **142** for collecting the crude turpentine and wood oils after separation from the water in the gravity separator **143**. Water from the latter retains considerable heat and this is preferably abstracted by passing the water through a preheater or heat exchanger **144**, in thermal conducting relation with the incoming water passing from the source **146** to the boiler **102**, following which the spent water is exhausted to waste. In this manner, incoming water is preheated prior to its entry into the boiler and this feature contributes greatly to the high efficiency of the system. It will be understood that strainers and traps of well-known construction may be utilized at various points in the system where their use is found to be desirable, and it has hence not been considered necessary to illustrate all of these elements. Also, an air vent is preferably utilized at the top of the kiln to exhaust the air, and a pressure relief valve is associated with one side of the kiln to prevent a vacuum within the kiln, when starting up. All of these elements are so constituted, however, that the kiln is steam-tight and maintains a pressure within the kiln at about 2 pounds per square inch, as determined by the setting of the pressure regulating valve **136**.

Referring to Figs. 5 and 6, there is disclosed therein, a novel timing arrangement for controlling the various operations of the kiln in an automatic manner. This timer is so arranged that it may be quickly and easily adjusted to secure the desired method of operation, once the cycling periods have been determined from a consideration of the various characteristics of the lumber to be processed. As shown, the arrangement comprises a timer **148** having a plurality of contact-supporting bus bars **150**, **152**, **154** and **156** carried by a suitable standard **158** and adapted to receive metallic elements **160** thereon, the latter carrying a contact face **162** or an insulating face **164**. A contact-carrying block **166** is arranged to cooperate with the elements **160** and carries a plurality of contacts **168**, **170**, **172** and **174**. The block is made of two parts of insulating material and is moved along the timer as by means of a threaded shaft **176** driven by a synchronous motor **178**, the latter being energized by an electric clock **180**. As shown, the block **166** rides between upper and lower grooved guides **182** and **184** respectively, this arrangement insuring longitudinal move-

ment of the block over the elements 160 in accordance with time. The surface of the upper guide 182 is provided with a time scale 185, numbered in hours and subdivided into fifteen minute intervals as shown. It will be understood that the elements 160 are assembled on the bus bars to secure any desired sequence of energization of the said bars and that the contacts 168, 170, 172 and 174 are all connected to a suitable source of electrical supply 186 through a lead 188 and switch 189. Preferably, opposite ends of the bus bars 150, 152, 154 and 156 are provided with end caps 190 for holding the elements 160 thereon in assembled relation, and opposite ends of the threaded shaft 176 are provided with smooth portions 192 so that the split block 166 may be assembled and manually moved to the initial position to engage the threads, and may be disassembled and removed from the opposite end of the shaft following the completion of the operation. As shown, the switch 189 is connected to the clock 180 by lead 194 and to the thermostat 128 by lead 196, the bus bars 150, 152, 154 and 156 being respectively connected as by leads 198, 200, 202 and 204, to the solenoid valves 112 and 132, the solenoid valves 110 and 134, the solenoid valve 118 and the solenoid valve 108. It is to be pointed out that for purposes of simplification of illustration the electric wiring employed is shown in dotted lines and comprises a single wire system with ground return, although a two wire system may be used if desired. Also all solenoid valves utilized are of the type which are spring-closed and only open, when electrically energized. Thus, any failure in the electrical system will result in the valves automatically closing, this materially improving the safety characteristics of the apparatus.

In operation, it will be assumed that a stack of cold or relatively dry thick lumber has been placed in the kiln for processing and that the timer 148 has been adjusted by so arranging the elements 160 on the bus bars 150, 152, 154 and 156 as to give the cycling desired for the particular lumber. With the boiler 102 in operation so as to provide a source of dry superheated steam of the order of 150 pounds per square inch absolute at a temperature in the neighborhood of 358° F., and the pressure regulating valve 136 set to 2 pounds per square inch gage pressure, the switch 189 is closed to energize the clock 180, the motor 178, the movable contacts 168, 170, 172 and 174, the thermostat 128 and the steam valve 126. The block 166 is then moved to the position shown whereby it is moved by the threaded shaft 176 over the contacts and insulating portions 162 and 164 in accordance with time. Energization of bus bar 154 will open solenoid valve 118 to convey the dry superheated steam past the steam pans 120, it being understood that the steam will be wetted as soon as any condensate returns by line 52. Inasmuch as the elements 160 on the bus bars 150 and 152 are so arranged as to alternately energize these bars every fifteen minutes it will be manifest that the solenoid valves 112 and 132 on the one hand, and valves 110 and 134 on the other will be periodically energized and opened. Such operation will alternately supply wet steam to each set of jets 28, it being understood that opposite exhaust lines 80 and 82 will be likewise periodically opened, to convey exhaust steam and wood oil vapors to the condenser 140 through the pipe 138. As shown in Fig. 5 this operation continues for 3½ hours and during this time the entire

stack 20 is heated, due to the steam pressure and the heating coils 40, to a temperature of about 230° F. and the thermostat 128, pre-set to this temperature, has just about closed valve 126. This preliminary step of heating and conditioning the lumber with wet steam has been found to be highly desirable, not only for the more complete reclamation of the natural oils, but also for the more rapid and complete drying of the lumber. During this step, a liberal amount of hot water of condensation is deposited on the cold lumber, and since heat travels much faster through water by convection than through cellulose by conduction, it will be seen that the stack is rapidly brought up to a relatively high temperature. The lumber may absorb some of this water so that the internal free and inbibed moisture, including the wood oils, more readily travels to the surface for removal and subsequent treatment. During this initial step, little or no drying is effected. Howerer, the lumber is thoroughly conditioned for subsequent treatment by the dry superheated steam which is cycled through the jets in precisely the same manner as soon as the bus bar 154 is de-energized and bus bar 156 energized. When this occurs, valve 118 will close and valve 108 will be opened and thus the superheated steam from the boiler will pass directly to the jets 28, rather than through the by-pass 116. During this stage of the operation, which continues to the end of the run as determined before-hand, the lumber is gradually dried by the action of the dry superheated steam, and a maximum amount of raw turpentine and woods oils is recovered by the treatment of the exhaust. While the foregoing explanation is based upon the use of a selected time period for the conditioning or initial step when using wet steam, and the periodic alternation of the jets every fifteen minutes, it will be understood that the preliminary step may be varied as to time period in accordance with the characteristics of the lumber to be treated, and that the reversal of jet action may be likewise altered. This may readily be effected by using contact elements of different lengths, in assembling them on the bus bars 150, 152, 154 and 156.

This ease and rapidity with which the timing cycle may be varied, with the present invention, gives the apparatus great flexibility in the conditioning of both soft and hard woods. In any of the foregoing, it will be understood that a final treatment of dry superheated steam may be utilized, if desired, to secure a thorough final drying of the lumber undergoing treatment. Such an arrangement, as above outlined, is effective to produce an entirely new process of drying and conditioning lumber which is termed "breathing," and is especially desirable in conditioning woods for certain purposes, such as for use in the manufacture of furniture. In this latter industry, lumber which has been air dried for a long number of years, and subjected to wet and dry seasonal atmospheric changes to the extent that it has acquired a permanent set, is in great demand. With the present process of breathing, a continuing method is provided which closely simulates the alternate swelling and shrinking of prolonged air drying, and yields a product which is substantially free from any further dimensional changes due to varying moisture conditions encountered in normal uses.

There is thus provided by the present invention a novel lumber drying apparatus together with a novel method of conditioning lumber.

which is so constituted as to not only more efficiently dry the lumber, but also to secure a maximum recovery of crude turpentine and wood oils from the wood. These novel and advantageous results flow from the many features heretofore described, among which is the novel retort type of insulated kiln which is so arranged as to be steam-tight, and heat-tight, the novel use of wet steam and dry superheated steam, the baffle and sticker constructions resulting in maximum use of the steam for conditioning, and maximum cubical content of the lumber stack, the flexible timer construction, the process of simulating prolonged air drying by breathing the lumber, and others.

While the invention has been described herein with considerable particularity, it will be understood that the same is not limited thereto, but is capable of variety of expressions without departing from the spirit of the invention, as will be understood by those skilled in the art. Reference will therefore be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. In combination with a dry kiln having a plurality of lumber-supporting cars therein arranged in tandem from one end of the kiln to the other, means positioned along the side walls of the kiln for alternately subjecting opposite sides of the lumber to the action of a drying medium, and baffle means for preventing the flow of said medium between the side edges of the cars and the kiln wall comprising elongated metal members supported by the kiln and bent into substantially U-shaped form for embracing the opposite side edges of all of said cars.

2. Apparatus of the type set forth in claim 1 which includes in addition, a weighted baffle carried at the top of the kiln and extending from

one end thereof to the other and contacting the top of the lumber supported by said cars.

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