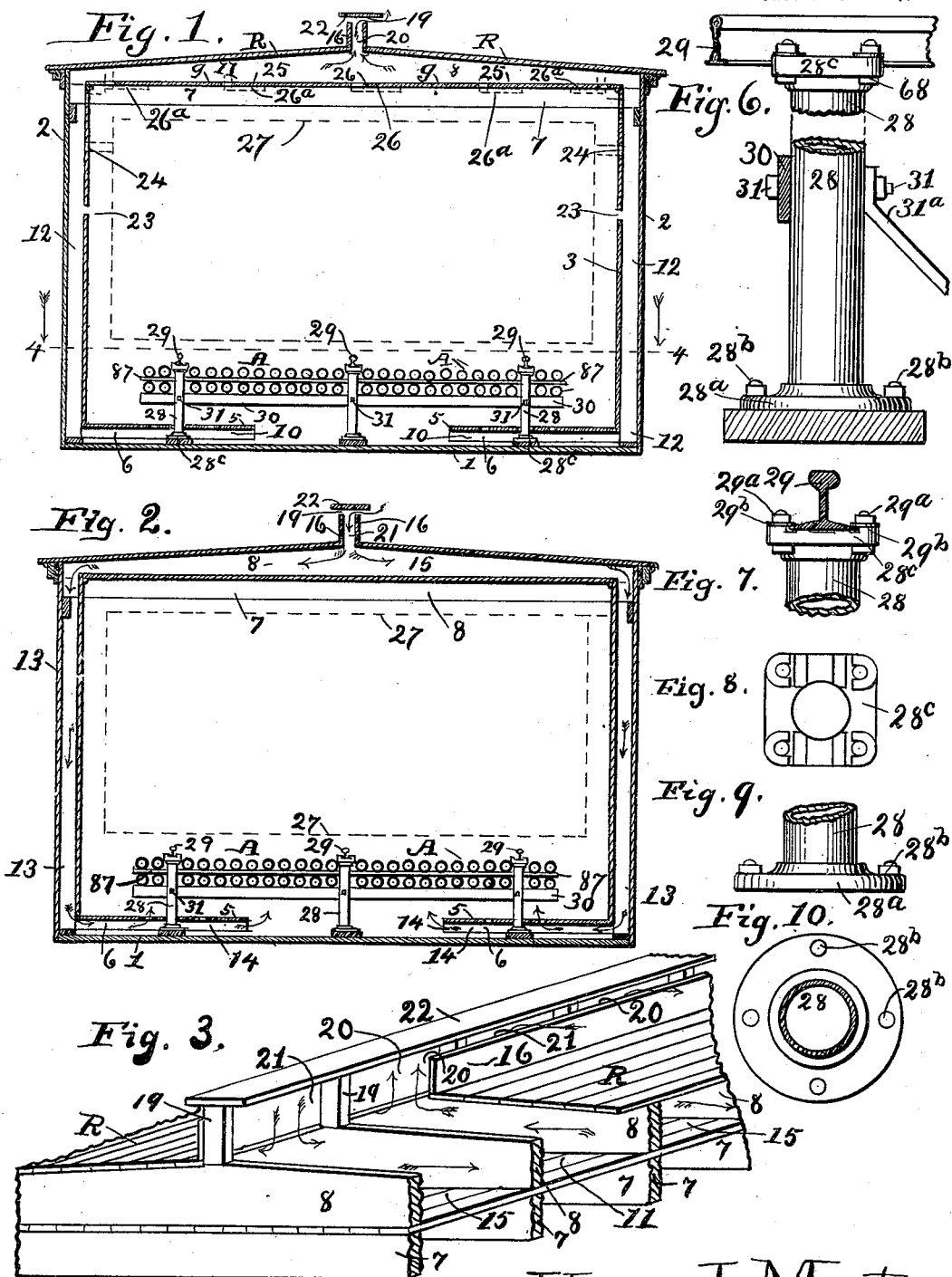


H. J. MORTON.  
DRYING KILN.

(Application filed Aug. 8, 1898.)

(No Model.)

3 Sheets—Sheet 1.



Witnesses:  
F. J. Brown  
H. J. Morton

Horace J. Morton;  
Inventor.  
By Charles Turner Brown,  
Att'y.

No. 645,753.

Patented Mar. 20, 1900.

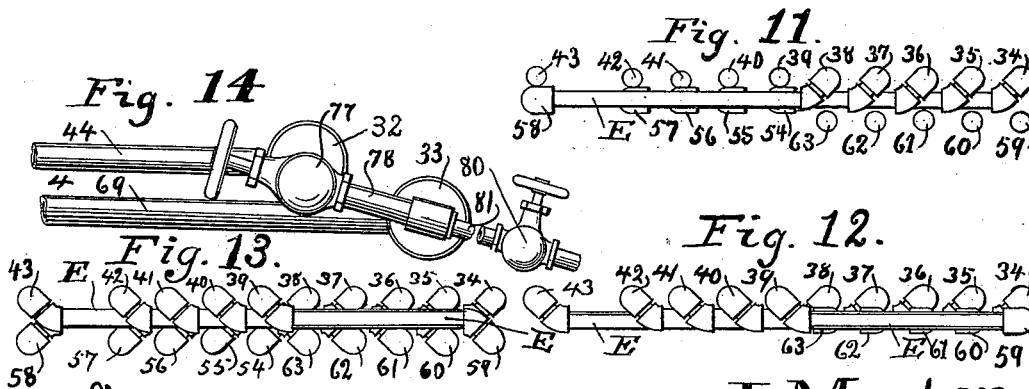
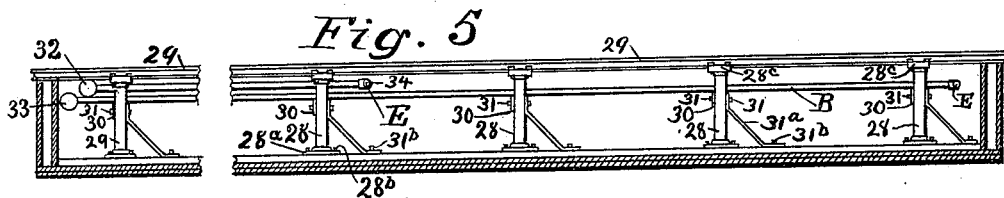
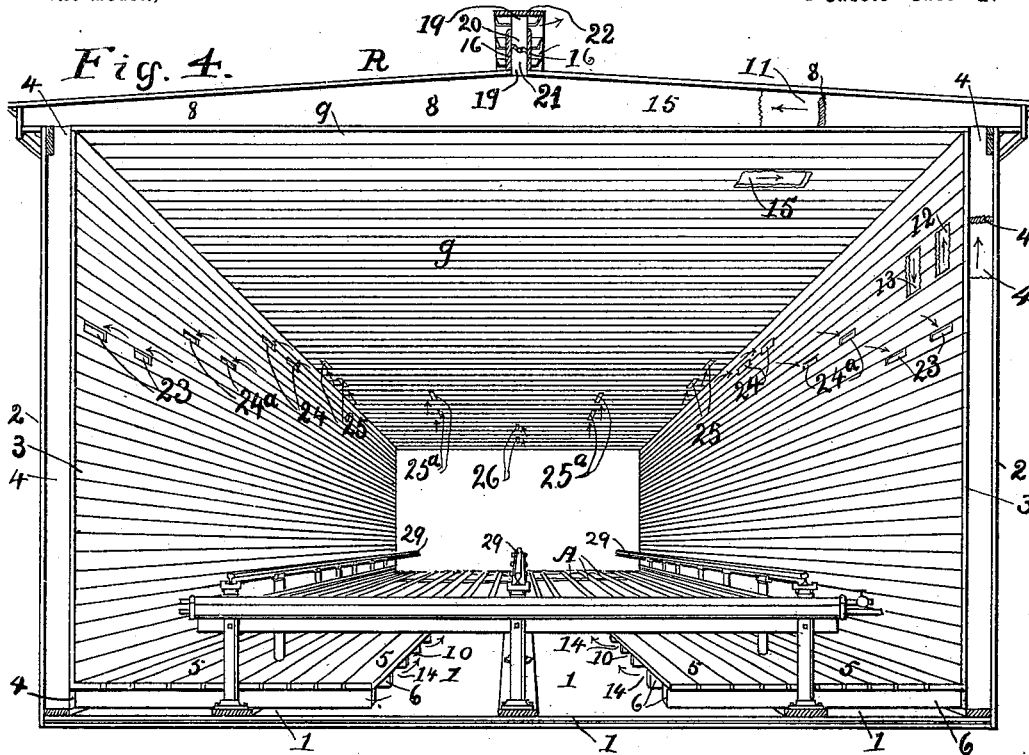
H. J. MORTON.

DRYING KILN.

(Application filed Aug. 8, 1898.)

(No Model.)

3 Sheets—Sheet 2.



Witnesses:

F. L. Brown.  
H. J. Morton

Horace J. Morton,

Inventor.

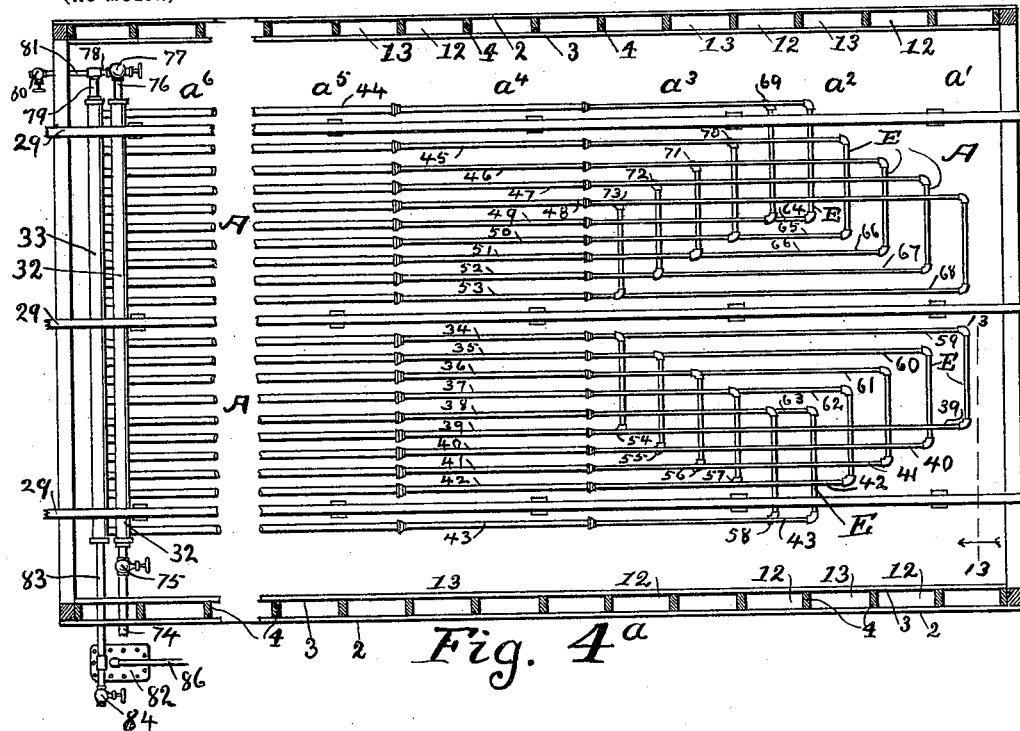
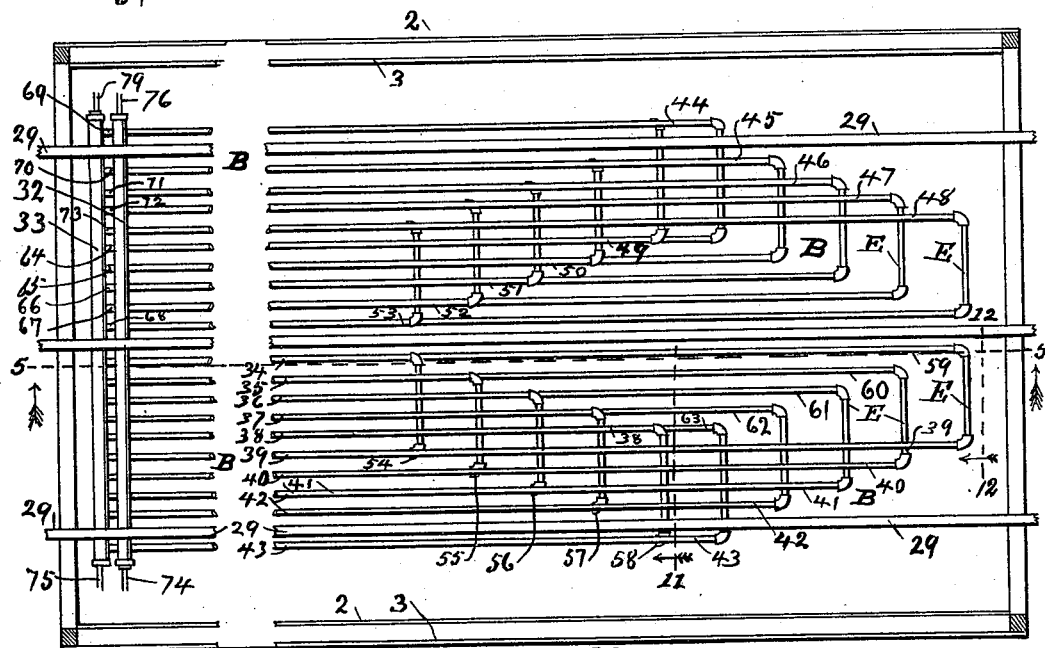
By Charles Turner Brown,  
Atty

H. J. MORTON.  
DRYING KILN.

(Application filed Aug. 8, 1898.)

3 Sheets—Sheet 3.

(No Model.)

Fig. 4<sup>a</sup>Fig. 4<sup>b</sup> Horace J. Morton,Witnesses:  
F. L. Brown.  
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By Charles Turner Brown,  
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# UNITED STATES PATENT OFFICE.

HORACE J. MORTON, OF CHICAGO, ILLINOIS.

## DRYING-KILN.

SPECIFICATION forming part of Letters Patent No. 645,753, dated March 20, 1900.

Application filed August 8, 1898. Serial No. 688,041. (No model.)

*To all whom it may concern:*

Be it known that I, HORACE J. MORTON, a citizen of the United States of America, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Drying-Kilns, of which the following, when taken in connection with the drawings accompanying and forming a part hereof, is a full and complete description, sufficient to enable those skilled in the art to which it pertains to understand, make, and use the same.

This invention relates to the class of drying-kilns which have fresh-air conduits or passage-ways taking air from above the piles of lumber which are being dried therein and discharging some or all of such air into the drying-room underneath the heating-coils therein.

The invention is an improvement upon those set out, illustrated, and claimed in Letters Patent of the United States granted to me on the 1st day of December, 1896, No. 572,210, and on the 18th day of January, 1898, No. 597,542, respectively.

The object of this invention is to obtain an improved construction of the drying-room and one that will not be expensive to build, a construction which will give improved facilities for control of the exit and inlet of air out of and into the drying-room during the different stages of the drying process, an improved and durable construction of the supports of the iron rails of the track and of the heating-pipes extending longitudinally of the drying-kiln, an improved construction of the heating-pipes whereby the contraction and expansion thereof are provided for and whereby provision is made for grading the amount of the heating-surface of the heating-coils in the different localities of the drying-kiln devoted to different stages of drying of the contents (usually lumber) thereof.

In the drawings referred to as accompanying and forming a part of this specification, and wherein a reference letter or numeral applied to designate a given part is used to indicate such part throughout the several views, Figure 1 is a vertical sectional view of a lumber-drying kiln embodying this invention on line 1 1 of Fig. 4 viewed in the direction indicated by the arrows; Fig. 2, a vertical sec-

tional view thereof on line 2 2 of Fig. 4 viewed in the direction indicated by the arrows; Fig. 3, a perspective view of a portion of the top and roof of the drying-kiln at the middle longitudinal line thereof. Fig. 4 is a perspective view showing the ceiling and walls of a drying-kiln embodying this invention, illustrating the arrangement of the outlet-openings; Fig. 4<sup>a</sup>, a horizontal sectional view on line 4 4 of Fig. 1 viewed in the direction indicated by the arrows. Fig. 4<sup>b</sup> is also a horizontal sectional view on line 4 4 of Fig. 1, viewed in the same direction as is Fig. 4<sup>a</sup>, showing a modification of the arrangement of certain pipes differing from the arrangement thereof shown in Fig. 4<sup>a</sup>; Fig. 5, a vertical sectional view on line 5 5 of Fig. 4<sup>b</sup> viewed in the direction indicated by the arrows; Fig. 6, a side elevation, by enlarged scale, of an iron post and a portion of the rail supported thereby; Figs. 7, 8, 9, and 10, respectively, details of the iron post and rail-supporter illustrated in Figs. 5 and 6; Fig. 11, a vertical sectional view on line 11 11 of Fig. 4<sup>b</sup>, by an enlarged scale; and Fig. 12, an elevation on line 12 12 of Fig. 4<sup>b</sup>, by an enlarged scale. Fig. 13 is an elevation at 13 13 of Fig. 4<sup>a</sup>, by an enlarged scale, of the ends of the steam-headers of the heating apparatus of the drying-kiln, of the connection-pipes and valves between the two headers, and a short section of the heating-pipes in the headers.

1 is the floor of the drying-room of the kiln, 2 2 the outer walls, and 3 3 the inner walls thereof.

4 4 are the studding of the drying-kiln, between the walls 3 3 and 2 2, and 12 13 are vertical passage-ways formed by such studding and the inner and outer walls.

5 is a false floor extending from the inner walls 3 3, respectively, toward the middle of the kiln to and beneath the heating pipes or coils A and B, as illustrated in Figs. 1 and 2.

6 6 are joists on floor 1, upon which joists the false floor 5 is laid. Joists 6 6 are laid adjacent to the studding 4 4, and by means of the floor 1 and false floor 5 with the joists 6 6 horizontal passage-ways are obtained which are extensions of the vertical passage-ways 12 13, respectively.

7 7 are ceiling-joists, and 8 8 are rafters.

9 is the ceiling of the drying-room of the

kiln, and R is the top or roof of the drying-kiln. Ceiling 9 rests on ceiling-joists 7 7, and the roof R rests on the rafters 8 8. Rafters 8 8 are laid adjacent to the studding 4 4, and by ceiling 9, roof R, and rafters 8 8 horizontal passage-ways are obtained which communicate with the vertical passage-ways 12 13, respectively. The horizontal passage-ways underneath the false floor 5, which communicate with and are continuations of the vertical passage-ways 12 12, are lettered 10, Fig. 1, and the horizontal passage-ways between ceiling 9 and roof R, which communicate with and are continuations of vertical passage-ways 12, are lettered 11, Fig. 1. The horizontal passage-ways underneath false floor 5, which communicate with and are continuations of vertical passage-ways 13 13, are lettered 14, and the horizontal passage-ways between ceiling 9 and roof R, which communicate with and are continuations of the vertical passage-ways 13 13, are lettered 15. (See Fig. 2.)

16 16 are vertical sides of vertically-extending passage-ways 20 21, such sides being separated by the studs 19 19, (to which the sides are secured,) which stand on the rafters 8 8, and such studs form the ends of such vertical passage-ways. Passage-ways 20 21 are open to the atmosphere at their upper ends, and at the lower ends thereof they open, respectively, into the passage-ways 11 and 15. Passage-ways 20 form continuations of horizontal passage-ways 11 11 and the outlets for the discharge of moisture-laden air from the drying-kiln, and passage-ways 21 21 form continuations of horizontal passage-ways 15 15 and constitute inlets for the admission of fresh air to the drying-kiln.

22 is a board or plank extending longitudinally the length of the drying-kiln and secured to the upper ends of the studs 19 19, forming a roof over the openings 20 21 21.

23 24<sup>a</sup> 24 are openings in the inner side walls 3 3, and 25<sup>a</sup> 25 26 are openings in the ceiling 9, between every alternate wall-stud and rafter, respectively, through which openings the heated and moisture-laden air can pass from the drying-room of the kiln into the passage-ways 12 12, from thence to the passage-ways 11 11, and out of the outlets 20 20. Openings 23, 24, 24<sup>a</sup>, 25, 25<sup>a</sup>, and 26, respectively, are often provided with a cover 26<sup>a</sup>, Fig. 1, whereby the discharge of moisture-laden air can be regulated; but the covers 26<sup>a</sup> 26<sup>a</sup> are not essential to the operation of drying-kiln for all kinds of lumber.

Fresh air, to replace the hot and moisture-laden air going out of the drying-room of the kiln at outlets 20 20, is taken in through the inlets 21 21, passing therethrough and through the passage-ways 15, 14, and 13 to underneath the heating pipes or coils A B of the drying-kiln. The inlet passage-ways are made to alternate with the outlet passage-ways 10, 12, 11, and 20.

The broken lines 27 27, Figs. 1 and 2, show

the outline of piles of lumber in the drying-kiln in position for drying.

28 28 are iron posts supporting the longitudinally-extending iron rails 29, such iron posts also carrying the iron cross-pieces 30 30, that are bolted by bolts 31 to the posts, on which cross-pieces the heating-pipes of coils or series A and B, hereinafter described, are placed. 28<sup>a</sup> is the base of the iron post 28, which is bolted to the floor 1, as by bolts 28<sup>b</sup>. (See Fig. 6.)

28<sup>c</sup> is the cap of post 28, and to such cap the iron rails 29 are secured, as by bolts 29<sup>a</sup>, having nuts 29<sup>b</sup> thereon.

31<sup>a</sup> 31<sup>a</sup> are iron braces bolted to the floor 1, as by bolts 31<sup>b</sup>, Fig. 5, and to the posts 28, as by bolts 31.

The steam-coils A A, placed on both sides or halves of the drying-kiln in Fig. 4<sup>a</sup>, may be and have been constructed by me differently from the steam-coils B, which are placed on both sides or halves of the drying-kiln, (see Fig. 4<sup>a</sup>), the purpose sought and effected being, however, the same—that is, assuming that the lumber to be dried is to be run into the drying-kiln at end *a'* thereof and that the stages of the drying comprises, say, six steps. Trucks loaded with lumber are run into the end *a'* of the drying-kiln and permitted there to remain during one of the stages of the drying, whereupon it is moved into, say, the position of locality *a*<sup>2</sup> and permitted to there remain during the second stage of the drying, after which it is successively moved into positions *a*<sup>3</sup>, *a*<sup>4</sup>, *a*<sup>5</sup>, and *a*<sup>6</sup> and permitted to remain in each of said places during one stage of drying. It is my desire that the temperature of the drying-kiln at the several localities shall vary, such temperature gradually increasing from locality *a'* to locality *a*<sup>6</sup>, and the about-to-be-described construction of the steam-coils A B is for the purpose of obtaining such difference in temperature. It is evident that if the drying-kiln be made of sufficient length to accommodate six piles of lumber upon the introduction of a new pile at the *a'* end of the drying-kiln a pile of dry lumber will be discharged at the *a*<sup>6</sup> end of the drying-kiln, and that the drying process may be divided into as many stages as there are contained piles of lumber in the drying-kilns, (or multiples thereof.) I do not therefore confine myself to six of such stages or six of such piles in the drying-kiln at any one time.

Steam-coils A B consist, respectively, of steam-pipes inclined toward the headers 32 and 33, such pipes extending outward from the headers, respectively. The pipes from header 32 extend into elbows having close nipples and forty-five-degree elbows made up to form offsets. (See Figs. 11 and 12.) The pipes from header 33 extend into elbows only. The outward-extending pipes from the headers 32 and 33 are, respectively, joined together by laterally-extending pipes called "spring-pieces" E E. The pipes extending

from header 32 form the top series or layer and are numbered as follows: 34, 35, 36, 37, 38, 39, 40, 41, 42, and 43, and 44, 45, 46, 47, 48, 49, 50, 51, 52, and 53. The pipes extending from headers 33 form the bottom series or layers of pipes and are numbered as follows: 54, 55, 56, 57, 58, 59, 60, 61, 62, and 63, and 64, 65, 66, 67, 68, 69, 70, 71, 72, and 73. The pipes of the upper row are connected to the pipes of the lower row by the spring-pieces E E, respectively, as follows: 34 to 54, 35 to 55, 36 to 56, 37 to 57, 38 to 58, 39 to 59, 40 to 60, 41 to 61, 42 to 62, and 43 to 63, 44 to 64, 45 to 65, 46 to 66, 47 to 67, 48 to 68, 49 to 69, 50 to 70, 51 to 71, 52 to 72, and 53 to 73. The pipe 74 connects header 32 with steam-supply, such steam-supply being governed by valve 75. The header 32 is connected to header 33 by pipe 76, valve 77, and pipes 78 and 79. 80 is a blow-off valve, and connects to header 33 by means of pipes 81 and 79. The connection to steam-trap 82 is by pipe 83 from header 33.

84 is a blow-off valve, and connects to lower header 33 by pipe 83. Pipe 86 is a discharge-pipe from the steam-trap 82.

Figs. 4<sup>a</sup> and 4<sup>b</sup> show the heating-coils A and B to be of different lengths, the object being to produce a gradually-increasing heat from the end of the drying-room first receiving the lumber toward the end of the room from whence the lumber is discharged. Two methods are shown of producing this result, viz: first, by heating-coils B, Fig. 4<sup>b</sup>, which are of widely-differing lengths; second, by heating-pipes A, Fig. 4<sup>a</sup>, which are of different sizes, with less variation in length, the smallest pipes being placed at the receiving end of the room. The connecting spring-pieces E E in coil B are best made of pipes smaller than the heating-pipes, the effect of such smaller connecting-pipes being to retard the flow of the steam when steam is first turned on and prevent the flow of steam taking the shorter pipes first and filling too quickly the lower header 33, thereby damming up or confining the air in some of the longer bottom pipes and tending therefore to retard the quick and thorough heating of such pipes as may have the air thus confined therein.

The more important purpose of employing the spring-pieces E E in the manner shown in Figs. 4<sup>a</sup> and 4<sup>b</sup> is to provide for taking care of the expansion of the long heating-pipes 34 to 73, both inclusive, and prevent injurious straining of the connecting fittings. When the top and bottom layer or series of heating-coils A B are connected with return-bends, as shown, described, and illustrated in Letters Patent of the United States granted to me on the 1st day of December, 1896, and numbered 572,210, the rigidity of such connection is so great that often the strain occasioned by the expansion of the long pipes when steam is first turned onto them is such that leaky joints occur. The liability of such results are entirely obviated when connections by spring-

pieces E E are employed, as shown, illustrated, and described herewith.

Wooden track-stringers, upon which the iron rails are usually laid, and wooden posts under such track-stringers, to which the pipe-supports are secured, are in a few years rendered so brittle and weak from the effect of the heat from the steam-pipes that often they break, causing damage to the pipes and rails and delays. The employment of iron posts 28 28 to carry the rails 29 29 and iron cross-pieces 30 30 to carry the heating-coils A and B provides a substantial structure that will not require renewal. The bottom series of coils A and B rest upon the iron cross-pieces 30 30. Across the top of these bottom series of pipes and directly over the iron cross-pieces 30 30 are placed lateral pipes 87 87, Figs. 1 and 2, upon which rest the top series of pipes of coils A and B.

The operation of the heating-coils is as follows: The valve 77 is closed and blow-off valves 80 and 84 are opened. Steam is then admitted through pipe 74 and valve 75 and flows into header 32 up the top series of pipes of coils A and B, respectively, and thence through the spring-pieces E E to the bottom series of pipes, forcing the air in all the pipes out of the blow-off valves 80 and 84. After the air is out of the pipes it will be followed by water of condensation and finally by steam. When this occurs, valve 77 should be opened and valves 80 and 84 should be closed, and in a few minutes the result is such that the steam-pressure in both headers and both series of pipes is equalized through their entire length and the water of condensation made by the steam giving up heat to warm the air surrounding the pipes flows by gravity from the top series of pipes of coils A and B, respectively, to the header 32 and thence through pipes 76, valve 77, and pipes 78 and 79 to the header 33. The water of condensation in the bottom series of pipes of coils A and B also flows by gravity to header 33 and uniting with the water of condensation from header 32 flows through pipe 83 to steam-trap 82, where it is automatically separated from the steam and is discharged through pipe 86 into the atmosphere or into a tank or directly into the steam-boiler. After the lumber has been properly piled on the car-bunks and run into the drying-room the doors are closed and steam is turned on as hereinbefore described. As the air becomes heated sufficiently it rises, being pushed up by the surrounding cooler air. It is from this action that the hot air from the steam-coils in the drying-room rises through the lumber and finds its outlet at the  $\alpha^1$  end of the drying-kiln, at the opening 26, at the  $\alpha^2$  locality of the drying-kiln through opening 25, at the  $\alpha^3$  locality through opening 25<sup>a</sup>, at the  $\alpha^4$  locality through opening 24, at the  $\alpha^5$  locality through opening 24<sup>a</sup>, and at the  $\alpha^6$  end of the drying-kiln through opening 23. The moisture-laden air passing through openings 26, 25, and 25<sup>a</sup> may and does pass

through the horizontal passage-way 11 toward and out of the outlet 20. The moisture-laden air passing through openings 24, 24<sup>a</sup>, and 23 passes into the vertical passage-way 12, and a portion thereof passes upward in said passage-way to and through the passage-way 11 and out of the drying-kiln through outlet 20, the remainder thereof passing downward in passage-way 12, and from thence through the horizontal passage-way 10 back into the drying-kiln underneath the heating-coils A and B. It is also from the action discharging heated air from the drying-kiln from outlet 20, as last above described, that cool air or fresh air enters the roof-inlets 21 21 and flows through the ceiling passage-ways or flues 15 through the wall passage-ways or flues 13 13 to and through the floor passage-ways or flues 14 to and beneath the heating-coils A and B and is there discharged into the drying-kiln.

The floor 1, side walls 2 and 3, and the ceiling 9 are preferably double-boarded, respectively, with felt paper between the boards. Therefore the inlet and outlet passage-ways are the only channels by which air can enter and escape from the drying-kiln and the results sought occur as described.

The circulation in the drying-room of a drying-kiln constructed and heated as hereinbefore described is not forced throughout the length thereof, is regulated to suit the condition of the material being dried, and is automatic. Such circulation is not, however, rapid in character, a rapid movement of the air in the drying-room inducing drafts and not being deemed by me advantageous and the downdraft for the inflowing air is for that reason employed. As the air in the drying-kiln is heated it is in a measure retarded in its rise by the counteraction of the down-flues, and only as the air laden with moisture passes out through the outlets at the top of the drying-kiln is the lower strata of air permitted to rise in the drying-kiln and a corresponding supply to descend through the down-flues, as shown and described. I therefore retain the air in the drying-kiln as long as possible to obtain therefrom as much effect as possible before its discharge therefrom. As the air at the  $a'$  end of the drying-kiln becomes more heavily laden with moisture in a given time than does the air at the  $a^6$  (discharge) end of such drying-kiln, the outlet-openings at the  $a'$  end are placed in the center of the ceiling 9. At the  $a^2$  locality such openings are placed in the ceiling, to one side of the longitudinal center thereof. At the  $a^3$  locality such openings are placed in the ceiling adjacent to the side walls 3 3, and at the  $a^4$ ,  $a^5$ , and  $a^6$  localities, respectively, such openings are placed in the side walls 3 3 at successively lower planes, those at locality  $a^6$  being the lowest.

In operation it occurs that substantially all the air laden with moisture which passes through the openings in ceiling 9 will pass out of the outlets 20 20 communicating there-

with, while at the  $a^6$  end of the drying-kiln a portion of the moisture-laden air passing through the openings through side walls 3 3 will pass down and back into the drying-kiln underneath the heating-coils, as hereinbefore described, a portion thereof will pass from the outlets 20 20, and a less portion of such moisture-laden air passing through the openings in the side walls 3 3 will pass down and back into the drying-kiln at localities  $a^5$  and  $a^4$ . In those localities in the drying-kiln where the openings are in the side walls 3 3 the discharge of moisture-laden air will be slower, (particularly at the  $a^6$  end,) as such air will rise to the ceiling and be there banked, there being no opening in the ceiling for it to pass out and from the kiln. Also lumber when it first enters the drying-room should be subjected to and remain in a low drying temperature until the heat has thoroughly permeated such lumber, after which the temperature can be gradually raised to a high drying temperature without injury to the fibers of the lumber if proper (and the hereinbefore described) means are provided to retain sufficient moisture in the drying-kiln to keep the surface of the lumber soft or open, and for such reason the graduated heating-surface of the steam-coils A B, as described, is employed, as well as the special arrangements for discharging moisture-laden air and admitting fresh air and the return of a portion of the moisture-laden air to the drying-room where needed.

It will be observed that during the third and succeeding stages of drying lumber it dries very rapidly and rupture of the fibers is liable to occur unless means are provided for retaining moisture in the drying-kiln at such localities, particularly in hard woods which are partially dry before being placed in the drying-kiln. When lumber green from the saw is put into the drying-kiln, especially lumber which is made from the softer woods, as such lumber is not liable to be injured by rapid drying it will be sufficient to make all of the outlet-openings through the ceiling 9 and none through the side walls 3 3 to give quicker movement to the air in the drying-kiln and consequent quicker operation of the drying-kiln, and, if required, to partially close the openings of some of them by covers 26<sup>a</sup> 26<sup>a</sup>.

The connecting spring-pipes E E vary in size preferably, so that the force required to drive steam from header 32 through each one of these several pipes extending outward therefrom through the connecting spring-pipe and the pipe extending from such connecting spring-pipe to the header 33 will be the same approximately—that is, in a short pipe extending out from header 32 (called by me a "header-pipe") the connecting spring-pipe connecting such header-pipe with a short return header-pipe to header 33 is restricted, so that the same force, substantially, is required to drive steam from one header through such short header-pipe, the connecting spring-pipe

E, and the return short header-pipe to header 33 as is required to force steam through a long header-pipe, the connecting spring-pipe thereof, E, and back to such header 33 in the connected long header-pipe. It therefore occurs that the connecting spring-pipe E is preferably of less diameter in the short header-pipes than in the long header-pipes, and the variation in diameter of the connecting spring-pipes E E corresponds with the variation in length of the header-pipes, increasing in diameter from that of the connections between the short header-pipes to that of the connections between the long header-pipes. If, however, the diameter of the connecting spring-pipes is with relation to the diameter of the header-pipes such that the connecting spring-pipes joining the short header-pipes form a substantial barrier to the passage of steam from the upper pipe to the lower one, different diameters in the connecting spring-pipes are not required in practical use. To give an approximate idea of the difference in diameter of the header-pipes and the connecting spring-pipes where one diameter is retained in the spring connecting-pipes, I may say that I have heretofore constructed drying-kilns embodying this invention with header-pipes of one-inch diameter, varying in length from thirty feet to sixty feet, with connecting spring-pipes of three-eighths of an inch in diameter and about three feet in length, and also I have constructed such steam-coils with the header-pipes, as above stated, with the connecting spring-pipes of one-half inch in diameter.

Ceiling 9 is placed on the ceiling-joists 7 7 7 and underneath the rafters 8 8 8 to prevent warping of such ceiling in the drying of green lumber when the air in the drying-kiln is at times heavily laden with moisture. When partially-dried lumber only is to be dried in the drying-kiln, the ceiling-joists 7 7 7 may be omitted.

Where a drying-kiln is constructed by me for the specific purpose of drying southern pine green from the saw, the coil B is placed on both sides of the drying-room, and in such case the header-pipes are made as nearly of the same length as possible, and the connecting spring-pipes E E are made of the same diameter as the header-pipes. In such case, too, the header-pipes are made of the same diameter the entire length thereof. In such case the function of the connecting spring-pipes is not extended to producing back pressure in the header-pipes, but provision for the expansion and contraction of the header-pipes is thereby made.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination with a drying-kiln, of steam-headers and steam-pipes arranged in an upper and a lower series extending upward and outward from the steam-headers, such pipes being of varying lengths, and con-

necting spring-pipes joining the pipes of the upper series of header-pipes with the pipes of the lower series, the diameter of the connecting spring-pipes increasing correspondingly with the increase in length of the header-pipes joined thereby, whereby a restricted passage-way for steam between a pipe of the upper series to a pipe of the lower series is obtained and the force required to send steam from one header to the other will be substantially the same in each of the pipes extending out from such header; substantially as described.

2. In a drying-kiln having inlet and outlet passage-ways through the roof thereof and provided with openings through the ceiling into the outlet passage-ways at one end of the drying-kiln and through the inner walls thereof into the outlet passage-ways at the other end thereof, such openings through the ceiling successively approaching the inner side walls and those in the inner side walls successively located in a lower plane, the combination of steam-coils comprising headers located at the end of the drying-kiln having openings through the inner side walls to the outlet passage-ways, an upper and a lower series of header-pipes of varying lengths extending outward and upward from the headers, respectively, and connecting spring-pipes joining the header-pipes of the upper series with header-pipes of the lower series such joined header-pipes being in different vertical planes; substantially as described.

3. In a steam heating-coil for a drying-kiln, the combination of steam-headers, a series of header-pipes extending upward and outward from each of such headers, and connecting spring-pipes joining the header-pipes of the upper series with corresponding pipes of the lower series, the radiating-surface of the several pipes of such steam heating-coil being less at the joined ends of the header-pipes thereof than at the header ends of such header-pipes; substantially as described.

4. In a steam heating-coil for a drying-kiln, the combination of horizontally-extending headers placed in different planes, a series of header-pipes extending upward and outward from each of such headers and connecting spring-pipes joining the header-pipes in the upper series to the header-pipes in the lower series, means for equalizing the force required to send the steam from one header through connecting spring-pipes to the other header, and means for successively diminishing the radiating-surface of the several pipes of the steam-coil as the distance thereof from the headers increases; substantially as described.

5. In a drying-kiln provided with alternate inlet and outlet passage-ways through the roof thereof communicating with horizontal passage-ways above the ceiling and provided with vertical passage-ways on the sides of the drying-room of the kiln communicating with such horizontal passage-ways, a ceiling, a



floor and inner side walls, and a steam-coil supported above the floor, such drying-room provided with communicating openings therefrom to the outlet passage-ways above the steam-coil, such openings extending through the inner side walls at one end of the drying-room and through the ceiling at the other end thereof, and with communicating openings therefrom below the steam-coil to the inlet passage-ways; substantially as described.

6. In a drying-kiln having inlet and outlet passage-ways through the roof thereof, with openings through the ceiling into the outlet passage-ways at one end of the drying-kiln and through the inner walls thereof into the outlet passage-ways at the other end thereof, such openings in the ceiling successively approaching the inner side walls and those in the inner side walls successively located in a lower plane, the combination of inner and outer walls, a floor, a false floor extending to underneath the heating-coils of the drying-kiln, a ceiling and a roof, such roof having openings therethrough and such drying-kiln having passage-ways from the openings in the roof to underneath the heating-coils, between the ceiling and the roof, the inner and outer walls and the floor and false floor thereover; substantially as described.

7. In a drying-kiln, the combination of vertical studding, inner and outer walls secured to such studding rafters adjacent to the studding, a ceiling and a roof secured to the rafters, whereby a series of communicating vertical and horizontal passage-ways are obtained, such roof having openings there-

through, a steam heating-coil above the floor of the drying-room of the kiln, such drying-room provided with communicating openings therefrom to alternate passage-ways, such openings located above the plane of the steam heating-coil, and such drying-room provided with additional openings located below the plane of the steam heating-coil communicating with the remaining passage-ways; whereby alternate outlet and inlet passage-ways are obtained through the roof of the drying-kiln; substantially as described.

8. In a drying-kiln, the combination of vertical studding, inner and outer walls secured to such studding rafters adjacent to the studding, a ceiling and a roof secured to the rafters, whereby a series of communicating vertical and horizontal passage-ways are obtained, such roof having openings there- through, with means for establishing communication between the drying-room of the kiln and the passage-ways communicating with alternate openings through the roof, whereby alternate outlet passage-ways are obtained through the openings in the roof, and with means for establishing communication between the drying-room and the remaining passage-ways from a lower plane of the drying-room, whereby alternate inlet passage-ways are obtained through the openings in the roof; substantially as described.

HORACE J. MORTON.

In presence of—

L. D. MORRIS,  
FLORA L. BROWN.