P. W. TURNER.

DRYING KILN.

APPLICATION FILED SEPT. 20, 1915.

1,221,776. Patented Apr. 3, 1917.

Fig. 1.

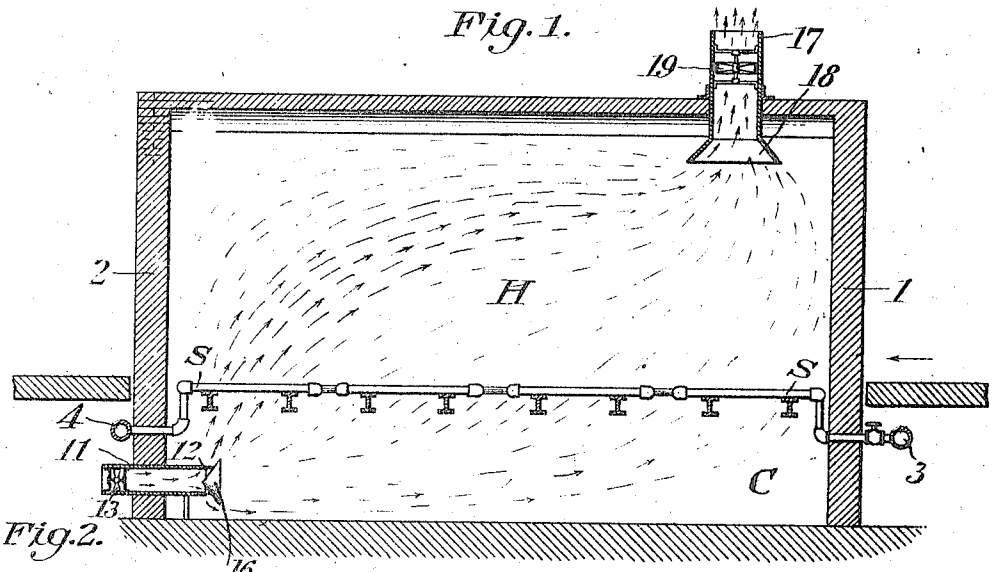


Fig. 2.

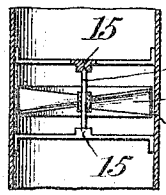


Fig. 5.

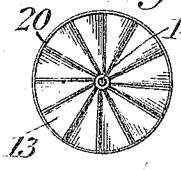


Fig. 4.

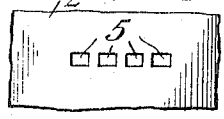
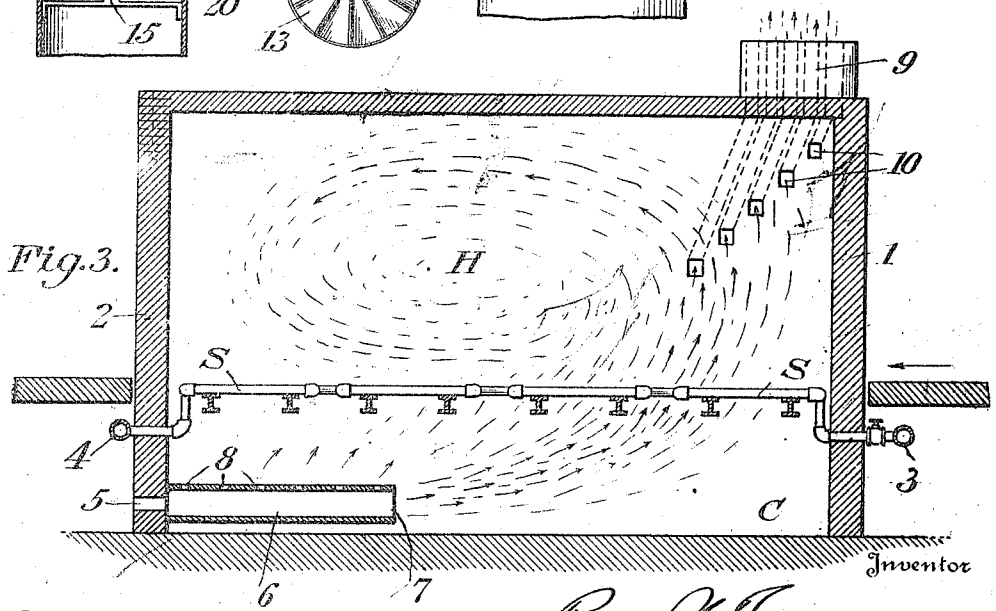


Fig. 3.



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UNITED STATES PATENT OFFICE.

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DRYING-KILN.

1,221,776. Specification of Letters Patent. Patented Apr. 3, 1917.

Continuation of application Serial No. 31,498, filed June 1, 1915. This application filed September 20, 1915. Serial No. 51,565.

To all whom it may concern:

Be it known that I, PERRY W. TURNER, a citizen of the United States, and a resident of Myndus, New Mexico, have invented certain new and useful Improvements in Drying-Kilns, of which the following is a specification.

This application is a continuation of my previous application Serial Number 31,498, filed June 1, 1915, for drying kiln, with modifications and improvements thereon.

My invention is especially adapted to drying kilns for lumber, but it is capable of use for drying bricks and other purposes. It will be sufficient herein to explain the invention as applied to a lumber kiln.

Kilns heretofore used for lumber are objectionable for one or more of the following reasons: incomplete or inefficient drying; excessive checking or splitting of lumber; "case-hardening" due to redeposit of moisture upon the lumber. These difficulties are believed to be due principally to improper or inefficient circulation, as will be more particularly explained hereafter.

One of the principal results obtained by my invention is to provide efficient circulation of the proper amount of air. In a long test under severe conditions a kiln embodying my invention has properly dried more lumber in the same time, or has more perfectly and uniformly dried the same amount of lumber in a shorter time, has reduced checking and splitting to a marked degree and has entirely avoided case-hardening, as compared with ordinary kilns of substantially the same nominal capacity.

The characteristics and advantages of my invention will be further described hereafter so far as may be necessary to enable persons skilled in the art to understand the same, in connection with a detailed description of the accompanying drawing, which shows one typical form of kiln previously used and also shows an exemplifying embodiment of my invention.

Figure 1 is a longitudinal vertical section through a kiln embodying my invention. Fig. 2 is an enlarged detail of the same. Fig. 3 is a longitudinal vertical section of a typical old form and Fig. 4 is a detail of the same. Fig. 5 is a face view of the regulating fans.

In previously approved kilns, of which Fig. 3 is one typical example, there is a cold air chamber C, above which is a hot chamber or drying chamber H. These chambers are inclosed in walls which are usually of brick with suitable provision for heat insulation and the drying chamber is suitably roofed with proper heat insulation. At the ends 1 and 2 are doors for the entrance and exit respectively of cars carrying lumber properly racked to permit the passage of air between the boards. The details of the building, doors and means for handling the lumber into and out of the kiln, are not of special importance and will not be particularly described. These arrangements may be any suitable ones well known in the art. Supported by suitable beams between the cold air chamber and the drying chamber is a grid of steam pipes S and steam is usually supplied to these pipes from a main at 3 and discharged at 4 so that the circulation of steam in the heating coils substantially corresponds with the course of the lumber through the kiln.

Air is supplied to the cold chamber through a plurality of flues 5 (shown in front elevation Fig. 4) which communicate with an oblong conduit 6 open at the discharge end 7 which is some distance from the rear wall of the kiln—usually about one-third of the length of the kiln. This conduit 6 is provided with narrow transverse openings 8 at intervals in the top, the purpose of which is to discharge air upward at intervals. At the front end of the roof upon one or both of the side walls is a chimney or stack 9, containing the discharge flues connected with discharge openings 10 usually arranged diagonally in the side walls of the drying chamber, the discharge openings and stack for one side of the kiln being clearly shown in Fig. 3. The cubic capacity of the discharge stack is usually considerably greater than that of the supply conduit 6 and its flues.

It has been found that kilns constructed

as described fail to dry lumber as quickly or as completely and uniformly as desired; that they frequently accumulate moisture upon the roof which drops back upon the lumber, also that there is a tendency for moisture extracted from the lumber near the entrance end 1 to be redeposited upon lumber near the exit end 2. This redeposit of moisture by dripping from the roof or directly from the air in the kiln causes the effect known as "case-hardening" in many cases. There is also an undue amount of checking and cracking of the boards. The principal cause of these difficulties is believed to be the fact that air does not circulate properly in the kiln. Instead of passing through the slits 8 in the top of conduit 6 to any considerable extent, the principal amount of air introduced into the cold chamber issues at the discharge end 7 under the influence of the draft from the stack 9. Most of the cold air therefore passes up through the heating coils between the center and front end of the drying chamber and after extracting moisture from the lumber a considerable part of the hot moist air passes out of the stack through the openings 10, but a substantial part of the air also returns toward the discharge end of the kiln and completes a circuit of air therein, indicated by light lines and arrows in Fig. 3. The circulation set up by the course of air from the supply conduit to the stack causes air containing moisture drawn from the lumber near the end 1 to circulate toward the discharge end 2. Being already loaded with moisture this air does not have proper capacity to withdraw moisture from the lumber near the discharge end, and on the contrary, there is a notable tendency for moisture to be redeposited upon the stacks of lumber which are soon to be discharged at the end 2. There is also frequently an accumulation of moisture upon the roof and this drips back upon the lumber. This effect is noticeable in lumber discharged, because it is frequently found that some of the lumber, and especially that in the center of the stacks, is quite moist even when the outer lumber of the stack is comparatively dry. Owing to the high temperature in the drying chamber it is impossible to make exact tests of the circulation, but the theory given to account for the deficiencies of the kiln is based upon the closest possible observation and accounts in a reasonable, and it is believed in a correct, way for the results obtained. The circulation consequent upon the conditions described is also believed to produce undesirably variable temperatures in the drying chamber and th variations of temperature are supposed to be responsible for the checking and splitting of the lumber which is often noticed. With kilns in use up to the completion of my invention it is often found to be difficult, even with the expenditure of liberal amounts of fuel, to maintain a sufficiently high temperature in the drying chamber and this is believed to be largely due to the fact that an unnecessarily large quantity of air is passing through the kiln in connection also, of course, with the inefficient circulation produced in the drying chamber, evidenced by the results obtained and theoretically accounted for as above.

Fig. 1 shows one embodiment of my invention which obviates or decidedly lessens the difficulties above mentioned. The kiln is constituted as previously described, except with respect to the circulation system. In place of the air supply means formerly used I provide usually a single intake flue or pipe 11, usually of round section and preferably located substantially centrally of the width of the front wall of the cold air chamber. This flue terminates at 12, a short distance within the cold chamber. Within this flue and usually near the intake end thereof is a regulating device 13, which in a preferred form consists of an automatically acting rotary regulating device. More particularly described this is, in the most improved form of the invention I have up to the present time devised, a rotary bladed fan, as shown in enlarged section in Fig. 2. The shaft or spindle 14 of this fan is parallel to the axis of the flue and is supported by suitable bearings 15 carried by suitable supports within the flue. It has been found usually desirable to permit the fan to run as freely as possible and for that purpose easy running cone or roller bearings may be used. If it is found by experiment that such free running bearings are not necessary or desirable, plain bearings or other suitable mounting for the fan or equivalent regulating device may be employed.

At the discharge end of flue 11 is a deflector or diffuser 16, consisting in this embodiment of a shallow cone or pyramid of sheet metal having its apex located slightly within the discharge end of the flue. A small substantially annular discharge space is thus afforded between the end of the flue and the face of the diffuser. This diffuser may be suitably supported in any convenient way in the position shown and details of the supporting means are therefore not particularly described.

In place of the discharge stack ordinarily employed I provide for a kiln of ordinary dimensions, a single discharge flue or pipe 17 which may be located substantially centrally in the roof of the hot chamber and near the end 1 or lumber entrance end thereof. The intake end of this exhaust flue is

preferably larger than the discharge end. In the present embodiment desired results are obtained by providing the flue with a flared intake 18 and this is located considerably below the top of the drying chamber. Within the flue and preferably near the top thereof is a regulating device 19 consisting in this embodiment of an automatic rotary bladed fan substantially the same as the intake fan, except for dimensions. As clearly indicated in the drawing, the discharge flue is substantially larger than the intake flue. The relative sizes of the flues may be varied somewhat, but in a satisfactory working embodiment of the invention I have employed the following dimensions: intake flue, diameter 12 inches; exhaust flue, diameter 28 inches. In the present embodiment this exhaust regulating device or fan is mounted to freely rotate in bearings similar to those used for the intake fan. A satisfactory detail of fan construction consists in connecting the tips of the diagonally arranged blades to a ring 20 of sheet metal. This ring runs very close to the inside of the respective flue.

When the kiln constructed as described is properly charged with green lumber and heat supplied through the steam pipes, expansion of air in the drying chamber causes an exhaust through flue 17 and the movement of air through the flue causes the fan 19 to revolve. Air enters the cold chamber through flue 11 and causes the fan 13 to revolve at such speed as to supply the proper amount of air to take the place of the air exhausted through flue 17. The entering air strikes baffle plate 16 and is to a considerable extent diffused throughout the cold chamber and rises through the grid of steam pipes in accordance with the draft created by the heat therein. A large part, and probably a major part, of the entering air however passes upward through the part of the steam coil nearer to the end 2 of the kiln. The current of the circulation of air is indicated by broken lines and arrows in Fig. 1, the heavier portion of the circulation lines indicate the probable course of the major part of the air. There is a large expansion of air in the drying chamber due to the heat supplied thereto and this expansion is probably considerably augmented by the expansion of water vapor drawn from the lumber. This expansion, it is believed, causes a noticeable pressure, especially near the top of the chamber H and this pressure causes a vigorous discharge of moisture laden air through the exhaust flue and the exhaust fan 19 rotates rapidly in accordance with the discharge of air through it. It is also believed that the properly selected capacity of the intake flue 11, combined with the baffling and regulating effect of the intake fan 13 and the retarding and diffusing effect of the baffle plate 16, creates a reduced pressure in the cold chamber and in the lower part of the hot air chamber. Probably the pressure in these parts of the kiln is decidedly below atmosphere and where this effect is obtained the evaporating capacity of the heat supplied is markedly augmented. It is supposed that the circulation from the intake to the exhaust flue is practically direct at all the parts, or most all parts, of the kiln, without any considerable return currents or eddies and that this circulation is approximately proportional to the proper requirements of the lumber in different parts of the kiln. It is found that there is little or no tendency for moisture to collect upon the roof of the drying chamber and practically no tendency for moisture to be redeposited upon the lumber. It is also found that lumber comes from the discharge end 2 of the kiln in a remarkably dry condition with unusual freedom from checks or splits. This indicates that the lumber, which becomes drier as it is moved from the entrance to the exit end of the kiln in the progressive loading and discharge of lumber, is progressively dried and that the lumber about to be discharged receives an ample current of dry hot air, which removes from it the last trace of moisture. This complete drying of the discharged lumber without the redeposit of moisture thereon indicates clearly that there is such circulation as to substantially eliminate recondensation.

It is also found that this kiln is remarkably free from the effect of atmospheric conditions, such as moisture, wind pressure and direction, etc. While each of the rotary fans evidently revolves in accordance with the air pressure imposed upon it, the results obtained from the kiln indicate that these fans have a mutual and coöperative baffling and regulating effect, which is not obtained in kilns having unrestricted or manually controlled supply and discharge flues. The impact of air directly against the blades evidently checks the speed of the air while it causes the fan to rotate and diverts the air tangentially and this tangential or whirling movement of air in the intake pipe is possibly responsible to a large extent for the proper diffusion of air in the cold chamber and its proper circulation in the drying chamber without return currents. The discharge fan 19, in addition to its other functions, is also believed to have a considerable effect in baffling heat and retaining heat within the hot chamber to a greater extent than ordinary, while at the same time permitting the discharge of moist air with sufficient freedom. As previously stated, ordinarily a smaller quantity of air is circulated

through this kiln than is ordinarily the case, but the circulation is more efficient, therefore with the same amount of heat supplied the average temperature will be greater and the drying more effective.

When the temperature in the kiln is relatively low, as, for instance, after the kiln has been opened for discharging lumber and recharging with green lumber, the draft is relatively moderate; but if the flues 11 and 17 were of sufficient area to admit sufficient air for all conditions, the draft even at the low temperature, except for the regulating fans 13 and 19, would be sufficient to pass through the kiln more air than could be efficiently heated. The result would be inefficient drying because a relatively large volume of air at low temperature has an inferior capacity to extract moisture from the lumber. But the employment of the automatic regulating devices 13 and 19 offers suitable resistance to the relatively moderate draft and reduces the air supply to the quantity that may be efficiently heated at the relatively low temperature of the kiln. As the temperature builds up the draft increases and the regulating fans by revolving faster permit a greater amount of air to pass through the kiln; but the fans at the same time exert a proportional regulating effect and prevent the passage of so much air as would be admitted without them; in other words, the quantity of air is suitably varied at different temperatures, but is at the same time regulated so that only so much air is passed through the kiln as may be effectively heated, and this air in turn acts most efficiently in extracting moisture from the lumber.

It has been found that under substantially the same conditions a much more uniform temperature and a higher average temperature is obtained with my invention than has been previously the case. In one test run 33 temperature readings were made at suitable intervals of a kiln embodying my invention and a kiln otherwise similar except that it has a decidedly larger heating surface and ordinary circulation system. These readings showed an average temperature in my kiln of 213° and in the other kiln 195° with the same steam supply. This temperature difference is of more value than the mere percentage difference, because at the higher temperatures an additional few degrees has a relatively greater effect than the same number of degrees at lower temperatures.

I have given above what I believe is the correct theory of operation of my invention, but owing to the working conditions and especially the temperature within the hot chamber, positive circulation tests cannot be made and the theory of operation is deduced largely from results noted. Whatever the exact operation of the device may be, there is a very decided improvement in drying efficiency as compared with previously used devices and this improvement is, in a few words, undoubtedly due to improved and efficient circulation afforded by the coöperation of the devices described.

The fan blades employed are usually quite wide and overlapping and set at a very obtuse angle to the axis of the flue; but these conditions may vary in some cases and different types of fans or rotary valves or other equivalent regulating devices may be employed where desired.

I have described one supply and one discharge flue for a kiln and this will probably be suitable in kilns of standard size, but in some cases, as where the kiln might be unusually wide, two or more supply or discharge flues or both might be used.

The combination of all the elements described is probably the most desirable for efficient drying, but it is to be noted that the coöperation of less than all of the elements may produce an improved result as compared with previous structures. For instance, the baffle plate 16 without the fan, in combination with suitable flues will produce an improved result. In some cases improved results from those formerly obtained would be noted if the exhaust regulating device were omitted while retaining the intake regulating devices as described.

I claim:

1. In a drying kiln, the combination of a drying chamber, a cold air chamber therebelow, heating pipes between the chambers, an air supply for the cold chamber, baffling means therefor and a discharge flue passing through the roof of the drying chamber near one end thereof and terminating in an enlarged inlet below the top of said chamber.

2. In a drying kiln, the combination of a drying chamber, a cold air chamber therebelow, heating pipes between the chambers, an air supply flue for the cold chamber, a rotary regulating device therein, a diffusing device for said flue, a larger discharge flue for the drying chamber and a rotary regulating device therein.

3. In a drying kiln, the combination of a drying chamber, a cold air chamber therebelow, heating pipes between the chambers, a supply flue for the cold chamber, a rotary bladed regulating device therein, a discharge flue for the drying chamber and a rotary bladed regulating device therein.

4. In a drying kiln, the combination of a drying chamber, a cold air chamber therebelow, heating pipes between the chambers, a supply flue for the cold chamber, an automatic rotary bladed regulating device in the flue rotating in a transverse plane there-

of, a baffling device at the rear end of the flue, a discharge flue at the top of the drying chamber and an automatic rotary bladed regulating device therein rotating in a transverse plane of said flue.

5. In a drying kiln, the combination of a drying chamber, a cold air chamber therebelow, heating pipes between the chambers, a supply flue for the cold air chamber, a rotary bladed regulating device in said flue, a discharge flue for the drying chamber terminating therein below the top of the chamber and a rotary bladed regulating device in said discharge flue.

6. In a drying kiln, the combination of a drying chamber, a cold air chamber therebelow, heating pipes between the chambers, a supply passage for the cold air chamber, a rotary bladed regulating device in said flue, a discharge flue for the drying chamber terminating therein below the top of the chamber, the intake end of said discharge flue being larger than the exhaust end thereof and a rotary bladed regulating device in said discharge flue.

7. The combination of a drying chamber, a cold air chamber therebelow, heating means between the chambers, an air supply flue for the cold air chamber, a discharge flue for the drying chamber entering said chamber below the top thereof and a rotary regulating device to regulate discharge of air from said drying chamber.

8. The combination of a drying chamber, a cold air chamber therebelow, heating means between the chambers, a supply flue for the cold air chamber provided with a baffle plate and a discharge flue for the drying chamber terminating therein below the top thereof.

9. In a drier of the class described, the combination of a drying chamber, a cold air chamber thereunder, a layer of heating pipes located in position to heat air as it passes from one chamber to the other, an air supply flue for the cold air chamber, a discharge flue for the drying chamber, and a rotary regulating device for the cold air.

10. In a drier of the class described, the combination of a drying chamber, a cold air chamber thereunder, a layer of heating pipes located in position to heat air as it passes from one chamber to the other, an air supply flue for the cold air chamber, a discharge passage for the drying chamber, and baffling means adjacent to the discharge point of the air supply flue.

11. In a drier of the class described, the combination of a drying chamber, a cold air chamber thereunder, a layer of heating pipes located in position to heat air as it passes from one chamber to the other, an air supply flue for the cold air chamber, a discharge flue for the drying chamber, and a rotary regulating device for the discharge flue.

12. In a drier of the class described, the combination of a drying chamber, a cold air chamber thereunder, a layer of heating pipes located in position to heat air as it passes from one chamber to the other, a supply flue for the cold air chamber, a rotary regulating device in said flue, baffling means adjacent to the discharge end of said flue, a discharge flue for the drying chamber, and a rotary regulating device in said discharge flue.

13. In a drier of the class described, the combination of a drying chamber, a cold air chamber thereunder, a layer of heating pipes located in position to heat air as it passes from one chamber to the other, air supply means for the cold air chamber comprising means for regulating the admission of air and diffusing through the cold chamber air supplied thereto, a discharge flue for the drying chamber, and regulating means therein actuated by the air passing through said flue.

14. In a drier for lumber or the like, the combination of a drying chamber, an air chamber thereunder, heating pipes, an air supply flue for the air chamber, a discharge flue for the drying chamber, and a regulating fan in said discharge flue actuated by the discharged air.

15. In a drier for lumber or the like, the combination of a drying chamber, an air chamber thereunder, heating pipes, an air supply flue for the air chamber, a discharge flue for the drying chamber, and a regulating fan in said air supply flue actuated by the entering air.

16. In a drier for lumber or the like, the combination of a drying chamber, an air chamber thereunder, heating pipes, an air supply flue for the air chamber, a discharge flue for the drying chamber, and a regulating fan in the discharge flue rotating on an axis substantially parallel with the flue.

17. In a drier for lumber or the like, the combination of a drying chamber, an air chamber thereunder, heating pipes, an air supply flue for the air chamber, a discharge flue for the drying chamber, and a regulating fan in the air supply flue rotating on an axis substantially parallel with the flue.

18. In a drier for lumber or the like, the combination of a drying chamber, an air chamber thereunder, heating pipes, an air supply flue for the air chamber, a discharge flue for the drying chamber, and a regulating fan in the discharge flue rotating on an axis substantially parallel with the flue, said fan being impelled only by the air current in the flue.

19. In a drier for lumber or the like, the combination of a drying chamber, an air chamber thereunder, heating pipes, an air supply flue for said air chamber, a discharge

flue for the drying chamber, and a regulating fan in the air supply flue rotating on an axis substantially parallel with the flue, said fan being impelled only by the entering air.

20. In a drier for lumber or the like, the combination of a drying chamber, an air chamber thereunder, heating pipes, an air supply flue for the air chamber, a discharge flue for the drying chamber, a regulating fan in said supply flue and a regulating fan in said discharge flue, said fans being impelled only by their respective air currents.

21. In a drier of the class described, the combination of a drying chamber, an air chamber thereunder, heating pipes located in position to heat air as it passes from the air chamber to the drying chamber, an air supply flue for the air chamber, a discharge flue for the drying chamber, and regulating means in one of said passages actuated by air passing through said flue.

PERRY W. TURNER.