Nov. 24, 1931. H. F. HAGEN 1,833,397

DRYING KILN

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Fig. 1

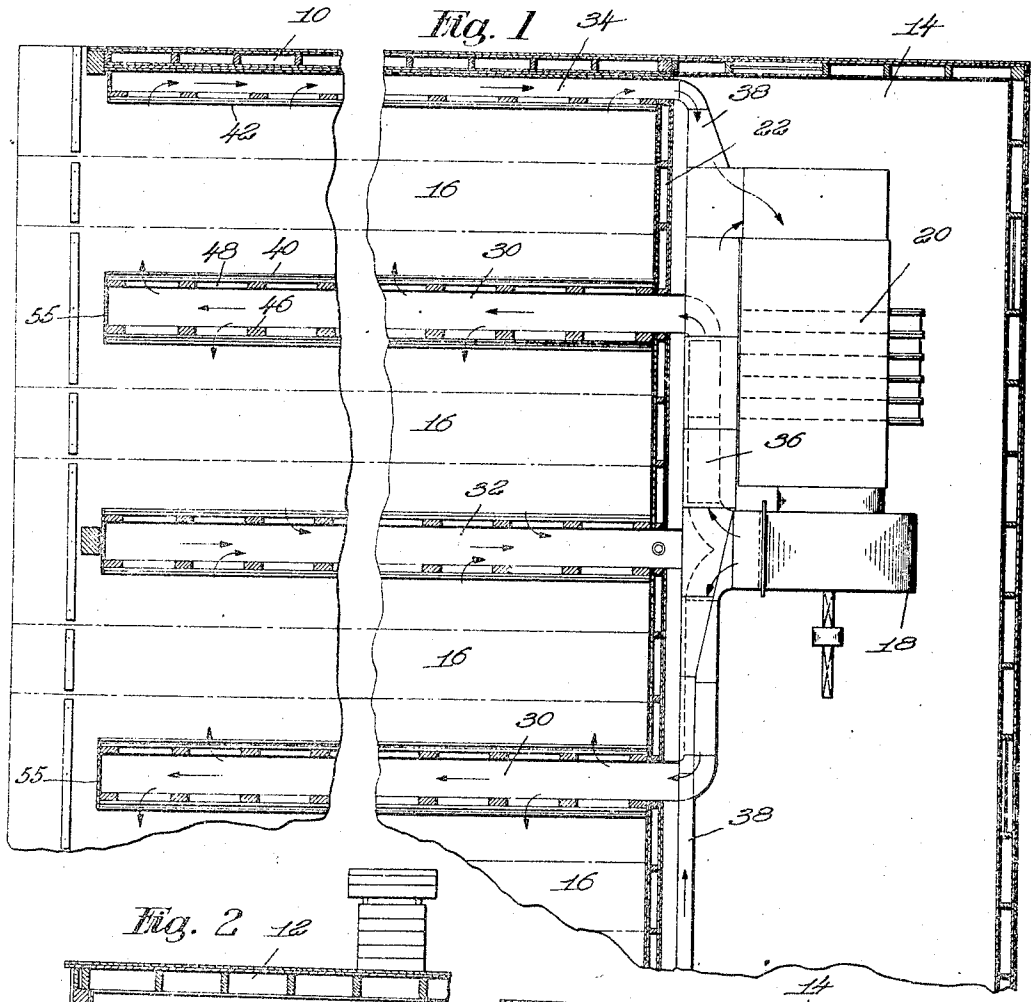
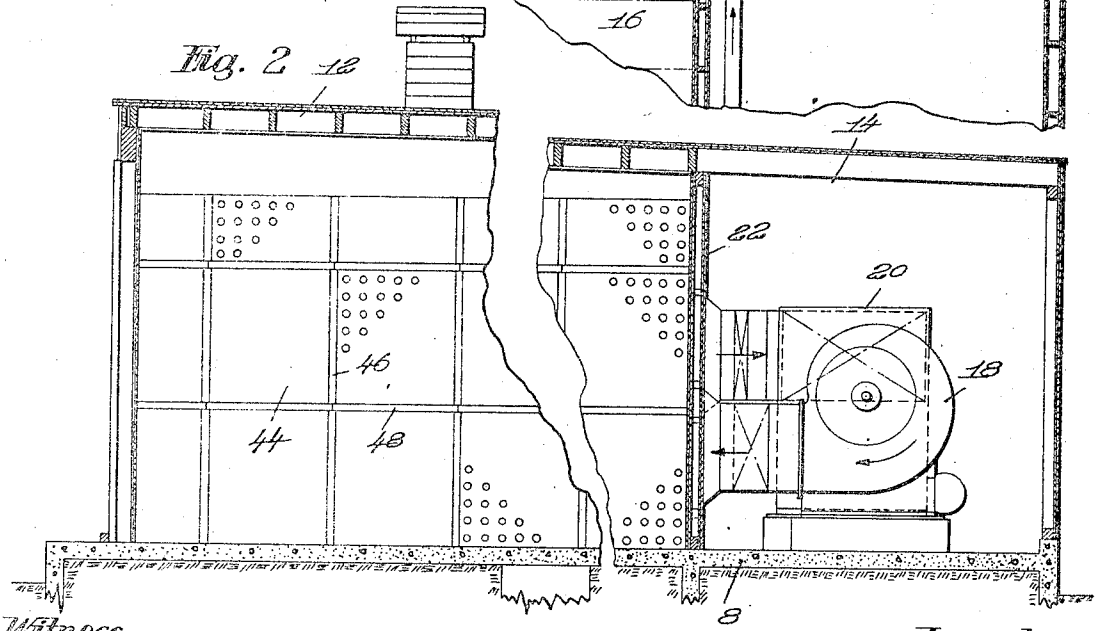


Fig. 2



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Fig. 3

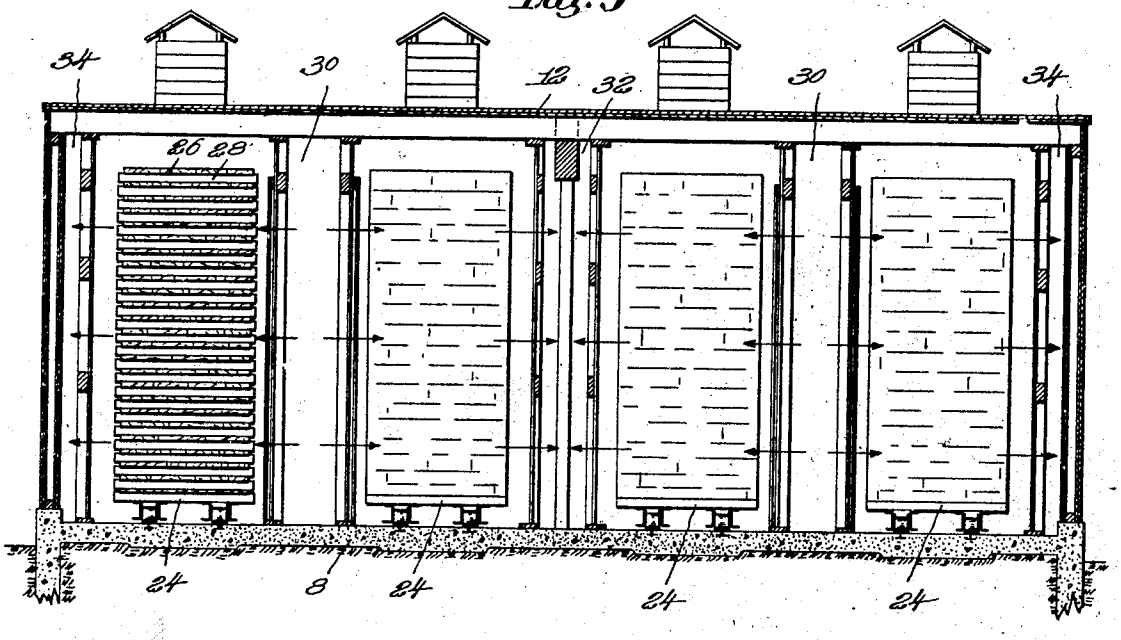


Fig. 4

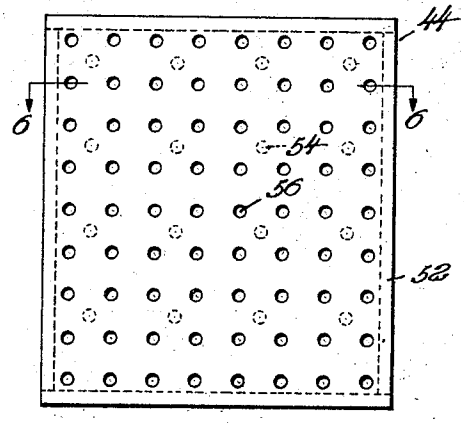


Fig. 5

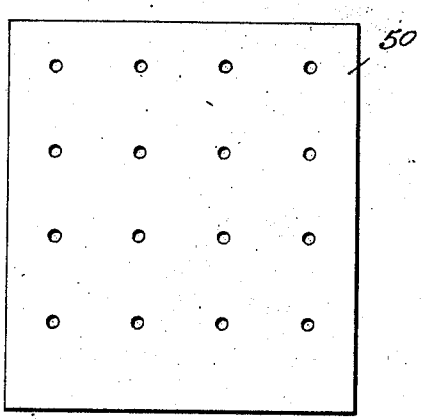
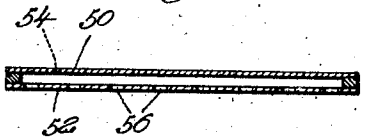


Fig. 6



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1,833,397

UNITED STATES PATENT OFFICE

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DRYING KILN

Application filed October 1, 1926. Serial No. 309,605.

The present invention relates to drying kilns.

In the drying of many materials such, for example, as lumber, it is very desirable that the drying shall proceed throughout the mass of material at the same rate, thus making it possible to obtain the desired degree of dryness, whatever it may be, for the entire product. In order to accomplish this result it is necessary that the drying air shall flow over and through the entire mass of material in substantially uniform amount and velocity, and it is the object of the present invention to provide a construction of drying kiln whereby such flow will be secured.

With this object in view the present invention consists of a drying kiln in which means are provided for securing a uniform and even distribution of the drying air throughout the transverse areas of the drying room or chamber, and for maintaining a constant head or pressure difference between oppoesd points of such transverse areas. These results are obtained according to the present invention by providing the walls at opposite sides of the drying room or chamber, transverse to the path of air flow, with uniformly distributed or spaced orifices for the passage of air therethrough, and supplying the drying air at a constant pressure to the inlet wall orifices. The loss of head measured from any point on the inlet or supply wall to a point on the outlet or return wall directly opposite thereto will, therefore, be the same as the loss of head between any other similarly opposed points on the surfaces of the walls, and the flow of air across the drying room or chamber will be the same in amount and velocity throughout the entire transverse section of the room.

An important feature of the present invention consists in supplying the air through the ducts at a relatively high pressure, and admitting it to the drying chamber at a relatively low velocity. This is accomplished through the provision of a wall on the supply side of the drying chamber consisting of two parallel partitions closely spaced and provided with uniformly arranged orifices. The space between the partitions forms a pressure chamber in which a uniform pressure head is maintained, with low velocity of flow. By providing the outer partition which lies between the air supply duct and such pressure chamber with orifices of considerably less total cross-sectional area than those in the inner wall between the pressure chamber and the drying chamber, and having the orifices in the two partitions out of register, a very uniform pressure of reduced amount will be maintained throughout this pressure chamber in the inlet wall, and a correspondingly highly uniform flow of air at reduced velocity secured throughout the entire inner partition and into the drying chamber. By the provision of an outlet or return wall provided with uniformly spaced orifices leading to the return ducts, the even distribution of drying air across the entire width of the chamber is maintained.

In the accompanying drawings illustrating the preferred form of the invention as applied to a kiln for drying lumber, Fig. 1 is a horizontal sectional view of as much of the kiln as is necesasry to describe the present invention; Fig. 2 is a sectional end elevation of the kiln; Fig. 3 is a vertical side elevation through the drying room of the kiln; Fig. 4 is a side elevation of a section of the double plate wall on the drying room side; Fig. 5 is an elevation of a plate forming part of the return wall; and Fig. 6 is a section on line 6—6 of Fig. 4.

The illustrated kiln comprises a cement foundation 8 and insulated outer walls 10 and a roof 12. The kiln is divided into a fan chamber 14 and a plurality of drying rooms 16. Within the fan chamber are received the centrifugal fan 18, which maintains a relatively high pressure in the supply ducts, and the air heating and humidifying apparatus 20 of any usual or preferred form.

The separate drying rooms are divided from the fan chamber by individual end partitions 22. The material to be dried is stacked on trucks 24 and rolled into the drying rooms on suitable rails in the usual manner. As shown in Fig. 3, the material to be dried comprises planks 26 of wood arranged

in horizontal rows and separated by the usual transversely arranged stickers 28. It is desirable that the material be stacked as uniformly as possible in order to present uniform resistances to the currents of air passing through the drying rooms.

The partitions between the separate drying rooms constitute a part of the supply and return ducts through which the air passes between the fan and the drying rooms. As shown in Figs. 1 and 3, there are two supply ducts 30, between the first and second and between the third and fourth drying rooms, a return duct 32 in the middle of the kiln between the second and third drying rooms, and return ducts 34 at the sides of the kiln. Conduits 36 connect the outlet of the fan with the supply ducts 30, and the return ducts 32 and 34 return the air to the conditioning apparatus 20 through suitable conduits 38.

Considering the right hand drying room of Fig. 3 which is shown in the upper part of Fig. 1, this drying room has a wall or partition 40 on the supply side and a wall or partition 42 on the return side, these walls being parallel to each other and perpendicular to the paths of air flow through the drying room. Each wall is made up as shown in Fig. 2 of a plurality of sections, each provided with orifices to permit the air to pass therethrough. As shown in Figs. 4 and 6, the inlet or supply wall 40 is composed of a plurality of sections indicated generally at 44 which are secured to suitable studs 46 and horizontal stringers 48. Each section 44 comprises two opposed closely spaced plates 50 and 52. The plate 50 which is on the supply or duct side of the wall has a number of orifices 54 and the plate 52 on the drying room side has a relatively greater number of orifices 56. These openings in the two plates, as shown in Fig. 4, are not in register. The side plate 50 for each section is illustrated as having 16 openings, while the plate 52 has 72 openings. The openings, except for the bottom row in the plate 52, are arranged so that one of the openings 54 is opposed to the center of a square of which the openings 56 form the corners, so that high pressure air from the supply duct 30 entering the openings 54 of the plate 50 strikes the imperforate portion of the plate 52, whereby its velocity head is reduced substantially to zero and a uniform, relatively low pressure within the chamber is built up.

In the preferred construction, the holes are approximately 3/8ths of an inch in diameter for both plates, the spacing between holes being three inches for the plate 50 and one and one-half inches for the plate 52. The separation between plates is small and may be as little as one-fourth of an inch.

The supply wall of the drying room, therefore, comprises in effect a pressure chamber of small dimensions in the direction of the flow of air and having provision for entrance of air into it at a relatively high velocity while permitting exit of air into the drying room at a relatively low velocity as determined by the greater number of holes in the plate 52. The air issuing from the holes 56 of the plate on the drying room side of the wall 40 comprises a large number of closely and uniformly spaced streams of air which are at a practically uniform velocity because of the uniform pressure built up within the pressure chamber. The streams are sufficiently close together so that there is a substantially uniform flow of air into the drying chamber.

The return wall of each drying room, as indicated at 42, comprises a plurality of plates of the type shown in Fig. 5, each of these plates being similar both as to size, number, and arrangement of holes as the plates 50 of the supply wall. Since there is a relatively small number of holes in the return plate, the velocity head of the air as it approaches the plate is largely converted into a pressure head which gives a substantially uniform pressure over all parts of the return wall. Under the influence of this pressure, the air is forced through the holes of the return wall at a relatively high velocity to enter the return ducts 32 and 34 from which it passes into the air conditioning apparatus.

The construction of the supply and the return walls of the drying chamber as above described, meets the most exacting requirements for uniformity of flow across the chamber and through the material to be dried. It is particularly advantageous in the drying of hard woods where uniformity of flow is necessary. For the drying of soft woods wherein the fibers are not so closely compacted as to resist the evaporation of moisture to as high a degree as in hard woods, the supply wall of the pressure chamber may be built up of single plates consisting either of the plates 50 alone or the plates 52 alone. For the single plate wall, the use of plates 50 having the smaller number of holes is preferable, not only because of the smaller expense, but also because of the greater and therefore more uniform building up of pressure on the supply side of the plate.

From Fig. 1 it will be seen that the sides of each of the ducts 30 consists of two of the walls 40 constructed as above described, the walls forming the sides of adjacent drying rooms. The ends of each duct 30 are closed by a vertical imperforate plate 55.

The provision of the return wall opposite the supply wall of each drying room is a feature of great importance. If no wall were provided at the return side, the head of air on the return side of the material to be dried would not necessarily be uniform over the entire transverse area of the drying room.

Instead of flowing in paths directly across the drying room, the air would tend to flow in oblique paths in such a manner as to enter the return ducts at the points nearest the fan chamber. By the provision of a perforated return wall which permits building up of a pressure within the drying room adjacent to it, the air within the drying room is reduced to a uniform head over the entire area of the wall. Inasmuch as the supply wall 40 also makes for a uniform head over the entire area of the supply side of the material to be dried, it will be seen that the loss of head from one side of the drying room to the other will be substantially the same for all perpendicular distances between opposite walls. The differences in head being uniform, the velocities of air flow will therefore be uniform, and stream lines perpendicular to the walls are thereby assured. All possibility of uneven drying of the material is therefore avoided.

In the operation of my improved drying kiln the cars or trucks are loaded or stacked outside of the kiln with the lumber to be dried arranged in horizontal layers with transverse separators or "stickers" between the layers of lumber in the usual manner. The trucks are then wheeled into the kiln, the doors closed, and the fan and conditioning apparatus set in operation.

If hard wood is to be dried, the double partition supply wall is used, and a pressure of from one-half to an inch of water is maintained by the centrifugal fan in the air supply ducts 30. With the partitions spaced as above described, and with the number, size and arrangement of orifices specified, the drying air will pass through the opening 54 in the duct partition at a relatively high velocity, approximately 3000 feet per minute, creating a pressure in the pressure chamber in the neighborhood of one-quarter of an inch. From the pressure chamber the air will pass through the orifices 56 in the inner partition and into the drying chamber at a velocity of about 800 feet per minute, and will create an even and uniform flow of air across the entire drying chamber of approximately twenty-five feet per minute. From the drying chamber the air passes through the orifices in the return wall into the return ducts 32, through which it is led back to the conditioning apparatus and the centrifugal fan for recirculation.

If the wood to be dried is of the softer varieties, the partition 50 in the duct side of the supply wall will be removed, permitting the drying air to pass directly from the supply ducts 30 through the orifice 56 on the partitions or plates 52 into the drying room. A greater quantity of drying air at higher velocities will, under these conditions, pass across the drying chamber, but owing to the construction of the supply and return walls, the flow will be uniformly the same for all transverse sections of the room.

It will be understood that although the perforated walls or partitions are described as forming the sides of the drying chamber, the invention is not limited to a construction in which these walls are vertically disposed, it being only necessary that they shall be parallel to each other and arranged so that they produce uniform heads on opposite sides of the material to be dried; for the purposes of the invention they may be horizontally arranged to permit vertical air flows, or may be arranged in any other direction perpendicular to the general direction of air flow.

Having thus described the invention, what is claimed is:

1. A kiln comprising a drying room, means for circulating air through the drying room including a pressure fan and supply and return ducts connecting the fan and the drying room, and a pressure chamber through which the air passes from the supply duct to the drying room comprising closely spaced, uniformly perforated partitions to afford a substantially uniform pressure over all parts of the pressure chamber, the total area of the perforations in the supply side of the chamber being less than in the drying room side.

2. A kiln comprising a drying room, a pressure fan and supply and return ducts for circulating air through the drying room, and a pressure chamber through which the air passes from the supply duct to the drying room comprising opposed closely spaced partitions each having perforations over their surfaces of approximately the same size but greater in number in the drying room side of the chamber than in the supply side to afford a substantially uniform pressure in all parts of the pressure chamber and a substantially uniform velocity of air into the drying room.

3. A kiln comprising a drying room, a pressure fan and supply and return ducts for circulating air through the drying room, a wall on the supply side of the drying room comprising oppositely disposed, closely spaced partitions to form a pressure chamber, the opposite partitions having uniformly arranged non-registering perforations whereby a substantially uniform pressure is permitted to build up in the pressure chamber to cause the air to flow with uniform velocity through the drying room.

4. A kiln comprising a drying room, a pressure fan and supply and return ducts for circulating air through the drying room, and a pressure chamber forming a wall at the supply side of the drying room and including closely spaced partitions through which the air passes to the drying room, the partitions having non-registering perforations small in number in the supply side to

cause air to enter at a relatively high velocity and maintain a uniform pressure in the pressure chamber, and relatively large in number in the drying room side whereby the air issues from the pressure chamber with a moderate velocity into the drying room.

5. A kiln comprising a drying room, a pressure fan and supply and return ducts for circulating air through the drying room, walls interposed in the path of the air flow on opposite sides of the drying room to resist the flow of air and to maintain the pressure adjacent each wall, the wall on the supply side of the drying room comprising oppositely disposed spaced perforated plates forming a pressure chamber through which the air from the supply duct passes, and the opposite wall having uniformly spaced perforations to permit uniform flow through the drying room.

6. A kiln comprising a drying room, a pressure fan and supply and return ducts for circulating air through the drying room, walls interposed in the path of the air flow on opposite sides of the drying room to resist the flow of air and to maintain pressure adjacent each wall, the wall on the supply side of the drying room comprising closely spaced, uniformly perforated partitions having a greater area of perforations in the drying room side than in the supply side, and the opposite wall of the drying room being uniformly perforated, whereby substantially uniform flows through the drying room are obtained.

7. A kiln comprising a drying room, a pressure fan and supply and return ducts for circulating air through the drying room, uniformly perforated walls interposed in the path of the air flow on opposite sides of the drying room to resist the flow of air and to build up the pressure adjacent each wall, the wall on the supply side of the drying room comprising a pressure chamber including closely spaced partitions having non-registering perforations greater in number on the drying room side of such pressure chamber than on the supply side, whereby a substantially uniform pressure is built up in the pressure chamber and uniform flow through the drying room is secured.

8. A kiln comprising a drying room, a pressure fan and supply and return ducts for circulating air through the drying room, walls interposed in the path of the air flow on opposite sides of the drying room to resist the flow of air and to build up the pressure adjacent each wall, the inlet wall of the drying room comprising a pressure chamber having an inlet partition with regularly arranged holes and an outlet partition closely spaced thereto with a relatively large number of holes out of register with the holes in the inlet plate, and the outlet wall of the drying room being similar to the inlet plate of the pressure chamber.

9. A kiln comprising a drying room, means for circulating air through the drying room including a pressure fan and supply and return ducts connecting the fan and the drying room, and a pressure chamber through which the air passes from the supply duct to the drying room comprising uniformly perforated partitions spaced from one another less than the minimum separation between perforations in the partitions to maintain a substantially uniform pressure over all parts of the pressure chamber and constructed and arranged to cause the air to flow with a substantially lower velocity from the pressure chamber to the drying room than from the supply duct to the pressure chamber.

In testimony whereof I have signed my name to this specification.

HAROLD F. HAGEN.

CERTIFICATE OF CORRECTION.

Patent No. 1,833,397. Granted November 24, 1931, to

HAROLD F. HAGEN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, line 6, claim 4, after the word "moderate" insert the word uniform; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of February, A. D. 1932.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.