Dec. 13, 1932. J. F. COBB 1,891,060

DRY KILN

Filed July 7, 1927 4 Sheets-Sheet 1

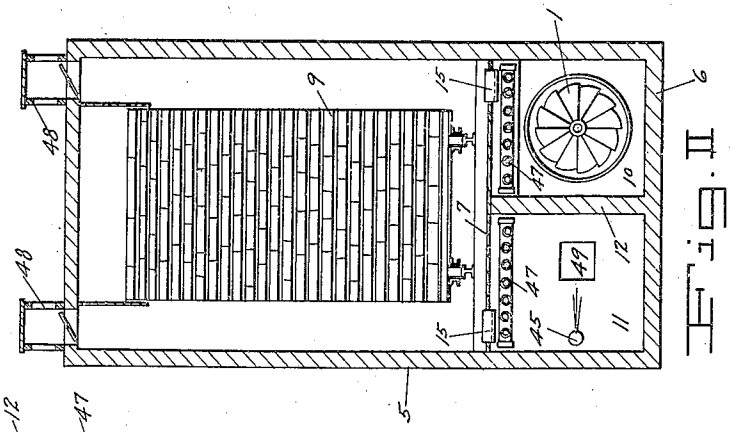


Fig. II

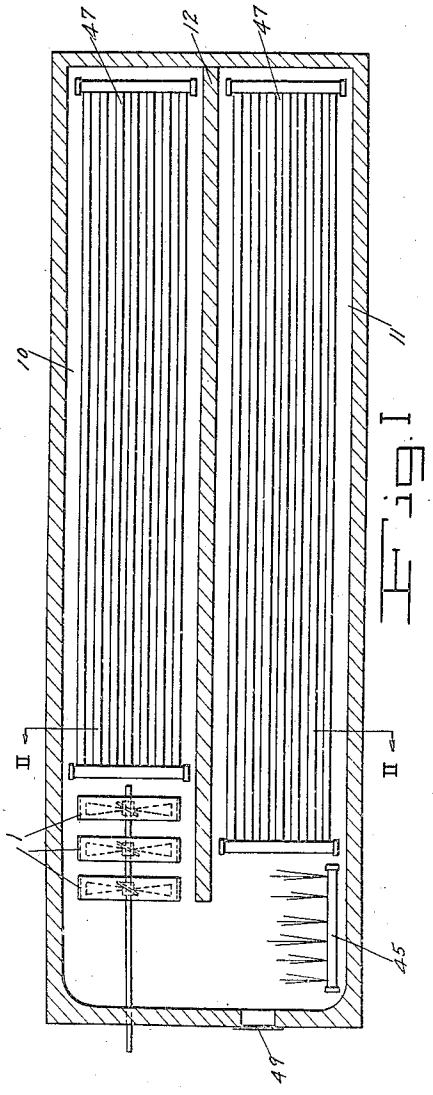


Fig. I

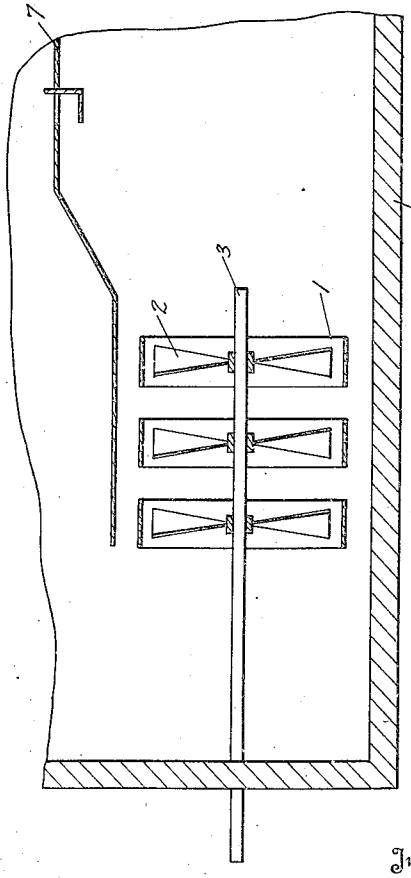


Fig. III

Inventor.

J. Francis Cobb,

By Atkins & Atkins,

Attorneys.

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DRY KILN

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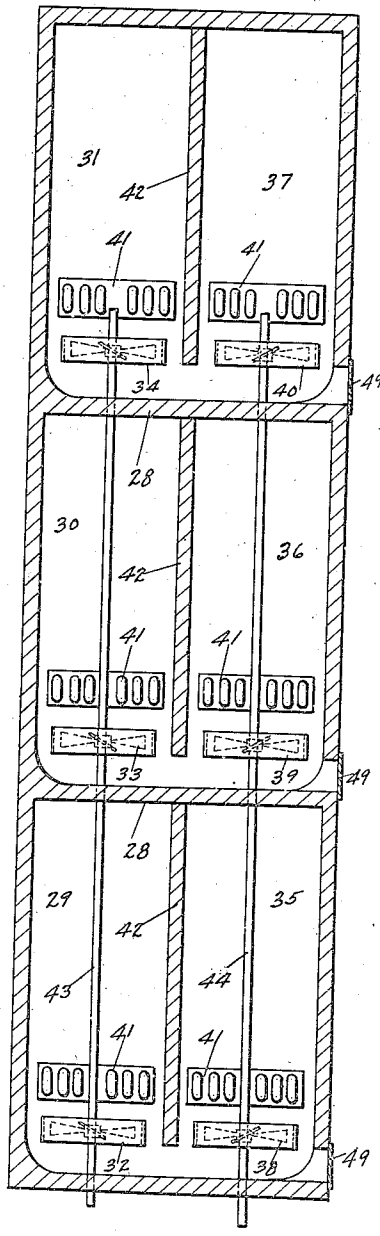


Fig. VI

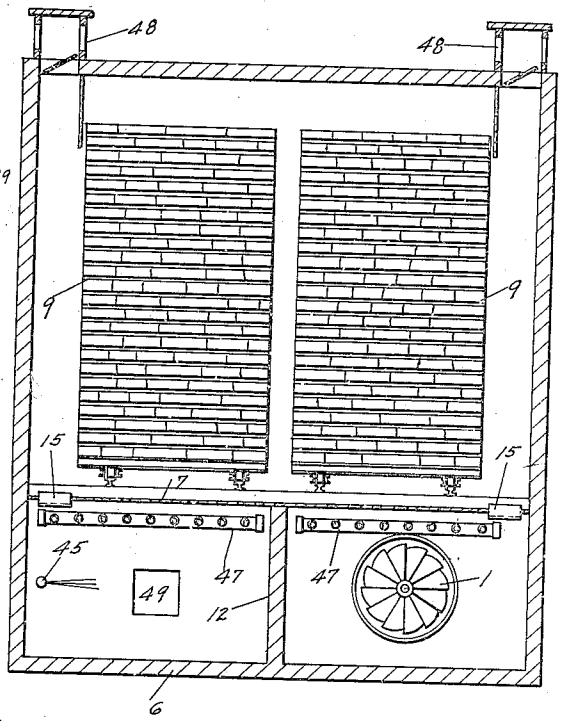


Fig. XI

Inventor:
J. Forrest Cobb,
By Atkins & Atkins,
Attorneys

Dec. 13, 1932. J. F. COBB 1,891,060

DRY KILN

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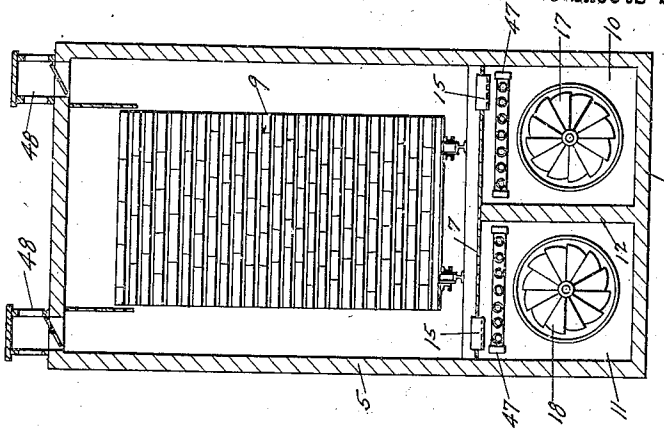


FIG. X

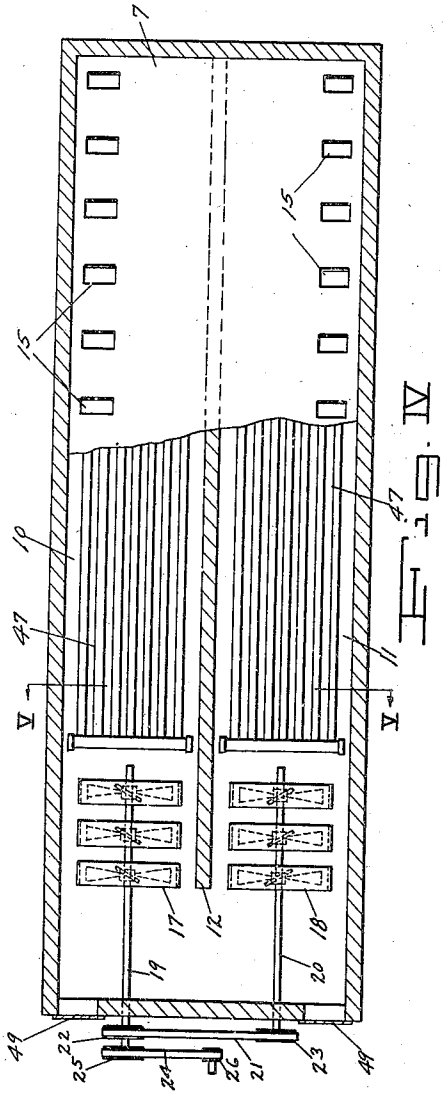


FIG. IX

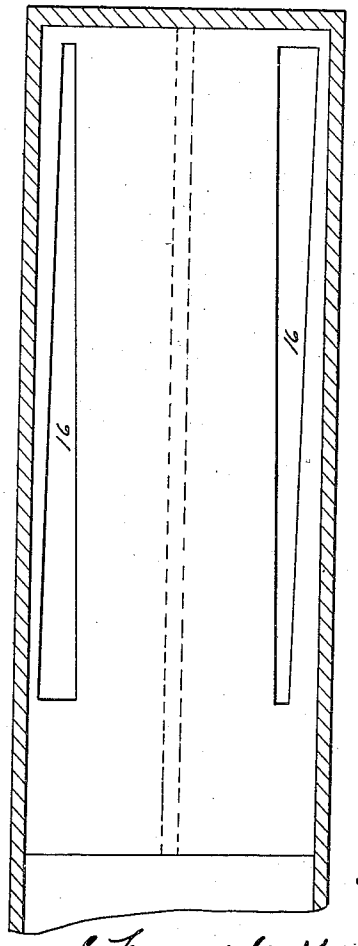


FIG. XI

Inventor:
J. Forrest Cobb,
By Atkins & Atkins,
Attorneys.

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DRY KILN

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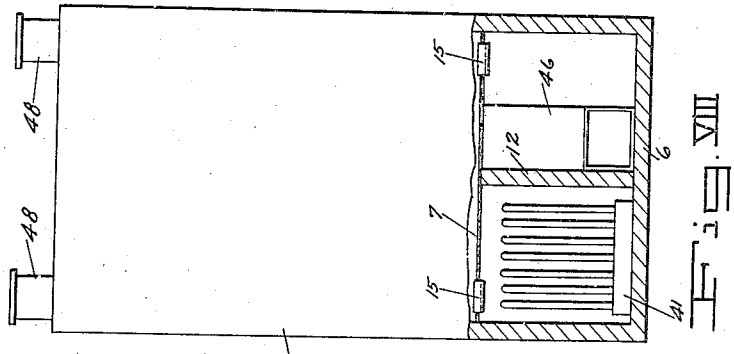


Fig. VIII A

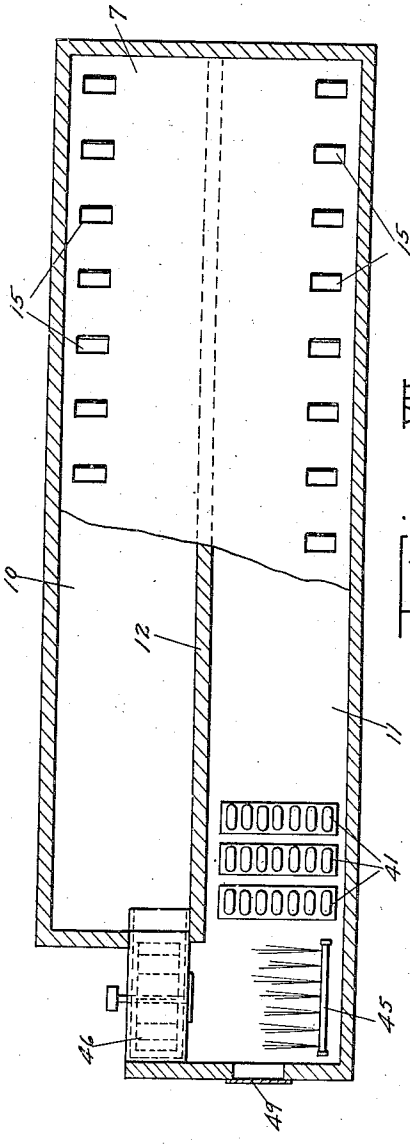


Fig. VII A

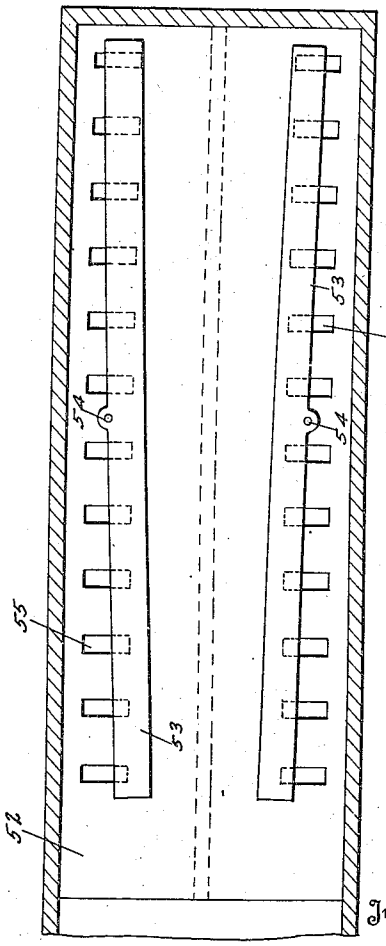


Fig. X

Inventor:

J. Foster Cobb,

By Atkins & Atkins,

Attorneys.

Patented Dec. 13, 1932

1,891,060

UNITED STATES PATENT OFFICE

JAMES FORREST COBB, OF PORTLAND, OREGON

DRY KILN

Application filed July 7, 1927. Serial No. 204,022.

My invention relates mainly to the art of kiln drying of lumber or other substances, but has for one of its principal objects the production of a novel portion of a drying kiln, hereinafter denominated a multiplex fan unit.

Another object of my invention is to produce improved means for effecting the circulation of the drying atmosphere of a dry kiln, wherein the preferred means employed for effecting such circulation is the aforesaid multiplex fan unit whose use is attended by definite advantage over other means of producing circulation, as will appear to one skilled in the art from the specification which follows.

Another object of my invention is to produce an effective forced air circulation within extended duct compartments by means of a single reversible fan system.

Still another object of my invention is to produce a unified circulation transversely through a series of loads of lumber in a kiln, from one plenum chamber in one portion of the kiln to a suction chamber in another portion of the kiln.

What constitutes my present invention will be hereinafter described in detail and succinctly defined in the appended claims.

In the accompanying drawings:

Figure I is a longitudinal horizontal section of one form of embodiment of my invention, complete, comprising illustration in plan of my multiplex fan unit which is the means preferred, by reason of its increase of efficiency, for producing forced circulation of the atmosphere of the kiln chamber, shown in Figure II.

Figure II is a vertical transverse sectional view taken on the line II—II of Figure I.

Figure III is a detached side elevation of one of my multiplex fan units shown on smaller scale in Figure I.

Figure IV is a view similar to Figure I, showing two complementary coacting fans of the kind shown in Figure III.

Figure V is a vertical transverse sectional view taken on the line V—V of Figure IV.

Figure VI is a view, similar to Figure IV, but showing a modification of my invention in respect to provision of a plurality of separate combined heating-and-circulating units instead of the single unit shown in other figures.

Figure VII is a view similar to Figure I, for example, but showing a variation consisting of a single fan located on the outside of but in operative communication with the interior of the kiln.

Figure VIII is an end elevation of the subject matter of the last preceding figure, partly in section.

Figure IX is a diagrammatic longitudinal view showing a trunk having a tapered slit for a port, instead of ports comprising a series of separate openings of graduated size disposed in endwise succession in the trunk.

Figure X is a like view showing a convertible duct comprising an oblong trunk or casing, say of rectangular shape in cross section, a snugly fitting cover-plate movable above the case upon a medial pivot over a series of transversely oblong openings, with the effect of defining a series of ports which, by pivotal movement of said plate, may be made to taper in size, respectively, towards one end of the trunk or towards the other end of it, at will.

Figure XI is a view similar to Figure II, showing a kiln enlarged to accommodate on two tracks a series of laterally disposed loads of lumber.

Referring to the numerals on the drawings, 1 indicates, in Figures I, III, and IV, for example, what I call a multiplex fan unit that is operatively encased by preference only in any suitable housing, the elements whereof, in various instances, are hereinafter indicated.

The fan mechanism, in respect to my invention, in all forms of embodiment thereof, is required to make air delivery to its proper elongated duct or trunk with force sufficient to create effective static pressure within said duct from end to end thereof. For this purpose I have found my multiplex fan unit 1 especially well adapted for extensively elongated ducts or trunks.

By the term multiplex fan unit, I designate a fan unit consisting of a plurality of any

preferred number of operatively grouped individual fan blades 2 fixed, as shown, for example, in Figure III, upon a common shaft 3 in cooperative propinquity and relative disposition one to another in the order of their sequence on the shaft, and all making a common air delivery lengthwise of the shaft in one direction or the other according to the direction of rotation of the shaft. The fans comprising blades 2 are preferably of the reversible disc type, whereby the fan unit may be rotated effectively in either direction.

The fan blades may be arranged in any preferred number and relative disposition on the shaft 3. They may be, for example, ranged on said shaft in a succession of circular series, as illustrated, or in any other cooperative disposition relatively one to another. The fans disposed in circular series of blades are illustrated in the drawings as being spaced equidistantly from each other along the length of the shaft 3, but it should be observed that my invention in this regard, contemplates variation between the individual fan blades as well as between the circular series of blades if employed.

In this connection, it is important to note that the first series of blades when in rotation acts upon the incoming air so as to impart to it a momentum which is in turn communicated to the next series, and by it augmented, and so on throughout the sequence of series along the shaft 3. Consequently, it is deemed advantageous in some instances, determined partly by working conditions, to gradually increase the distances betwen the fan blades or the successive series of blades, in order to utilize the force of momentum of the air generated in passing through the entire range of series.

I have discovered that the multiplex fan unit, constructed substantially as described above, has the effect, in operation, of greatly increasing the force and effective reach of its air delivery in direction endwise of its shaft over what has been heretofore possible by the use of disc fans, thereby rendering it peculiarly available, under some conditions, for accomplishing the end proposed in respect to my dry kiln herein specified. Under some conditions, however, other forms of fans for inducing circulation may be employed to advantage, as hereinafter indicated, by way of example.

My kiln comprises a kiln-chamber 5 made of any suitable material, shape, size, and dimensions, such as are well known in the art or such as may be adapted for the purpose as occasion may demand. The chamber 5 has a bottom floor 6, and a horizontal wall or walls 7, above which, within the kiln-chamber, kiln loads 9 of drying stock that are permeable to air circulation, are carried, usually upon rail-supported trucks, which being of common use in dry kilns are deemed to require no further illustration herein than that which is suggestively presented in Figures II and V, for example.

In Figure XI, a plurality of loads 9 in lateral communication one with another within one kiln is shown.

In Figures I, II, IV, V, and VII, I illustrate a plurality of say two trunks, 10 and 11, in paired relationship, which are separated from each other by an imperforate vertical wall 12 which being somewhat shorter than the trunks, serves, to the extent of its length, as a closure between the floor 6 and the horizontal wall 7. One wall 7 for the full complement of trunks may be employed, or one for each trunk may be used. If a plurality of more than two pairs of trunks be employed, an additional wall or walls 12 will be, of course, required between additional pairs of trunks.

One of each pair of trunks, for example 10, constitutes in use a plenum chamber or a chamber wherein static pressure is, by suitable means, for example the fan 1, built up, and the other a suction chamber. Air supply is, in such case, communicated under pressure to the interior of the trunk 10 below its wall 7, which is provided with ports 15, preferably of the louvre type if fans for effecting circulation be employed, and constituting, in the instance assumed, eduction ports for affording means of communication between the trunks 10 and 11 as aforesaid.

By reason of and in respect to the reversibility of the direction of circulation within the kiln of the circulatory medium, otherwise herein for brevity denominated air, which is contemplated in some forms of embodiment of my invention, it should be understood that the ports 15 may be, in such case, alternately converted at will into induction or eduction ports. Wherefore, I employ the common term "ports" as one of sufficient identification of them.

The trunk 11, being, for the instant, assumed the suction chamber, is also provided, like the trunk 10, with ports 15. In operation, circulation within the interior of the kiln-chamber 5 passes in continuous flow (however regulated) above the wall 7 from the plenum chamber, say 10, to the suction chamber, say 11, through the ports 15 in the wall 7 of the respective chambers, and from the suction chamber around the end of the partition wall 12 back to the plenum chamber.

The ports for each trunk may be arranged as a series of separate apertures of graduated capacities, respectively, or by equivalent means for effecting a graduated force of delivery, such, for example, as a tapered series of slits 15, which are in familiar use in the art, of such other ports as may be devised and adapted for the purpose.

In different figures of the drawings, I illus-

trate different modified forms of means for supplying the trunks 10–11, for example, with air. For instance, in the preferred form of embodiment of my invention illustrated in Figure I, the multiplex fan unit 1 is the one preferably used. In Figure IV, two multiplex fan units 17 and 18 mounted on separate shafts 19 and 20, respectively, are shown mounted within the trunks 10 and 11, respectively. The fan units are contrived to make air delivery in opposite directions. Said shafts may be to that end, and preferably are, operatively united by a common driving belt 21 mounted on pulleys 22 and 23, fixed to the said shafts, respectively, so as to rotate them in the same direction, but the fans 17 and 18 being right and left hand fans, respectively, make air delivery in opposite directions. They are operably connected, as by a belt 24 and a pulley 25 fixed on the shaft 19, for example, to the shaft 26 of an electric or other motor.

In Figure VI, the trunks are, by transverse partitions 28, divided into a plurality of sets, say three, of separate plenum chambers 29, 30, and 31, each plenum chamber being provided with a preferably single propulsion fan respectively designated by reference numerals 32, 33, and 34, and a corresponding plurality of suction chambers, 35, 36, and 37, each provided with a suction fan numbered 38, 39, and 40, respectively. Heating units 41, in sufficient number to meet heating requirement, are provided for each of the plenum and suction chambers, which are separated one from another by partitions 42. In other words, the construction shown in Figure VI is, in effect, simply a transverse division of the trunks 10 and 11 into series of three independent trunks disposed in end to end assemblage, and separated by the respective partitions 28. The sets of fans 32, 33, and 34, are fixed to a common shaft 43, and the fans 35, 36, and 37, are fixed to a common shaft 44.

The shafts 43 and 44 may be driven by means corresponding to that shown in Figure IV, for example, as means already described for driving the shafts 19 and 20.

In Figure VII an external multiblade fan 46 of usual or other preferred construction, is diagrammatically illustrated instead of the internal disc fans shown in the other figures, and is intended to indicate that a non-reversible fan disposed outside the kiln-chamber as well as a reversible fan of the internal fan type is contemplated as available for use in my present invention.

In each figure of the drawings a sufficient complement of heating units, which may be of any suitable type preferred, is provided for each trunk. For example, in Figures I and IV, heating units 47 consisting of longitudinally disposed heating coils, are shown. In Figures VI and VII, transversely disposed heaters 41 aforesaid are shown; but it should be observed that either of said forms of heaters may be used interchangeably, or other heating units of any known or suitable form may be, at will, employed in any form of embodiment of my invention.

The circulation of air produced up one side of the load, thence transversely between the layers of permeably stacked stock constituting said load and thence down the opposite side of the load, gives a greater velocity of air movement than if the currents were divided, and thus that method of circulation increases the capacity of the kiln without increase of expenditure of power for producing circulation.

It should be also understood that in respect to my present invention, the employment of any usual or any other suitable and preferred means for effecting results that are commonly employed in kilns is contemplated by me, such, for example as any means preferred for effecting ventilation, heat control humidification of the kiln, and air current directing baffles. I show, for instance, humidifying and auxiliary circulator sprays 45, damper-controlled vents 48, and fresh air intakes 49. Such instrumentalities as are above named, or the like incidentals usual in kiln drying operations, may be disposed within the kiln wherever it may be deemed to be advantageous to place them.

In respect to the arrangement aforesaid of the ports 15 of graduated sizes in series, I illustrate in Figure IX provision of two oppositely tapered ducts 50 and 51, each having a longitudinal slit 52 which is the equivalent of a series of ports 15 in effect of graduated sizes. The ducts 50 and 51, where employed, are reversely disposed in respect to the taper of each, and communicate, respectively, with trunks 10 and 11.

A convertible tapering duct adapted to accommodate itself to reversal of circulation, is shown in Figure X, wherein is illustrated a rectangular trunk or casing 52^a having provided against one side of it a snugly fitting juxtaposed movable cover-plate 53 connected by a pivotal support 54 to the wall of the trunk 52^a. The plate 53 is adapted to be swung in contact with a wall of the casing 52 which is perforated by a series of corresponding, transversely disposed, elongated openings 55. By movement of the plate 53 on its axis 54, the series of openings 55, in consequence of being partially covered by the said plate, may be made to taper towards one end of the duct or towards the other end thereof, at will. Consequently, the larger end of the series of openings may be presented towards the oncoming volume of circulation, to suit the direction of flow of the circulating medium. The uncovered portions of the openings 55 in the casing 52 constitute, in effect, a graduated series of ports in one trunk adapted to operatively communicate with

the series of ports in the companion trunk, or the one paired with the first named trunk, in a manner corresponding to that already described with reference to the ports 15.

The operation of my apparatus may be, in view of the foregoing description, briefly described as follows.

Referring to Figure I, for example, if it be assumed that the shaft 3 is rotated in a direction to effect air delivery from the fan 1 into the trunk 10, the effect will be to produce circulation through the trunk 11 in the opposite direction. By air circulation through either of the respective trunks 10 and 11, determined by the direction of circulation employed, a static pressure therein will be built up, thereby effecting operative communication from one set of ports 15 in one trunk with the other set of ports 15 in the other trunk. The result will be to effect within that portion of the interior of the kiln chamber 5, which is above the level of the wall or walls 7, a forced movement of the circulatory medium through the openings in the stacks of stock with drying effect on the stock.

In Figure IV, the operation is, in effect, the same, the circulation in the trunks 10 and 11 being effected by the operative coaction through pressure and suction, respectively, of the fans 17 and 18.

In respect to the operation of the embodiment of my invention shown in Figure VI, the operation of the apparatus is substantially varied in only one respect, namely, that three independent plenum chambers 29, 30, and 31, are used instead of the one plenum chamber shown in other figures, said plenum chambers being also reversible in operation with the chambers 35, 36, and 37. Distribution of the fans by using a series of paired trunks in each kiln makes it possible to use large inlet and outlet ports in proportion to the volume of air circulated than is possible when uniform distribution of circulation is effected solely by creating a high static pressure in the trunks. The static pressure against which the fans are made to effect circulation is considerably lessened, resulting in lower power consumption for driving the fans and thus considerable gain in circulation efficiency.

In respect to the apparatus shown in Figure VII, the operation is substantially identical, in effect, with that of the apparatus shown in Figure I, for example, except that the external fan 46 shown in Figure VII is non-reversible, and functionates in itself alone by a direct drive of air into the trunk 10 and by a return pull upon the air from the companion trunk 11. In other words, the single fan 46 is contrived to keep up continual forced circulation through ports provided in trunks as means of communication between paired trunks.

The functional effect of separate ports 15 of relative graduated capacities is accomplished by the substitution therefor of longitudinally disposed tapered slits 52 in the trunk shown in Figure IX.

Figure XI illustrates a plurality of stock loads (two by way of example only) through the horizontal interstices in which the circulatory medium, with drying effect upon each load, travels in passing from one load to the one next adjacent in series. The effect of such multiplication of the number of stock loads is to increase the capacity of the kiln by merely enlarging its transverse extent, but without the necessity of materially amplifying the capacity of the means for heating and for driving the circulatory medium, although said capacity may be, of course, increased upon occasion if deemed to exist in any instance.

An economical advantage in the operation of the kiln may be gained by the employment of means for varying the speed of the fans at different stages of the drying operations. In that regard, I have discovered that more driving force is necessary to effect increased rate of circulation of the drying atmosphere of the kiln when the stock loads are first introduced into the kiln in a wet or green state, than when afterwards they have given off a portion of their moisture content. The reason appears to be that the gaseous medium of circulation, in passing through the interstices of the stock loads, takes up so much of moisture therefrom in passing through part of the load as to incapacitate it for taking up a corresponding proportion of moisture in passing through the remainder of the load. In other words, the drying atmosphere of the kiln functionates to better advantage in passing through part of the distance it has to travel in passing through the interstices of the load than it does in passing through the remainder of the distance. The remedy for that condition is to increase the rate or volume of circulation during such period as the stock is wet and the condition above indicated continues. This requires increase of power for such period. After the stock becomes drier, the reduction of its moisture content diminishes gradually the necessity for the higher rate of circulation, and permits reduction of the rate of speed of circulation and of the power necessary to effect it. In other words, the rate of speed of circulation is by my invention made proportionate to the lag in the capacity of the circulating medium to absorb moisture in passing across the surfaces of the drying stock loads. The term lag is, in this connection, defined to be loss of the functionating capacity of the drying atmosphere, taking into consideration that such capacity is diminished by loss of heat from the drying atmosphere as well as by increase of the moisture content thereof. The rate of circulation desired is that which will ren-

der the drying operation on the stock loads as uniform as possible, throughout its different stages.

A definite advantage of using a greater speed of circulation at the earlier stages of the drying process is, that it affords means to overcome the natural-draft tendency of circulation within the kiln due to the cooling effect of evaporation of moisture from the stock when the moisture content is greatest.

The use of a multi-speed fan driving means makes it possible to effect material economy in the drying of the stock loads by using a faster rate of circulation at an early stage of the drying process and a slower rate at later stages.

In other words, a greater rate of circulation at the earlier stages of the drying process, or at what is known in the progressive kiln art as the green end of the kiln where the temperature at the immediate surface of the stock is lower and the humidity is higher, is needed to convey more heat for evaporation purposes to the surfaces of the stock being dried. At such time there is more moisture in the stock to be evaporated, and the moisture carrying capacity of the kiln atmosphere is lower. More circulation is also needed at such time to remove from the surfaces of the stock, the moisture as soon as it is evaporated. At a later stage of the drying process, or ultimately at the dry end of a progressive kiln when the temperature is higher and the humidity is lower, and the transfusion rate is slower, and when there is less moisture to be evaporated and removed, the moisture-carrying capacity of the kiln atmosphere is then greater and there is, therefore, less need at that point for a high rate of circulation across the stock.

Hitherto, a substantially constant rate of speed has been imparted to the fans throughout the whole period of the drying operation of the kiln. My invention contemplates economy in the saving of power, for instance, through the employment of means for driving the fans at different speeds or of interrupting the operation of the fans altogether and relying in such case upon natural draft for effecting circulation in different stages of the drying operation, proportionate to the condition, at any stage, of the drying atmosphere, as affected, for example, by the stock to be dried. My invention in this regard, consists in using fans of variable speed and in setting their speed proportionately to the amount of work demanded of them at different stages of the drying operation.

Variable speed circulation at different stages of the drying process, is being claimed in another application Serial No. 607,651.

What I claim is:

1. As part of a dry kiln, a convertible duct consisting of an oblong substantially rectangular trunk provided with a series of transverse elongated openings, in combination with a movable cover-plate snugly fitting over said openings and medially pivoted to the trunk, whereby movement of said plate may at will convert the said openings into a series of ports graduated in size towards either end of the trunk.

2. As a part of a dry kiln, a convertible duct consisting of an oblong substantially rectangular trunk provided with a series of transverse elongated openings, in combination with a movable cover-plate snugly fitting over said openings whereby movement of said plate may at will convert the said openings into a series of ports graduated in size towards either end of the trunk.

3. In a dry kiln, a convertible duct consisting of a pair of laterally disposed substantially parallel trunks provided with a series of openings in combination with means for oppositely tapering the openings, respectively, for air delivery and suction so as to equally distribute the air delivery and suction at each pair of opposite openings through the kiln.

4. In a dry kiln with lumber stacked therein, a pair of covered trunks having operative communication therebetween at one of their ends, respectively, means for producing cross circulation through the lumber, said means being adapt to reverse the air circulation in the trun through the lumber and constituting means for converting at will either of the trunks into a suction or an air pressure trunk, and means for distributing the air circulation from trunk to trunk uniformly in each cross section of the kiln consisting of means for oppositely tapering the louver openings on each side of the kiln at will.

5. A dry kiln comprising a kiln chamber provided with means for accommodation of kiln loads of stock and provided with heating means in combination with the plurality of pairs of covered trunks laterally disposed to the stock in paired relationship, ports disposed longitudinally of and in operative communication with said trunks, respectively, and reversible fans on longitudinal shafts for converting one of each pair of trunks into a plenum chamber and the other into a suction chamber, whereby continuing circulation of drying circulatory medium from one trunk to another through their ports, may be maintained within the kiln from one portion of it to another through the kiln loads of stock provided within the kiln chamber and permeable to the said circulatory medium.

6. A dry kiln comprising a kiln chamber divided within by horizontal partition wall, and provided with means above said wall for accommodation of kiln loads of stock and provided with heating means, in combination with the plurality of trunks laterally disposed to the stock in paired relationship below said wall, ports in said wall disposed

longitudinally of and in operative lateral communication with said trunks, respectively, and reversibly operative fans on a longitudinal shaft for converting one of each pair of said trunks into a plenum chamber and the complementary trunk into a suction chamber whereby continuing circulation of the drying circulatory medium from one trunk to another may be maintained within the kiln from one portion of it to another through kiln loads of stock provided within the kiln chamber above the horizontal partition wall and permeable to the said circulatory medium.

7. A dry kiln comprising a kiln chamber divided within by horizontal partition wall and provided with means above said wall for accommodation of kiln loads of stock and provided with heating means in combination with a plurality of paired trunks laterally disposed to the stock in paired relationship below said wall, ports of graduated capacities in said wall disposed longitudinally of and in operative lateral communication with said trunks, respectively, and mechanical means consisting of reversible fans on one shaft for converting one of each pair of said trunks into a plenum chamber and the complementary trunk into a suction chamber, whereby continuing circulation of drying circulatory medium from one trunk to another may be maintained within the kiln from one portion of it to another through kiln loads of stock provided within the kiln chamber above the horizontal partition wall and permeable to the said circulatory medium.

8. A dry kiln comprising a kiln chamber divided within by horizontal partition wall, and provided with means above said wall for accommodation of kiln loads of stock and provided with heating means in combination with a plurality of trunks laterally disposed to the stock in paired relationship below said wall, ports in said wall disposed longitudinally of and in operative lateral communication with said trunks, respectively, and a multiplex fan unit rotating on a common member in operative communication with one of said trunks, for converting said trunks on one side of the stock load into a plenum chamber and thereon the other side into a suction chamber, whereby continuing circulation of drying circulatory medium from one trunk to another through their ports may be maintained within the kiln from one portion of it to another through kiln loads of stock provided within the kiln chamber above the horizontal partition wall and permeable to the said circulatory medium.

9. A dry kiln comprising a kiln chamber divided within by horizontal partition for support of kiln loads of drying stock in combination with paired trunks laterally disposed to the stock disposed below said partition and separated by vertical wall supporting said partition, said wall being shorter than the length of the kiln chamber so as to render the trunks intercommunicating below the horizontal partition, ports in said partition for rendering the trunks intercommunicating above said partition, means for heating said trunks, respectively, and reversible fan mechanism on one longitudinal shaft in operative communication with the trunks.

10. A dry kiln comprising a kiln chamber divided within by horizontal partition, in combination with a series of laterally disposed independent intercommunicating paired trunks in end to end assemblage below said partitions each having heating means, and fan mechanism on longitudinal shafts, in operative communication therewith below said partition and ports communicating through said partition with the respective trunks for affording means of intercommunicating within the kiln chamber between each pair of trunks above said partition.

In testimony whereof, I have hereunto set my hand.

J. FORREST COBB.