Feb. 16, 1932. J. F. COBB 1,845,398

PROGRESSIVE DRYING KILN

Filed Dec. 5, 1925 6 Sheets-Sheet 1

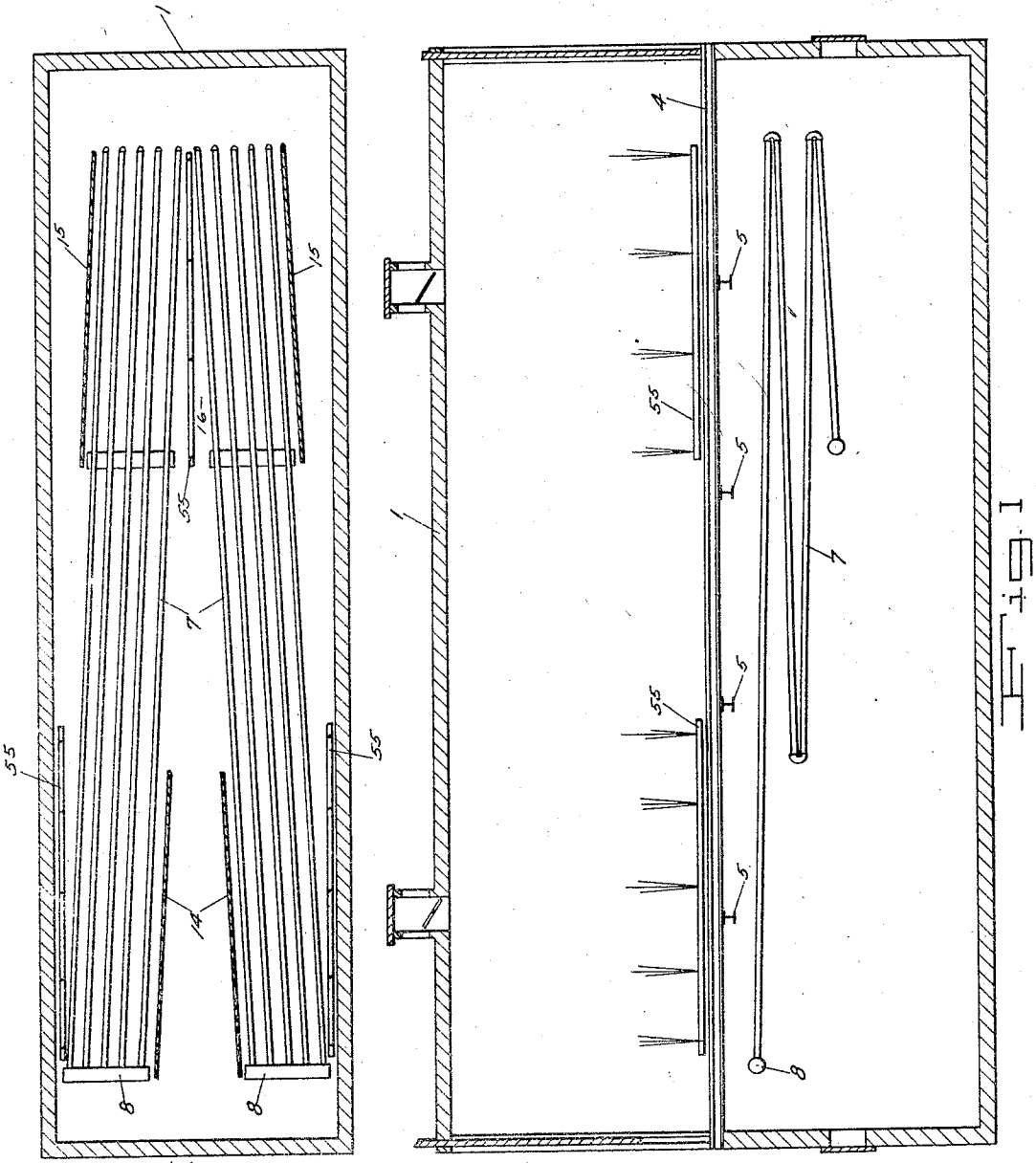


Fig. 1



Fig. 5

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PROGRESSIVE DRYING KILN

Filed Dec. 5, 1925 6 Sheets-Sheet 2

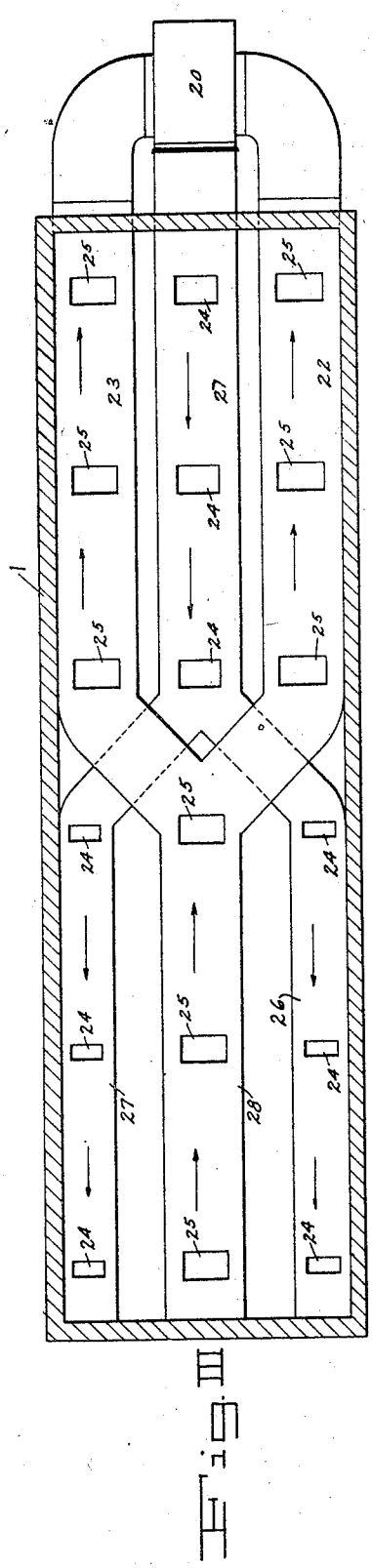



Fig. III

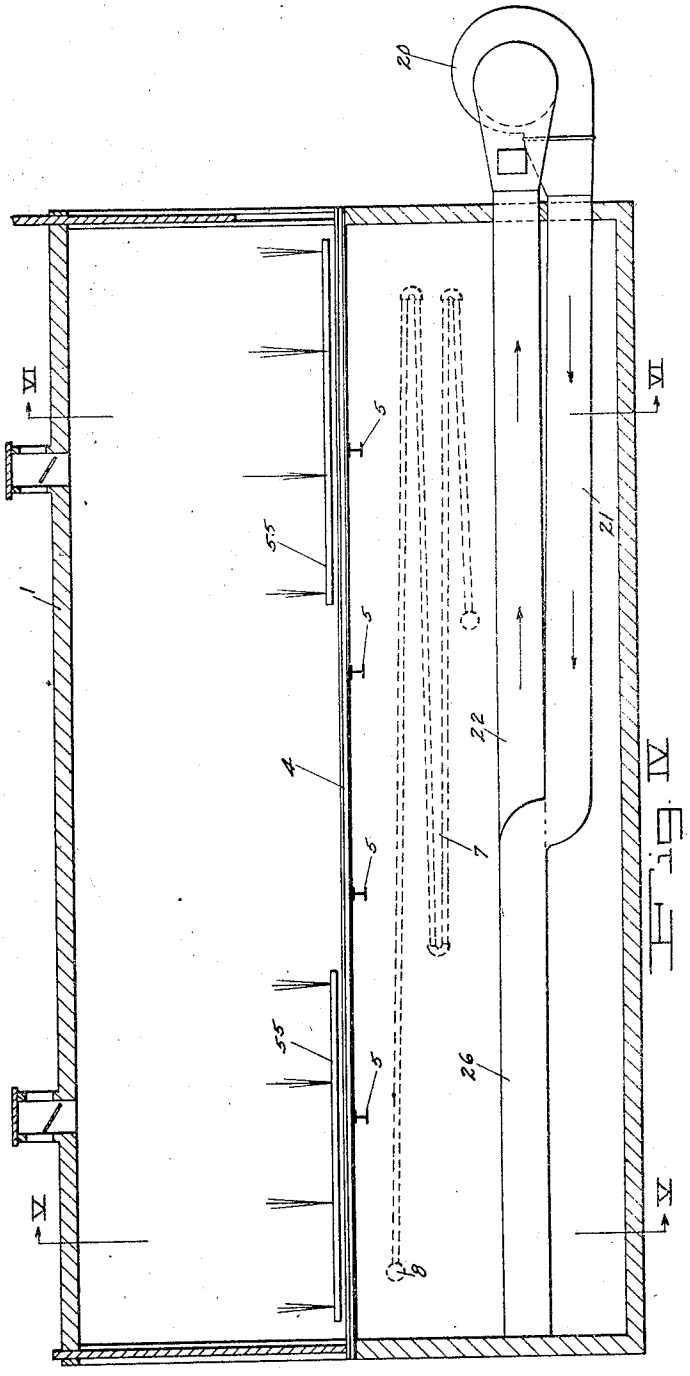



Fig. IV

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PROGRESSIVE DRYING KILN

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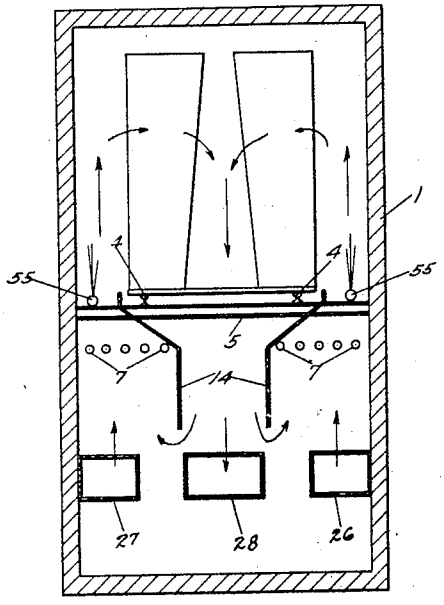



Fig. V

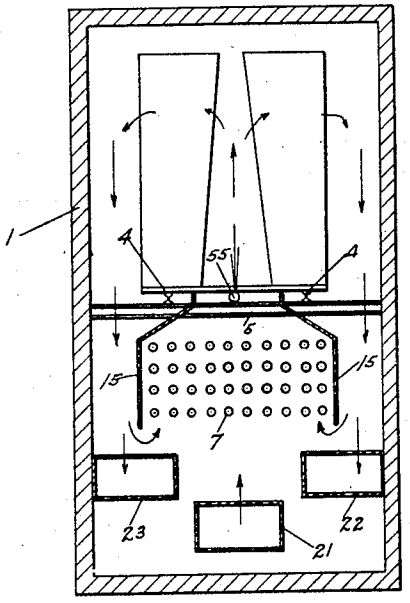



Fig. VI

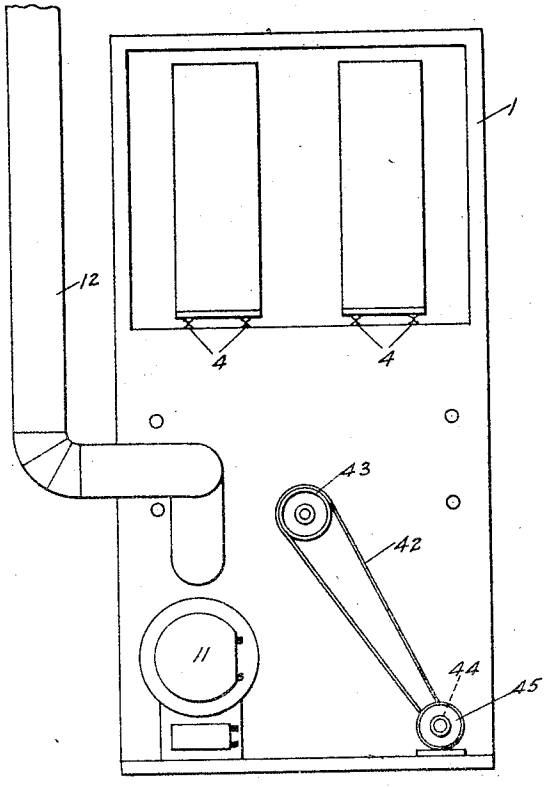



Fig. X

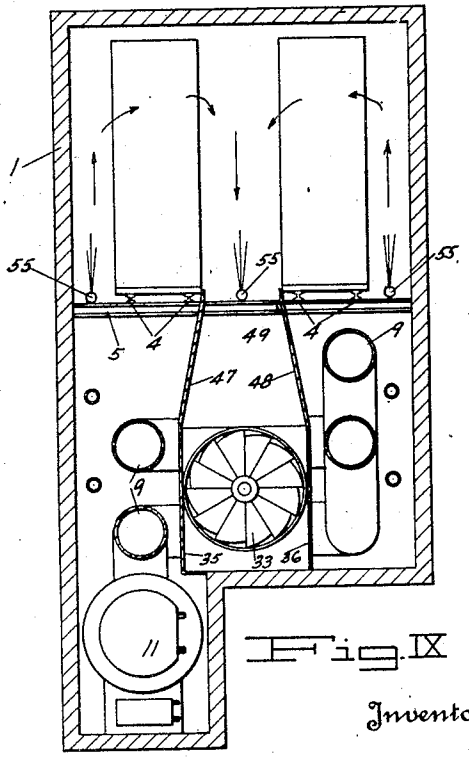



Fig. IX

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PROGRESSIVE DRYING KILN

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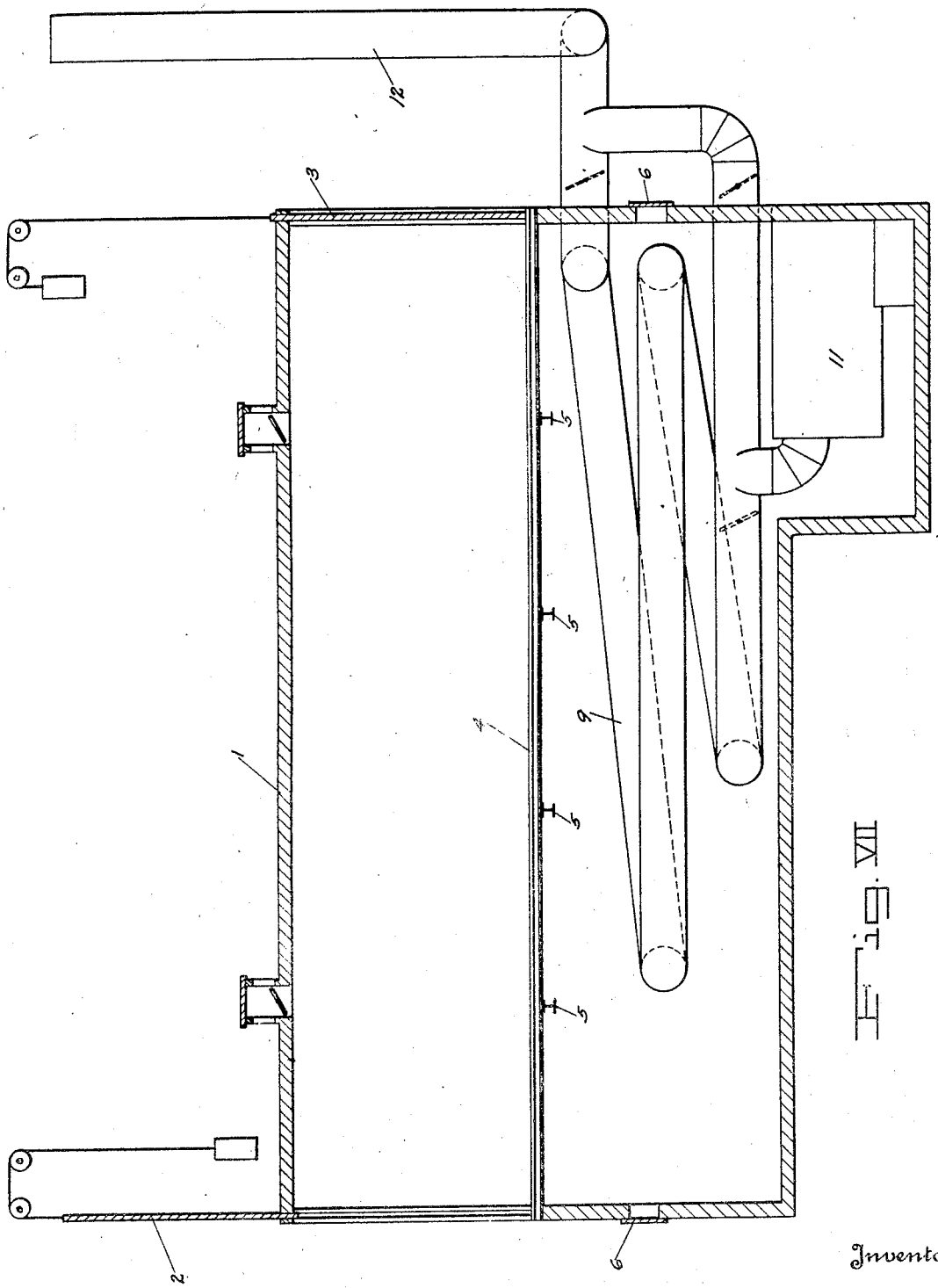



Fig. 6A

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PROGRESSIVE DRYING KILN

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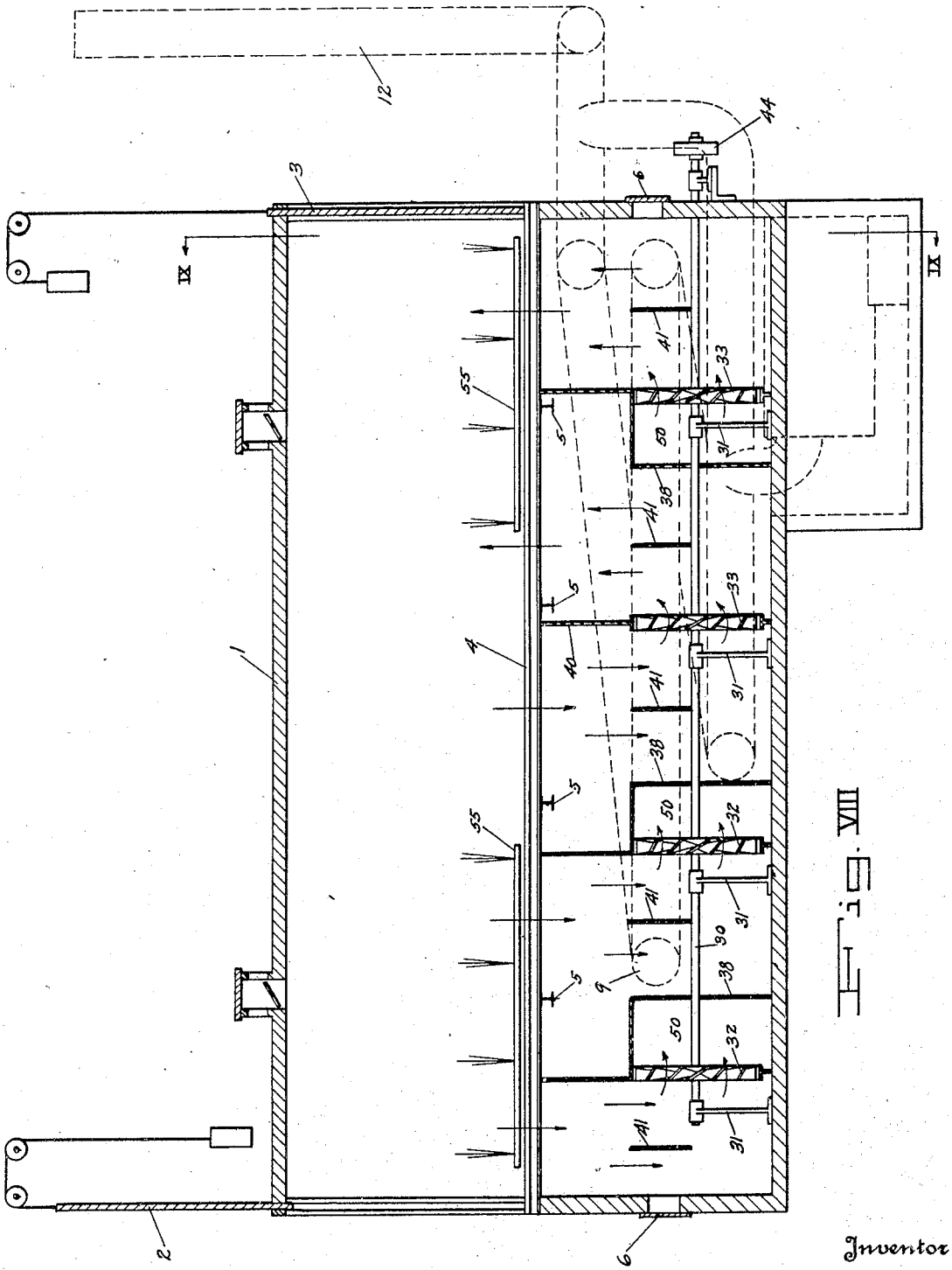



Fig. VIII

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PROGRESSIVE DRYING KILN

Filed Dec. 5, 1925 6 Sheets-Sheet 6

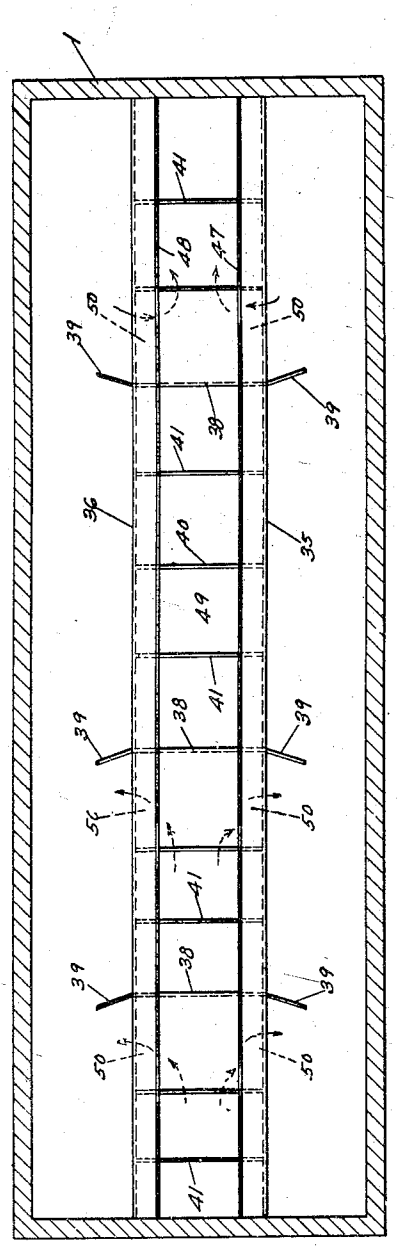


Fig. XII

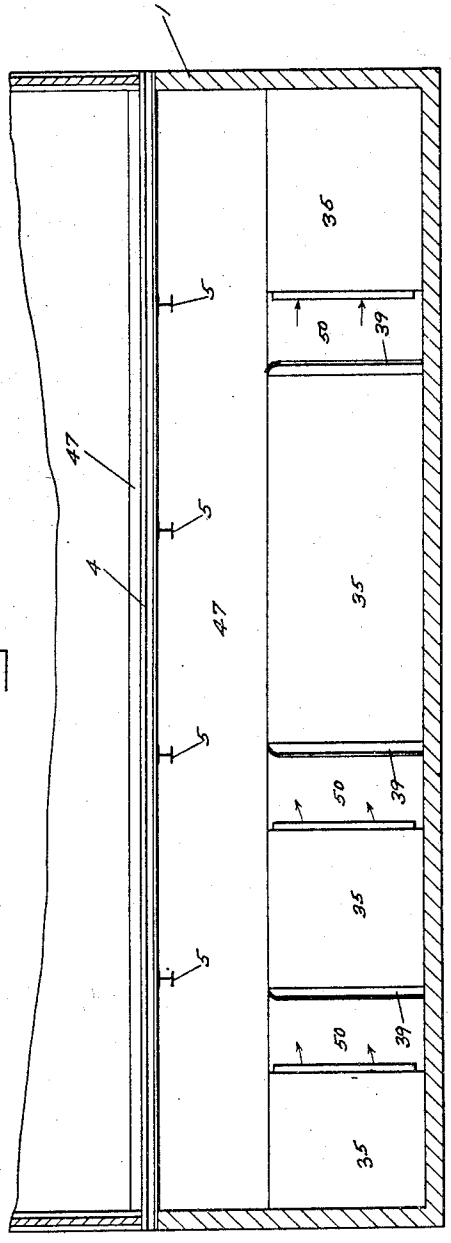


Fig. XI

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Patented Feb. 16, 1932 1,845,398

# UNITED STATES PATENT OFFICE

J. FORREST COBB, OF PORTLAND, OREGON, ASSIGNOR TO MOORE DRY KILN COMPANY, A CORPORATION OF FLORIDA

## PROGRESSIVE DRYING KILN

Application filed December 5, 1925. Serial No. 73,504.

My present invention relates to apparatus for drying organic substances and particularly but not exclusively for drying lumber.

Selected for enumeration from among numerous objects of my invention, those set forth in the next following general statement are at present deemed most important.

In general terms the main object of my invention is to provide means for increasing the speed and uniformity of the drying operation of a kiln.

A scarcely less important object of my invention is to provide in a kiln through which the stock to be dried is caused to advance from end to end by progressive step by step movements, means for causing the circulation within the kiln of a gaseous drying medium having a gradually increasing temperature beginning with a comparatively low degree of heat at the intake end of the kiln, and increasing to a maximum high degree at the outlet end thereof.

The purpose of the object just set forth is to apply a circulating medium at a low degree of heat and high percentage of humidity to the stock when in a green state it first enters the kiln and when it is most heavily laden with moisture required to be gradually removed from it in the drying operation; and, afterwards, as the moisture is eliminated from the stock by evaporation, to apply ultimately to the stock said circulating medium substantially dehydrated and at a high degree of heat at a stage of the drying process when such application may be made not only without injury but with positive advantage to the quality of the product resulting from the complete drying operation. Between the two extremes of heat and humidification above specified there is of course a graduation of conditions upwardly and downwardly toward said extremes.

Another object is to provide positive one way circulation through the stock, in different directions in the two ends of the kiln.

Another object of my invention is to provide means for effecting within the kiln reversal of the direction of circulation of the circulatory medium, said means being preferably devised to cause said medium to follow a generally descending course at the intake end of the kiln where the weight of water or aqueous substance is greatest and when it has strong tendency to descend by gravity towards the floor of the kiln, and to cause it to follow an ascending course as the stock approaches the outlet end of the kiln, where the heated and dried medium assumes, by reason of its buoyancy, a rising tendency, due to well known physical laws.

In the foregoing description contained in the preceding paragraph, the use of vertical piling lumber or of a vertical flue system of piling is contemplated; but it should be understood that the same principle applies if horizontal or other form of piling is employed, the only difference being that in the latter instance the circulatory medium is forced under pressure to pass through the transverse interstices in the pile of lumber in order to reach a space through which it may ultimately accomplish a substantially vertical descent or ascent, as the direction of its circulation at different points of circulation, respectively, may demand.

The means for attaining the object mentioned in the second above paragraph may operate through the sole agency of heat applied within the kiln, or through the additional agency of a forced draft obtained by mechanical means. In the following specification I illustrate and describe separately the two means proposed to be employed, and in respect to means for producing a forced draft I also illustrate and describe two distinct types of mechanism for accomplishing the object proposed.

In addition to the main objects above specified, my invention comprehends numerous details of construction and combination of mechanical elements which it is deemed unnecessary to further indicate in this general statement, in view of the detailed specification which follows.

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

In the accompanying drawings, wherein arrows are used wherever it is deemed nec-

essary to indicate the direction of movement,

Figure I is a longitudinal section of a kiln embodying that form of my invention in which heat alone carried in steam coils is depended upon as a means of effecting circulation within the kiln of a gaseous drying medium.

Figure II is a top plan view of the system of heating coils shown in Figure I.

Figure III is a view of a kiln similar to that in Figure II, showing in plan a power fan for effecting forced circulation of the gaseous contents of the kiln by aid of a two-way circulator, the heating coils as shown in the preceding figures being omitted for the sake of simplifying the drawings.

Figure IV is a longitudinal section of the kiln shown in Figure III, showing the details of the fan mechanism in full lines and the heating coils in dotted lines.

Figure V is a vertical transverse section, on the line V—V, at the inlet end of Figure IV, this illustration minus the circulator being also substantially applicable to Figures I and II.

Figure VI is a vertical transverse section to like effect in respect to Figures I and II, as Figure V, but taken on line VI—VI of Figure IV, at the outlet end of the kiln shown therein.

Figure VII is a view similar to Figure I, but showing heating flues communicating with a furnace as a modification of the heating means represented by the steam coils in Figure I.

Figure VIII shows a further modification of a forced draft system, in which internal fans operatively disposed along a rotatable shaft within the kiln are shown in combination with heating flues as shown in Figure VII, but being equally applicable, upon substitution of steam coils for flues, to the system of heating by steam coils as shown in Figures I and II.

Figure IX is a vertical transverse section on the line IX—IX of Figure VIII, at the outlet end of the kiln.

Figure X is an elevation of the outlet end of the kiln shown in Figures VIII and IX.

Figure XI is a vertical longitudinal section of portions of my kiln in the form shown in Figure VIII made to illustrate in side elevation the construction of one side wall of the fan enclosure shown in said figure, of which some parts are omitted.

Figure XII is a horizontal longitudinal section of the subject matter of Figure XI, made to illustrate in top plan view complete the fan enclosure of the preceding figure.

Referring to the numerals on the drawings, 1 indicates a kiln chamber which may be a substantially air tight structure of any desired size and dimensions, and built in any preferred manner of any suitable material. The chamber 1 is usually an oblong building having suitable doors at its opposite ends for inlet and outlet respectively of stock to be dried. Of such doors, two, for example only, of the vertically movable sort are indicated by numerals 2 and 3, in Figures VII and VIII.

The chamber 1 is preferably traversable from end to end by truck loads of any material to be dried which is herein designated generally by the term "stock", the same being preferably carried on tracks 4 which may be a single track or a plurality of tracks as may be desirable, provided substantially in the usual and well known manner. The tracks 4 are preferably supported near the middle altitude of the chamber 1, as by I-beams 5 supported in the side walls of the chamber which is also provided with the usual equipment including ventilators of any preferred type.

Doors 6 for admission of fresh outside air, if desired, may be provided at opposite ends of the chamber 1 as shown for example, in Figures VII and VIII.

A kiln chamber with its appurtenances, such as I have just described, for example, is already well known in the art, and is referred to only in sufficient detail to meet the requirements which the subsequent description of my invention demands.

A feature common to all forms of embodiment of my invention is found in the provision of means for effecting within different parts of a kiln chamber oppositely directed currents of circulation. Such means may, for example, comprise a cumulative heating system, that is to say, a system for heating the interior of the chamber 1 in which the effective heating capacity of the system is, as by multiplication at one end of the kiln of the heating elements, for example, the steam coils, regulated and controlled.

For instance, in Figures I and II, coils of steam pipes 7 are kept supplied as through headers 8 with an adequate supply of steam derived from a source not illustrated.

The pipe coils may extend, substantially but not quite, from end to end of the chamber 1. At its end into which stock to be dried is first introduced, which is next the headers 8 and which is called the inlet end, the coils are reduced in heating capacity by reduction of their heating surface to that of a single layer of pipes or, if desired, to curtailment of length of pipes so as to leave a blank space of limited area at said inlet end. Towards the opposite end of the chamber 1, by multiplied convolutions of the coils as shown in Figure I, the heating capacity of the heating system, whereof the coils 7 are, for example, the heating agents, is brought to a maximum. Consequently, in the operation of my kiln, a load of stock finds, on entering at the inlet end of the kiln, an atmosphere of comparatively low temperature and of high humidity.

The said load, progressing with step by step movement through the kiln finds a gradual rise of temperature and lowering of humidity until the temperature reaches maximum and the humidity minimum just before the final discharge of the stock, load by load, from the kiln.

Instead of the steam coils 7, other heating agency may be employed. For example, in Figure VII a system of direct heating flues 9, leading preferably underneath the track rails 4 from a furnace 11 to a stack 12, is substituted, with similar effect but with desirable economy in some instances, for the steam coils 7. It is contemplated that interchange of one heating system for another, in all the various forms of embodiment of my invention, may be effected at will according to variations of conditions which are present in the actual drying operation.

In all forms of embodiment of my invention, some means for effecting circulation of the circulatory medium, that is to say the gaseous contents of the chamber 1, must be employed. In the embodiment shown in Figures I and II, the means contemplated for effecting such circulation is heat alone, which operates by imparting superior buoyancy to one portion of the contents of the chamber over the remainder thereof and at the same time effects a positive down-draft by pull upon the body of the circulatory medium due to the tendency of a portion of said medium to fall by gravity. The desired circulation obtained by heat alone may be furthermore aided by at least two means. One of such means for aiding circulation is derived from the employment of two sets of baffles 14 and 15, respectively, disposed towards opposite ends of the chamber 1. The baffles 14 preferably consist of vertical plates disposed between the legs of the system of steam coils 7 which is bifurcated for their accommodation at the inlet end of the chamber 1. At the opposite end thereof the fork 16 of the bifurcation of the said system is located, and also the heating efficiency of the system is amplified, in the manner already specified, to its full cumulative capacity. Towards the end last mentioned of the chamber 1, the baffles 15 are located and are distinguished from the baffles 14 by being located so as to flank the pipes of the heating system upon its opposite sides.

It is to be understood that employment of the baffles 14 and 15 is optional, and only that under some conditions their use is advantageous and therefore preferable. If without the baffles the bifurcated heating system is used, represented by steam coils 7 having the fork 16 from which the two legs of the heating system extend, a degree of circulation is obtained, the function of the bifurcated system in such instance being to distribute the effective heat at the forked end of the system medially within the kiln chamber and the effective heat at the two legged ends of the system to the sides of the kiln chamber. The result, in such case, is to effect a circulation of the circulatory medium from the middle of the kiln chamber to the sides thereof or from the sides to middle of the kiln chamber as may be desired. The result, as aforesaid, is to produce the transverse circulation elsewhere herein specified, said circulation being upwardly directed in the middle and down the sides of the kiln chamber at its outlet end or, in other words, the narrow end of the heating system, for example the end in which the fork 16 is located. At the same time the circulation at the two legged end of the heating system, namely the end opposite the fork 16, takes place up the sides and down the middle of the kiln chamber, that is to say, in a reverse direction from that proceeding at the end of the system where the fork 16 is located.

The height of the baffles 14 and 15 may be varied in sound discretion, the purpose of them being to prevent short circuiting of the currents of the circulatory medium, or, in other words, positively to compel said medium to pass through the spaces between the heating coils and through the interstices of the stock to be dried. To that end said baffles should extend both above and below the tracks 4 a sufficient distance to obstruct the open spaces thereabout and to prevent the circulatory medium from following a line of least resistance which the absence of such obstruction might present.

The second means above noted for aiding natural circulation may consist of spraying devices disposed wherever desired for obtaining the result of aiding the circulation. By spraying devices I intend to include steam jets, water sprays or sheets, and air blasts.

A third means for aiding natural circulation may consist, as elsewhere herein specified, of multiplication of the area of the heating surfaces employed, for example by accumulation of steam pipes in larger or smaller groups at points desired.

In operation, the circulatory medium within the kiln is caused even by a comparatively low temperature, to ascend by reason of its rarefaction, through the portions of the coils 7 that are located in passage ways defined by the baffles themselves outside the baffles 14. Thence the current of circulation enters and ultimately descends through the stock loads on the tracks 4 carrying with it from the stock moisture of evaporation therefrom, which has in itself, by reason only of its superior gravity, a definite tendency to descend. In this manner a transverse circulation of the contents of the kiln is kept up about each stock load, with a tendency to penetrate interstices in the load wherever they are provided.

While this is going on at one end of the

chamber 1, a reverse circulation, in consequence of the relative disposition of the baffles 15 in respect to the stock load or loads adjacent to them is taking place at the other end of the chamber 1.

At some variably disposed vertical plane along the longitudinal axis of the chamber, the two oppositely rotatory currents must meet. The location of said plane may be varied at will with effect of ultimate gain in the final results of its drying operation. There is, moreover, a longitudinal circulation from end to end of the chamber 1 taking place within it at all times while the kiln is in operation. This results from a preponderance of air pressure at the outlet end, whereby an accumulation under pressure of the circulating medium at the top of the outlet end of the kiln is compelled by said pressure to seek egress by descent through the stock at the inlet end of the chamber. The result effected is a circulation of the circulatory medium in two directions, with a consequent commingling at each end of the kiln chamber 1 of portions of the said medium derived from the circulation which is constantly taking place at opposite ends of the kiln chamber. One of said commingling portions is derived from the transverse circulation induced by the operation of the baffles 14, where the circulatory medium is heavily laden with the moisture of evaporation from green stock. The other portion of the circulatory medium is derived from the outlet end of the kiln chamber and where it is kept consequently in a comparatively hot and dry state. The combined effect of the twofold currents of circulation just described is to temper, advantageously to the product of the kiln, the condition of the circulatory medium at each end of the kiln chamber by contributions to it of portions of said medium drawn initially from the opposite ends of said chamber under contrasting conditions which there exist, but gradually changing in quality of heat and moisture as it moves from either end of the chamber to the other.

It may now be observed that instead of depending upon the operation of heat alone as the means for effecting circulation of the circulatory medium within the kiln chamber, mechanical means, ancillary to the means first mentioned, may be often used to advantage.

Such ancillary mechanical means is shown in two different forms in Figures III–VI and in Figures VIII–X, respectively.

In the group of figures first named in the last preceding sentence, the ancillary mechanical means comprises what may be denominated a circulator in operative communication with a power-driven fan 20. The fan makes delivery through a main duct 21 to the circulator, and preferably makes upon its opposite sides return induction through return ducts 22 and 23 of the circulator. The fan is preferably located outside of the kiln chamber 1, while all the ducts are in operative communication with the interior of said chamber as through suitable delivery ports 24 and intake ports 25, respectively, disposed at suitable intervals along the respective ducts.

At about the middle of the kiln chamber 1, the main delivery duct 21 is bifurcated into two branch delivery ducts 26 and 27, so that while the main delivery duct is disposed throughout its length medially within the chamber 1, the branches are disposed likewise along the opposite sides thereof, as illustrated in Figure III.

As shown also in Figure III, the return ducts 22 and 23 are unified substantially in mid chamber into a single return duct 28 which is disposed medially within the kiln chamber 1. By aid of the circulator through the operation of the fan 20, the circulatory medium is, at the intake end of the kiln, driven upwardly from the branch delivery ducts 26 and 27 upon opposite sides of the baffles 14, and is, after effecting transverse circulation in the manner already described with reference to Figures I and II, sucked into the single return duct 28. Simultaneously with the operation described in the last sentence the main delivery duct 21 is making delivery to the interior of the kiln chamber 1 at its outlet end so as to create a transverse current of circulation returning to the fan through induction by suction into the return ducts 22 and 23, respectively. It should be observed that the circulator above described is, in operation, strictly ancillary to the means of circulation described with reference to Figures I and II, and that its operation is attended with the same longitudinal circulation as that described with reference to said figures, but only to an increased or amplified degree or extent.

By proper selection of the type of fan 20 employed, and by adaptation of the fan to the purpose required of it, the said fan may be made reversible, so as to reverse the direction of rotation of the circulatory medium at the opposite ends of the chamber, whenever desired. By such reversibility of the direction of rotation of the circulatory medium a peculiar uniformity of the drying operation upon the drying stock may be effected.

The ancillary mechanical means of circulation shown in Figures VIII–X, comprises an internal fan mechanism, consisting of a rotatable shaft 30, which is operatively mounted on upright bearing-supports 31 within and along the length of the kiln chamber 1, and of disc fans 32 and 33 fixed to said shaft at intervals along its length. The fans 32 make air delivery in one direction and the fans 33 in the opposite direction, with the result of a reversal of direction

of circulation substantially to the same effect as the circulatory operation described with reference to Figures III–VI. The area immediately about the fans 32 and 33 is, as shown in Figures XI and XII, flanked by side walls 35 and 36 extending substantially from end to end of the interior of the chamber 1, while transverse upright plates or partitions 38 are disposed at intervals determined by the location of the respective fans along the length of the shaft 30. The partitions 38 are secured to the opposite side walls 35 and 36 and rising substantially to a plane tangential to the tops of the several fans extend outside the walls 35 and 36 in wing baffles 39 which partially fill the spaces between the said walls and the inner surface of the outside wall of the kiln with deflecting effect upon the circulatory medium. These wing baffles 39 are adjustable by the common expedient of permanent flexure and remain set in adjustment imparted to them. A medial partition 40 identical in form to the partitions 38 divides the space between the walls 35 and 36 into two lengths (not necessarily of equal extent) in one of which rotate the fans 32 and in the other the fans 33. Baffle plates 41 depending from a suitable support below the tracks 4 are disposed at intervals in opposition each to its respective fan so as to co-operate each with its corresponding partition with the effect of directing upwardly into the interior of kiln chamber 1 at one end the current of air derived from the rotation of each fan. The shaft 30 is driven by any suitable means as, for example, a belt 42 passing about pulleys 43 and 44 upon said shaft and the shaft of an electric motor 45, respectively.

The walls 35 and 36 extend upwardly in vertically inclined plates 47 and 48, respectively, which define between them, for their full length, an open throat 49. Between next adjacent wing baffles 39 on the transverse partitions 38, the walls are at intervals broken away or provided with suitable openings, as indicated at 50, with the following effect, namely, that the fans 32 by their rotative movement serve to suck in from above the circulatory medium through the throat 49, and to discharge it laterally through the openings 50 whence it is caused to circulate transversely through the interior of the kiln, returning in said circulation through the throat 49 as aforesaid, but not necessarily returning to the same fan as that from which it first proceeded.

The fans 33, encased precisely as are the fans 32 and rotated with them, suck in the circulatory medium through the openings 50 and discharge them upwardly through the throat 49. It will therefore appear that there is effected a reversal of the direction of transverse circulation at opposite ends of the chamber 1 on opposite sides of the medial partition 40. It will also appear from what is already specified that a longitudinal circulation takes place within said chamber of the circulatory medium derived from that which enters into the transverse circulations which I have just above described.

The same effect in respect to reversal of circulation may be accomplished by using fans, 32 and 33, respectively, of the kind commonly known in the art as right hand and left hand fans, disposed on the opposite sides of the medial partition 40, the duct system comprising the members 35, 36, 37, 38, 39, 40, 47, 48, 49, and 50, as previously specified being retained.

It should be observed that the internal fan mechanism last described is shown as combined with a flue heating system, but it should be in that connection borne in mind that each heating system contemplated by me is, as already specified, regarded by me as interchangeable in every instance with another.

In addition to what has been already specified, it should be mentioned that it is my purpose to provide within the kiln chamber 1 hot fluid delivery pipes 55 distributed at such points as may be deemed most advantageous. Such pipes may be, at wise discretion, made to discharge steam, water, or air in fine jets or sheets for purposes well understood in the art, it being understood that such jets or sheets may be employed so as only, for the most part, to accelerate currents of circulation, or they may be employed also for the purposes of humidifying or ventilating the circulatory medium. For the purpose of acceleration the pipes 55 should discharge in any direction which the flow of the circulatory medium may require, or they may be adapted for reversal of direction of discharge to meet the requirements of reversibility of circulation where reversibility, as has been elsewhere herein specified, may necessitate. For the purpose of simple humidification or for ventilating purposes, the pipes may make lateral discharge so that they will be neutral, and, therefore, suitable for any direction of flow of the circulatory medium.

The operation of my invention is deemed in the main, to be so plain and so sufficiently set forth in the foregoing specification as to require no recapitulation here, but it may be added that in utilizing my kiln for drying of lumber for instance, no special method of piling or stacking the lumber on the trucks need be employed. Each particular method of piling as now known in the art or as may be devised may have, under certain conditions, special advantages, but my kiln, in its various forms and methods of operation, is deemed to be advantageously adaptable to all available methods of piling lumber which may be employed in the art of kiln drying.

What I claim is:

1. In a drying kiln, the combination with a kiln chamber, and stock-supporting track therein, of heating means in operative relationship to stock supported on said track, said means comprising means for effecting at each end of the kiln chamber a separately directed circulative movement of the gaseous medium of circulation relatively to the stock in the kiln chamber, means ancillary to said heating means for compelling said circulative movements, respectively, and means for reversing at will the direction of circulation of said circulatory movements, respectively.

2. In a drying kiln, the combination with a kiln chamber, and stock-supporting track therein, of heating means in operative relationship to stock supported on said track, said means comprising means for effecting at each end of the kiln chamber a separately directed circulative movement of the gaseous medium of circulation relatively to the stock in the kiln chamber, means ancillary to said heating means for compelling said circulative movements, respectively, and means for effecting additional circulation of said circulatory medium from end to end of the kiln chamber.

3. In a drying kiln, the combination with a kiln chamber, stock-supporting track therein, heating means therefor comprising, substantially at opposite ends of the kiln chamber, areas of heating surfaces of different capacities, means for effecting transverse circulation of the gaseous medium of the chamber heated by said surfaces, respectively, in different directions relatively to the stock load, whereby the relative capacities of the said heating areas is made to effect longitudinal as well as transverse circulation of the heating medium within the kiln chamber.

4. In a drying kiln, the combination with a kiln chamber, and stock supporting track therein, of a driven shaft rotatable within the chamber, fans fixed at intervals upon said shaft to rotate with it, and plates in effect partially encasing each fan and defining openings for circulation of a gaseous circulatory medium relatively to each fan, whereby each fan effects an individual circulation within the chamber, some of said fans operating upon said circulatory medium by suction from the chamber and others by propulsion thereinto, whereby predetermined currents in opposite directions are set up and maintained within the chamber.

5. In a drying kiln, the combination with a kiln chamber, and stock supporting track therein, of a driven shaft rotatable within the chamber, fans fixed at intervals upon said shaft to rotate with it, and plates in effect partially encasing each fan and defining openings for circulation of a gaseous circulatory medium relatively to each fan, whereby each fan effects an individual circulation within the chamber, some of said fans operating upon said circulatory medium by suction from the chamber and others by propulsion thereinto, whereby predetermined currents in opposite directions are set up and maintained within the chamber, and means for reversing the direction of the shaft whereby the fans may be made to function with reverse effect, respectively.

6. In a drying-kiln, the combination with a kiln chamber, and stock supporting track therein, of a driven shaft rotatable within the chamber, fans fixed at intervals upon said shaft to rotate with it, and plates in effect partially encasing each fan and defining openings for circulation of a gaseous circulatory medium relatively to each fan, whereby each fan effects an individual circulation within the chamber, some of said fans operating upon said circulatory medium by suction from the chamber and others by propulsion thereinto, whereby predetermined currents in opposite directions are set up and maintained within the chamber, and a medial partition dividing the interor of the chamber into two lengths, one set of said fans being located in one of said lengths and the other set of fans being located in the other length, whereby circulation longitudinally within the kiln from one set of fans to the other may be effected.

7. In a drying kiln, the combination with a kiln chamber, and stock supporting track therein, of a driven shaft rotatable within the chamber, fans fixed at intervals upon said shaft to rotate with it, and plates in effect partially encasing each fan and defining openings for circulation of a gaseous circulatory medium relatively to each fan, whereby each fan effects an individual circulation within the chamber, some of said fans operating upon said circulatory medium by suction from the chamber and others by propulsion thereinto, whereby predetermined curents in opposite directions are set up and maintained within the chamber, a medial partition dividing the interior of the chamber into two lengths, one set of said fans being located in one of said lengths and the other set of fans being located in the other length, whereby circulation longitudinally within the kiln from one set of fans to the other may be effected, and means for reversing the direction of rotation of the shaft whereby the direction of movement of all the several currents of circulation within the kiln chamber may be simultaneously reversed at will.

8. In a drying kiln, the combination with a kiln chamber, and stock-supporting track therein, of heating means in operative relationship to stock supported on said track, said means comprising means for effecting at each end of the kiln chamber a separately directed transversely circulative movement of the gaseous medium of circulation relatively

to the stock in the kiln chamber, and sprays operatively discharging into the body of the circulative medium and terminally disposed with respect to the chamber.

9. In a drying kiln, the combination with a kiln chamber, track rails therein, and flat piled stacks of lumber supported on said rails, of heating means in operative relationship to said lumber, and oppositely directed reversible means, substantially at opposite ends of the kiln chamber, for effecting circulation through the lumber in opposite directions at opposite ends of the kiln chamber.

10. In a progressive drying kiln, the combination with a kiln chamber, stock-supporting track therein, and heating means in operative relationship to stock supported on said track, of a circulator comprising supply ducts and delivery ducts, said ducts being branched for differently directed discharge, respectively, at the opposite ends of the kiln, and being operatively disposed in relationship to said heating means within the chamber, and reversible means for producing circulation within the kiln through said ducts, respectively, whereby reversal of the operation of the respective ducts may be accomplished with distinctive drying effect on the stock.

11. In a drying kiln, the combination with a kiln chamber, and stock supporting track therein, of a driven shaft rotatable within the chamber, partially encased fans fixed at intervals upon said shaft to rotate with it, said fans at one end of the chamber being adapted to make delivery toward one side of the chamber and those at the other end of the chamber being adapted to make delivery towards the other side of the chamber.

12. In a progressive kiln having truck supporting tracks therein, a unitary heating system having more heating surface at the dry end than at the green end, said heating system being divided to be on opposite sides of a pair of baffles at the green end of the kiln and massed together at the dry end, being flanked by a pair of baffles to produce an oppositely directed circulation at the opposite end of the kiln.

13. In a progressive kiln having truck supporting tracks therein, a unitary heating system having more heating surface at the dry end than at the green end, said heating system being divided to be on opposite sides of a pair of baffles at the green end of the kiln and massed together at the dry end, being flanked by a pair of baffles to produce an oppositely directed transverse circulation at opposite ends of the kiln and a longitudinal circulation independent of the transverse oppositely directed circulation at opposite ends of the kiln.

14. In a progressive drying kiln having stock supporting tracks therein, a driven shaft rotatable within the chamber, partially encased fans fixed at intervals upon said shaft to rotate with it, said fans at one end of the chamber blowing through lateral banks of coils, and fans at the opposite end sucking through a lesser number of heating coils.

15. In a progressive drying kiln having stock supporting tracks therein, a driven shaft rotatable within the chamber, partially encased fans fixed at intervals upon said shaft to rotate with it, said fans at one end of the chamber blowing through lateral banks of coils, and fans at the opposite end sucking through a lesser number of heating coils, said fans being reversible.

16. In a progressive kiln, the combination with truck supporting tracks therein, of means for producing successive currents of transverse circulation throughout the kiln chamber, means for imparting different degrees of heat to said successive currents of transverse circulation, and means for effecting longitudinal circulation therein so as to sweep along and homogenize the medium of the currents of transverse circulation.

17. In a drying kiln, the combination with a kiln chamber, and stock-supporting track therein, of heating means in operative relationship to stock supported on said track, a circulator also in operative relationship to said stock, said circulator having at its opposite ends, respectively, relatively transposed supply and return ducts so arranged as in operation to produce oppositely directed transverse circulations at each end of the kiln chamber, and a power driven fan in operative communication with said circulator.

18. In a drying kiln, the combination with a kiln chamber, and stock-supporting track therein, of heating means in operative relationship to stock supported on said track, a circulator also in operative relationship to said stock, said circulator having at its opposite ends, respectively, relatively transposed supply and return ducts so arranged as in operation to produce oppositely directed transverse circulations at each end of the kiln chamber, and a reversible power-driven fan in operative communication with said circulator.

19. In a drying kiln, the combination with a kiln chamber, and stock-supporting track therein, of heating means in operative relationship to stock supported on said track, a circulator, substantially as specified, also in operative relationship to said stock, said circulator having at its opposite ends, respectively, relatively transposed supply and return ducts so arranged as in operation to produce oppositely directed transverse circulations at each end of the kiln chamber, and a power-driven fan in operative communication with said circulator, said fan comprising means of communicating with the supply and return ducts, respectively.

20. A progressive dry kiln comprising an elongated chamber provided with means for heating the chamber, means for producing circulation of the air within the chamber longitudinally through the material therein and means for producing crosswise circulation of the air through the material within the chamber.

21. A progressive dry kiln comprising an elongated chamber provided with means for heating the air within the chamber, means for producing longitudinal circulation through the material of the air within the chamber and means for producing crosswise circulation of the air through the material at both ends of the kiln.

22. A progressive dry kiln comprising an elongated chamber provided with means for heating the air within the chamber, means for producing longitudinal circulation of the air within the chamber through the material therein, and means for producing crosswise circulation through the material at one end of the chamber.

23. In a dry kiln, in combination, a heating chamber, means for developing self-controlled air recirculation actuated by differences in density of partially counterbalancing columns of hot and cold air, and means for developing air recirculation independently of and crosswise of the first-mentioned circulation.

In testimony whereof, I have hereunto set my hand.

J. FORREST COBB.