Feb. 5, 1924. 1,482,812

W. E. ROBERTS

APPARATUS FOR DRYING DIVIDED MATERIALS

Filed Dec. 14, 1921 3 Sheets-Sheet 1

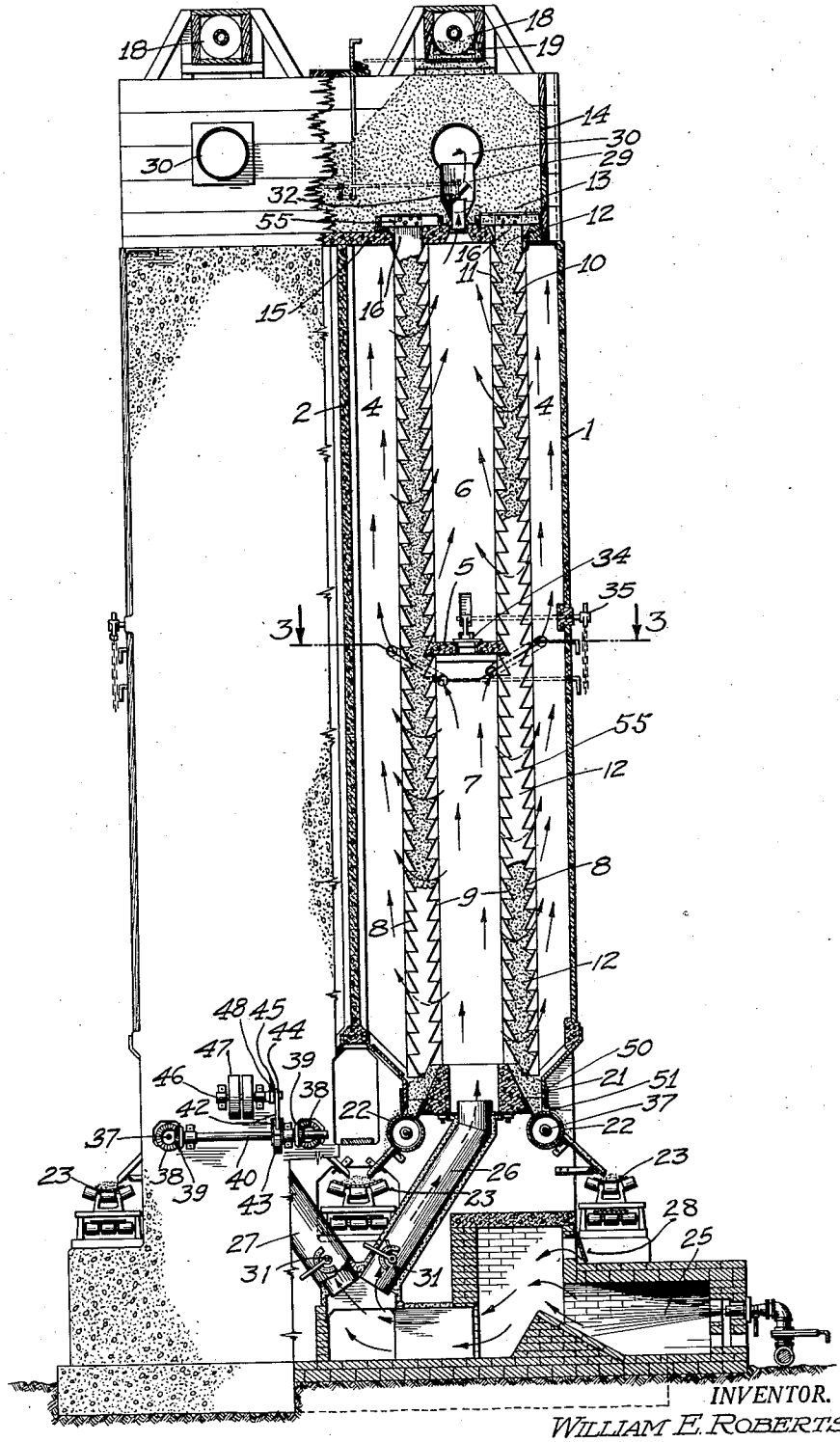


Fig. 1.

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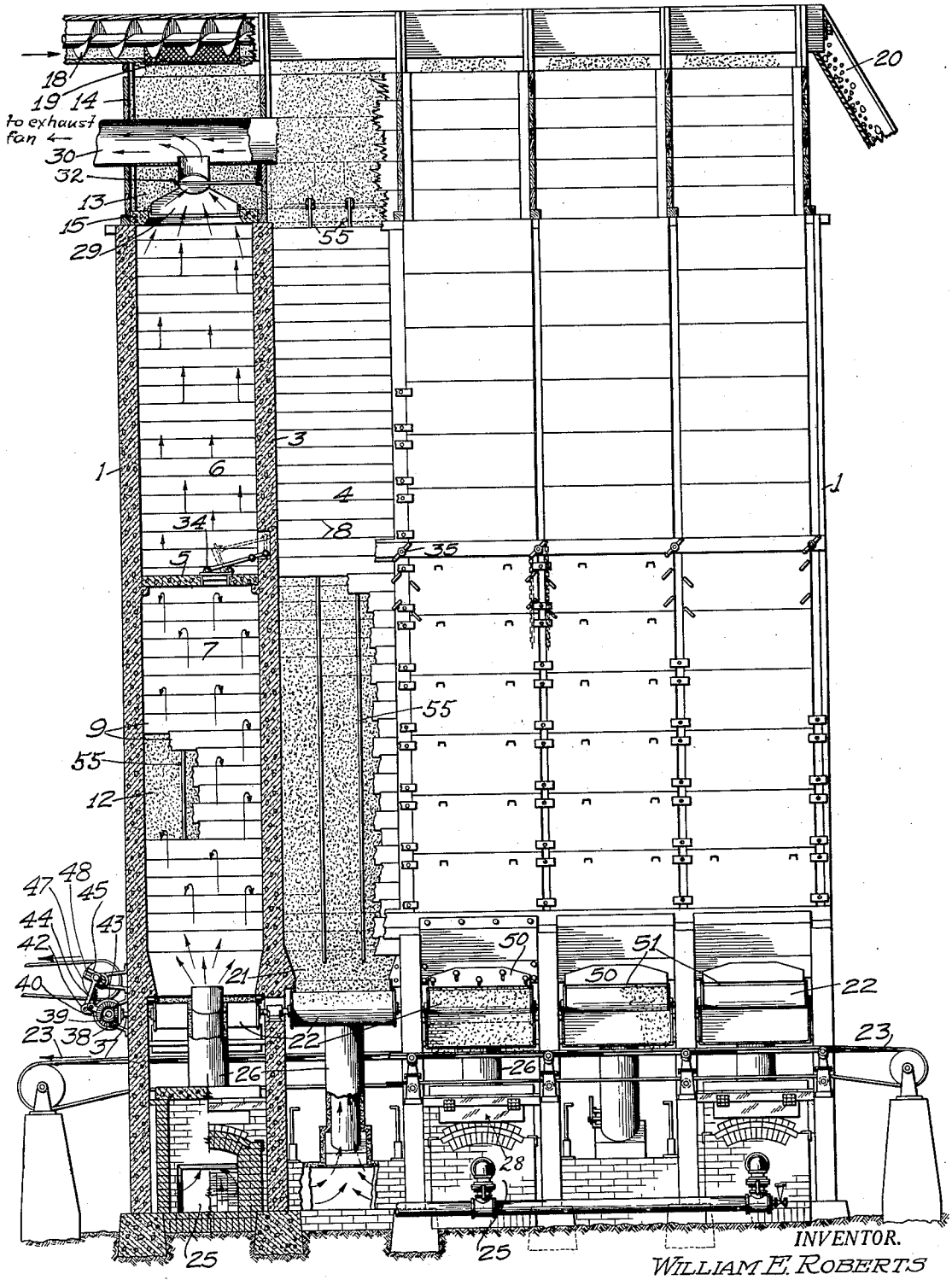


Fig. 2.

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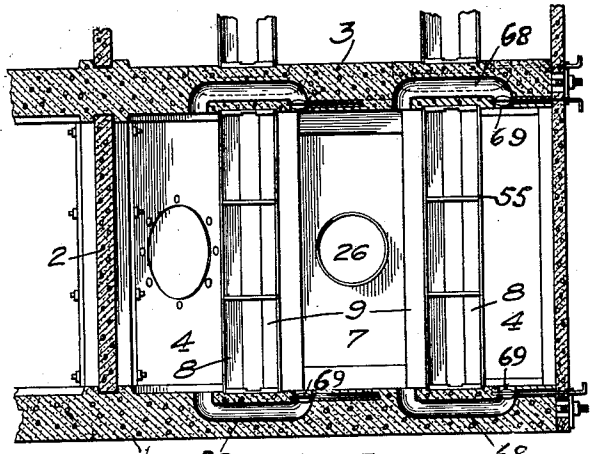


Fig. 3.

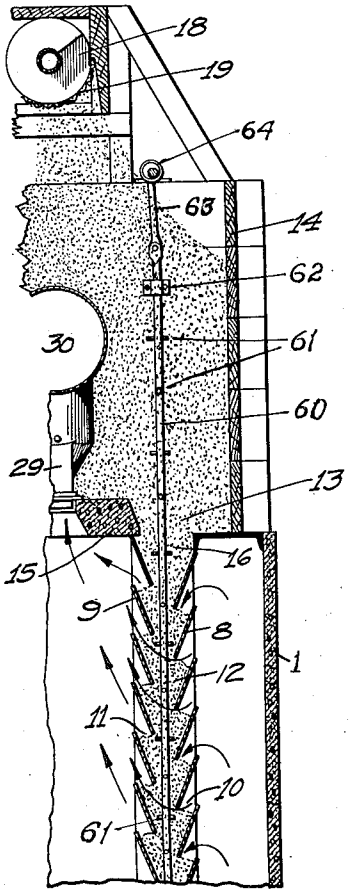


Fig. 4.

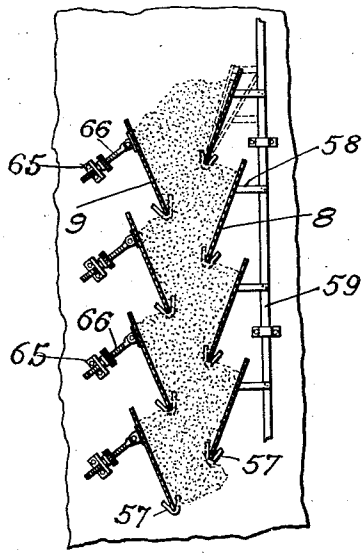


Fig. 5.

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UNITED STATES PATENT OFFICE.

WILLIAM E. ROBERTS, OF LOMPOC, CALIFORNIA.

APPARATUS FOR DRYING DIVIDED MATERIALS.

Application filed December 14, 1921. Serial No. 523,253.

To all whom it may concern:

Be it known that I, WILLIAM E. ROBERTS, a citizen of the United States, residing at Lompoc, in the county of Santa Barbara, in the State of California, have invented a new and useful Apparatus for Drying Divided Materials, of which the following is a specification.

This invention relates to the drying of more or less finely divided materials such as diatomaceous earth or other materials which require dehydration or drying in order to render them available for use. I will describe my invention with particular reference to the drying of diatomaceous earth, which in its natural state or when received from the quarry contains considerable moisture; the extreme porosity of the diatomaceous earth making the removal of said moisture a matter of some difficulty.

The main object of the present invention is to provide for drying diatomaceous earth or other more or less finely divided materials in an effective and economical manner. Another object of the invention is to provide for passing the drying medium repeatedly in contact with the material to be dried to enable the maximum amount of moisture to be taken up and removed by said medium. A further object of the invention is to so carry out the drying operation that the capillarity of the mass is maintained during the drying so as to insure flow of the moisture to the surface where the material is exposed to the drying gases. In the drying of finely divided porous material such as diatomaceous earth, there is a tendency in the drying of the exposed surface for the capillarity of the mass to be interrupted so that the moisture fails to pass to such surfaces and the drying operation proceeds slowly and with minimum efficiency. I provide for continually maintaining the capillarity of the mass and continually exposing wet surfaces to the drying operation, so that the drying operation proceeds to completion with maximum efficiency and rapidity.

A further object of the invention is to provide for uniform passage of the drying medium through the body of the material to be dried and to effect such passage with minimum gas pressure or "head", and with low velocity so as to decrease the power required for forcing the gas through the material and preventing any of the material being carried along with the stream of gas or drying medium.

Another object of the invention is to provide for maintaining the material to be dried in sufficiently loose condition to enable passage of the gases therethrough, while at the same time maintaining the material in a condition of uniform distribution so as to prevent "channeling" and also to insure the retention of capillarity in the mass of material.

The accompanying drawings illustrate an embodiment of my invention and referring thereto: Fig. 1 is a partly sectional end elevation of an apparatus suitable for carrying out my invention. Fig. 2 is a partly sectional side elevation thereof; Fig. 3 is a section on line 3—3 in Fig. 1. Fig. 4 is a vertical section of a portion of one of the drying units. Fig. 5 is a vertical section of the means whereby the material to be dried is supported in the form of a vertical curtain, as hereinafter described.

The apparatus as shown in the drawings comprises a casing, housing or enclosure 1 of reinforced concrete or other suitable material formed interiorly with means for holding or supporting the material to be dried and with passages or chambers for receiving and directing a drying medium. The apparatus is shown as constructed in duplicate, having a central partition wall 2, and on each side thereof, a series of drying units, arranged in a row, and separated by partition walls 3. Each drying unit comprises material supporting means extending vertically therein and dividing the space within the drying unit into outer chambers 4 (constituting intermediate chambers) and a central chamber which is divided by a horizontal partition 5 to form an upper outlet chamber 6 and lower inlet chamber 7.

Each of the material supporting means comprises two vertical wall means formed of baffles or louvre plates 8 and 9, which are arranged opposite one another and are inclined so that the baffles or louvre plates on each side incline inwardly and downwardly toward the baffle plates on the opposite side and are arranged in staggered or alternate relation with respect to the opposing baffles, the construction being such as to form a vertical chute 12 for receiving the material to be dried, and supporting the same in the form of a vertical curtain extending between the chambers 7 and 4 at the lower part of

the drying unit, and between the chambers 4 and 6 at the upper part of such unit, in such manner that the heating medium is caused to pass through such curtain of material in passing from chamber 7 to chamber 4 and again in passing from chamber 4 to chamber 6. Such material, indicated at 13, is retained by and descends between these opposing baffles or louvre plates, forming a vertical curtain extending the full height of the chambers 4, 6 and 7. Said material is supplied from a top bin 14, the floor 15 of which is provided with openings 16 for permitting the material to flow freely into the spaces or chutes 12 between the respective sets of baffles 8 and 9. The material may be supplied to the bin 14 by any suitable feeding means, for example, by a screw conveyor 18 which may be provided with a screen 19 for screening the material as it is delivered to the bin 17, the over size passing out at the end as indicated at 20. At the bottom of the material receiving passages 12, chutes 21 are provided for conducting the dried material to a delivery or ejecting means 22 of any suitable construction, whereby the dried material is delivered to suitable means such as the conveyors 23 for conducting the same to a suitable point for use, storage or shipment.

Suitable means are provided for passing drying medium such as hot gases into the lower chamber 7 of each drying unit. The gases utilized as a drying medium may be heated either directly or indirectly. In any case, however, it is desirable that source of heat should be adjacent to and below the respective drying units so as to utilize to the fullest extent the heat generated thereby. For this purpose a furnace or combustion chamber 25, may be arranged below the drier, the outlet of said furnace communicating by pipes 26 and 27 with the lower chamber 7 of the respective drying units. Furnace chamber 25 may have an inlet damper 28 for admitting cold air to control the temperature of the drying gases. The upper chamber 6 of each drying unit communicates through a flue 29 with an exhaust main 30 extending over the series of drying units and leading to an exhaust fan or other suitable means, not shown, for drawing air or gases from the apparatus so as to maintain a slight "vacuum" within the apparatus. Suitable dampers 31 and 32 may be provided in the inlet pipes 26 and 27 and the outlet flues 29 for controlling the rate of flow of the hot gases or drying medium. A damper 34 is also preferably provided in the horizontal partition 5 for controlling the passage of heating medium or hot gases between the lower chamber 7 and the upper chamber 6, for the purpose hereinafter set forth, said damper or valve means 34 being operated by suitable means indicated at 35. Passages or conduits 68 are provided leading from the lower central chamber 7 direct to the outer chamber 4, these passages being controlled by valves or dampers 69.

The discharge or ejecting means 22 for removing the dried material from the bottom of the chutes 12 is preferably such as to provide for intermittent or periodic removal of the material so that the material will have periods of rest alternating with periods of descent. For this purpose, the discharge means 22 may be formed as a roll or drum mounted to rotate on a horizontal axis at the bottom of each discharge chute 21, the shaft 37 of said roll being connected by gearing 38 and 39, to a countershaft 40 which is operated intermittently, for example by a pawl 42 engaging a ratchet wheel 43 on said shaft 40, said pawl 42 being carried by a link 44 connected to a crank or arm 45 on a driving shaft 46 operated by suitable pulley means 47. The link 44 may be adjustable in a radial slot 48 on said crank 45 to vary the "throw" of the pawl and correspondingly vary the angular movement of the discharge roll 22 at each operation. A discharge gate 50 is provided over the discharge roll 22 said gate being adjustable to vary the size of the discharge opening 51 between said gate and the top of the roll.

In order to overcome any tendency of causing parts of the material to roll to the end portions of the drying passages or chute 12, resulting in lack of uniformity of the material, I prefer to divide the passages or chutes by vertical partitions 55 which are serrated to correspond more or less with the baffles 8 and 9. The baffles or louvre plates 8 and 9 may be adjustable so as to vary the inclination thereof, this being particularly desirable when the apparatus is to be used for drying different materials, or material in different states of aggregation, or with varying moisture content, or otherwise variable in its physical properties. For this purpose the baffles 8 and 9 may be mounted on seats 57 as shown in Fig. 5, and as indicated for baffles 8, may be held at any desired inclination by abutments 58 engaging therewith and carried by a vertical rod 59 which is adjustable in any suitable manner to vary the height of the abutments 58 and tilt the baffle 8 more or less, as indicated in dotted lines, or as shown for baffles 9, they may be adjusted as to inclination by means of set screws 66 connected thereto and mounted on fixed supports 65.

It is desirable in some cases to provide means for agitating or stirring the material while confined in the drying chute 12 between the louvre walls formed by the baffles 8 and 9, and for this purpose stirring rods 60 may be provided, extending vertically in said chutes and provided with

prongs 61 if necessary, each of said rods sliding vertically in guide means 62 and being connected by link 63 to a vibrating means such as in eccentric 64, driven in any suitable manner to reciprocate the rods vertically and thereby effect stirring of the material.

My process may be carried out in the above described apparatus as follows:

The diatomaceous earth, or other material to be dried, is supplied in a suitable state of division to bin 14 by the feed means 18, and passes from such bin downwardly into the drying chutes 12, wherein it descends gradually by gravitative action, assisted, if necessary, by the operation of the stirring devices 60. When the chutes or spaces between the louvre means 8 and 9 become filled with material, further descent of the material is arrested until some of the material is withdrawn from the bottom of the chutes 12 by the operation of the discharging means 22. The operation takes place intermittently as stated, so that the material descends intermittently. Through the operation of the furnace or heater, or by any other suitable means, a current of drying medium, such as hot air or other gases is supplied to the lower central chamber 7 of each heating unit and passes transversely through the curtain of material supported by baffles 8 and 9, the latter being so placed that the air passing through the openings or slots between adjacent baffles, passes upwardly through the material to reach the nearest opposite opening through which the gases pass to the outer chambers 4. The air or hot gases then pass from each outer chamber back through the upper part of the curtain of material, to the upper central chamber 6, and then out through the outlets 29 to the fan, stack, or other draft inducing means, which maintains the draft or air current through the apparatus. In the first passage of the hot gases through the material, in passing from the lower central chamber 7 to the outer chamber 4, such gases are considerably reduced in temperature, and it is desirable to boost the temperature of the gases before they are passed again through the material. For this purpose, the dampers 39 are opened more or less so as to allow hot gases from such central chamber to pass direct to the outer chamber 4 and reheat the gases therein before they pass again through the material.

The damper 34 between lower and upper chambers 7 and 6 may be opened in starting the drier in operation, or at any other time when it is desired to allow part or all of the gases to flow directly from the furnace to the outlet of the drier.

The principle upon which the drier is operated is that the passing of hot air repeatedly through a vertical "curtain" wall of moist material, will set up capillarity of moisture in the material, bringing the moisture to the surface where, by temperature and convection, it will be vaporized or evaporated and be carried away by the air current passing through the material. The passing of air through the wet material repeatedly is necessary to completely saturate it with moisture before exhausting this air to atmosphere. By increasing the temperature of air after each passage through the material a greater moisture absorbing capacity can be obtained and also the temperature of the drying material increased, which promotes capillarity and accelerates evaporation.

In order to have as short a passage of air through the material and at as many points as is possible, the material is supported on inclined surfaces set opposite each other, also directly over each other, in such a manner as to expose to the drying air a large surface area of wet material and also by reason of the inclination of these supporting surfaces to permit the material to gravitate from one support to another.

The hot air current is drawn through the material without interruption, but the flow of material is periodic and controlled as to motion and amount. It is desirable to have the curtain wall of material come regularly, after it has been allowed to flow downward a short distance, in order that new and wet surfaces can for a short time be exposed to the drying air. This interrupted movement of the material also helps to eliminate separation of the coarse and fine particles. This separation is further provided against by dividing the curtain wall of material into narrow curtains, the partitions being within the baffle supports or louvres and extending from top to bottom of curtain walls of materials.

The advantage of using an exhausting system rather than a pressure system for the hot air, lies in the slight vacuum thereby obtained which promotes capillarity and a small increase in evaporation due to this vacuum.

The inclined supports are arranged so that the enclosed material will move or gravitate in a zigzag manner. This is done for two reasons: first to prevent arching of material between supports, and second, to more completely turn over material as it is gravitated so as to be constantly exposing new and wet surfaces to the drying air.

What I claim is:

1. An apparatus for drying divided materials, comprising material supporting means consisting of opposing walls formed of downwardly converging inclined louvre plates separated to provide openings therebetween, said walls forming a vertical chute adapted to receive the material and to con-

fine and support same by such inclined surfaces, while permitting descent of the material by gravity, means for passing drying medium through said openings so as to pass transversely through material confined between said inclined surfaces and a vertically reciprocating agitating means extending vertically between the opposing louvre plates to agitate and loosen the material.

2. An apparatus as set forth in claim 1, and comprising in addition means for intermittently and positively removing the material from the said outlet to permit intermittent descent of the said material in said chute.

3. An apparatus as set forth in claim 1, wherein the said louvre plates are pivotally mounted at their lower ends and are provided with means for lateral adjustment of their upper ends to vary the inclination of said plates.

4. A drying apparatus comprising opposing walls forming a chute adapted to confine material in the form of a vertical curtain and having openings through which drying medium may be passed transversely through the material, and an enclosing housing formed with an inlet chamber on one side of said chute and with means for supplying hot gases thereto, an intermediate chamber on the other side of said chute adapted to receive gases which have passed from such inlet chamber through to material in the chute and to conduct such gases to another part of said chute, and an outlet chamber adapted to receive the gases passing through the chute from said intermediate chamber.

5. An apparatus as set forth in claim 4, and comprising in addition controllable passage means for conducting gases from the inlet chamber to the intermediate chamber for reheating such gases before they are again passed through the chute.

In testimony whereof I have hereunto subscribed my name this 2nd day of December 1921.

WILLIAM E. ROBERTS.