

Jan. 23, 1940.

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2,187,799

DRIER

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3 Sheets-Sheet 1

Fig. 1.

Fig. 2.

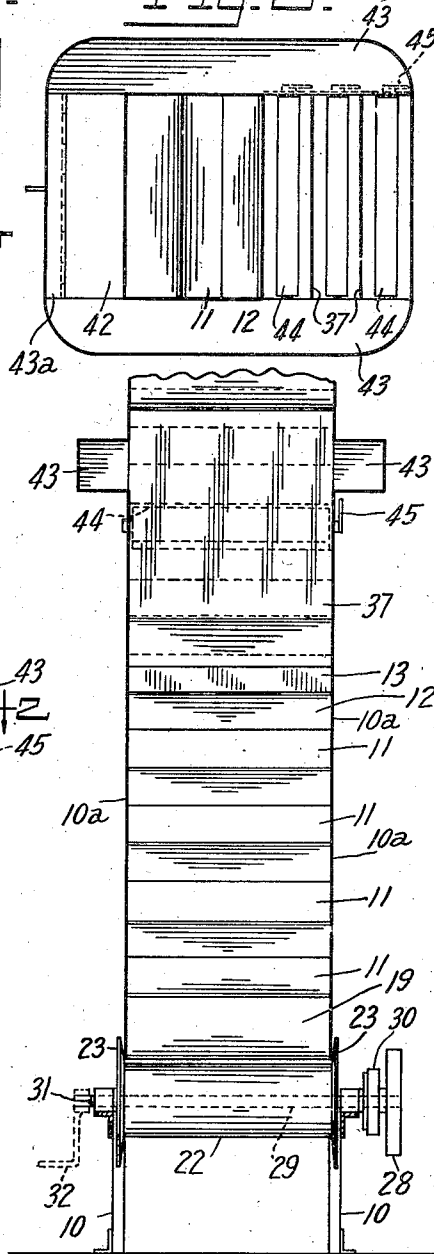
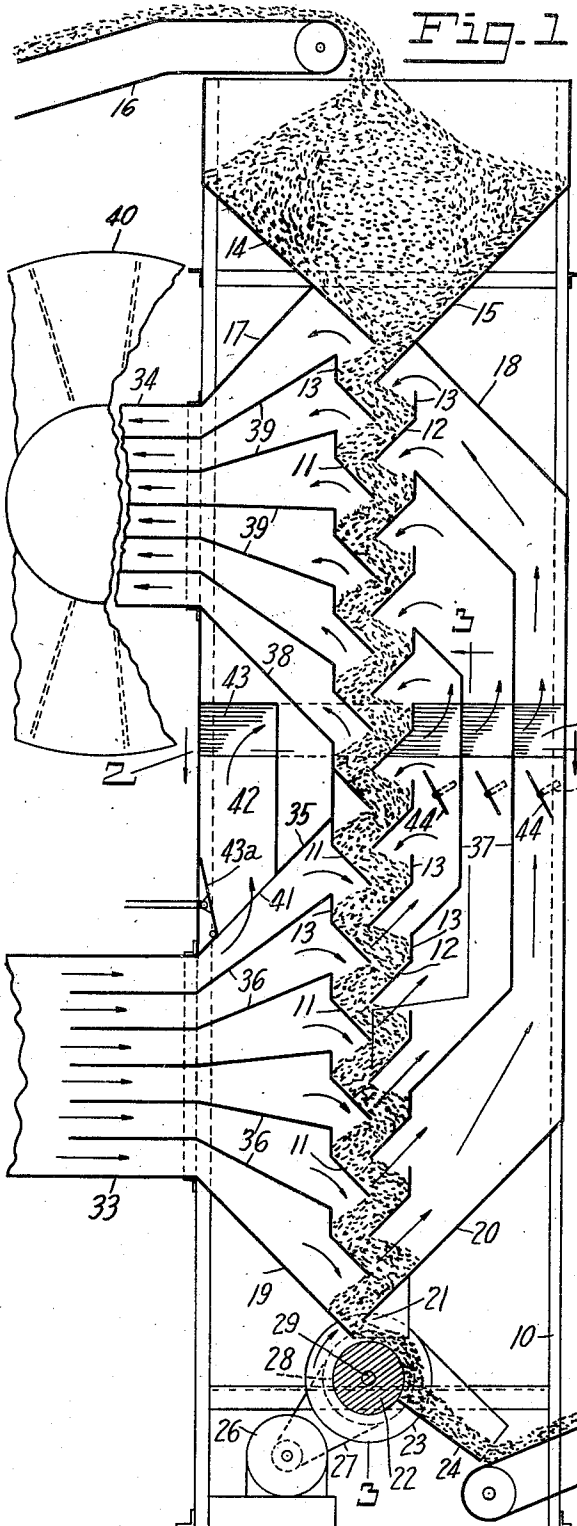


Fig. 3.

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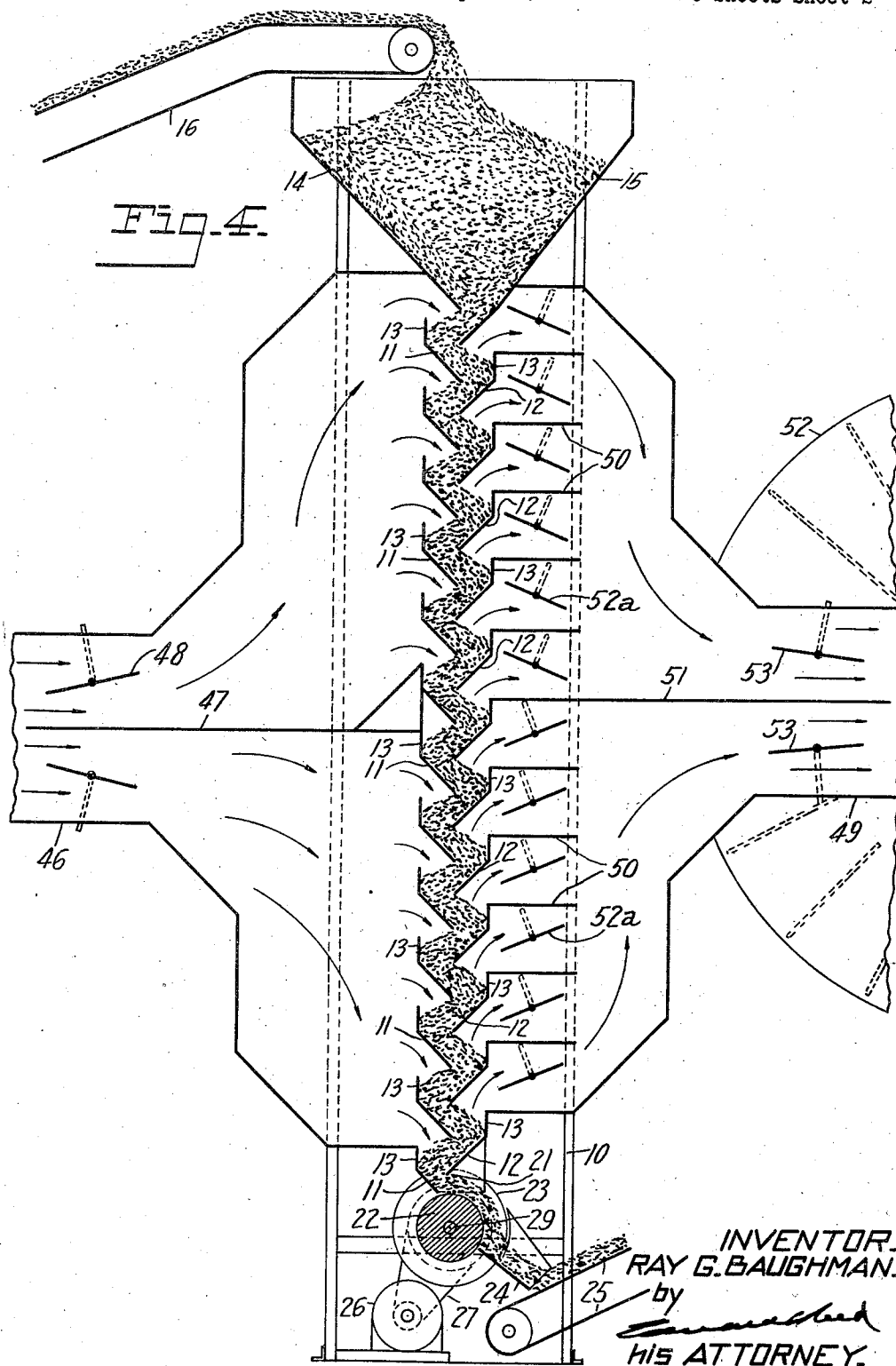
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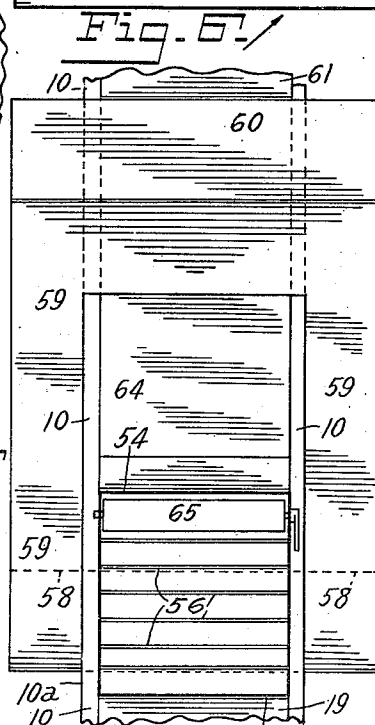
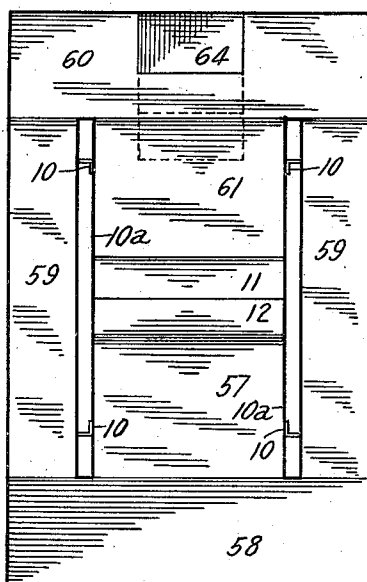
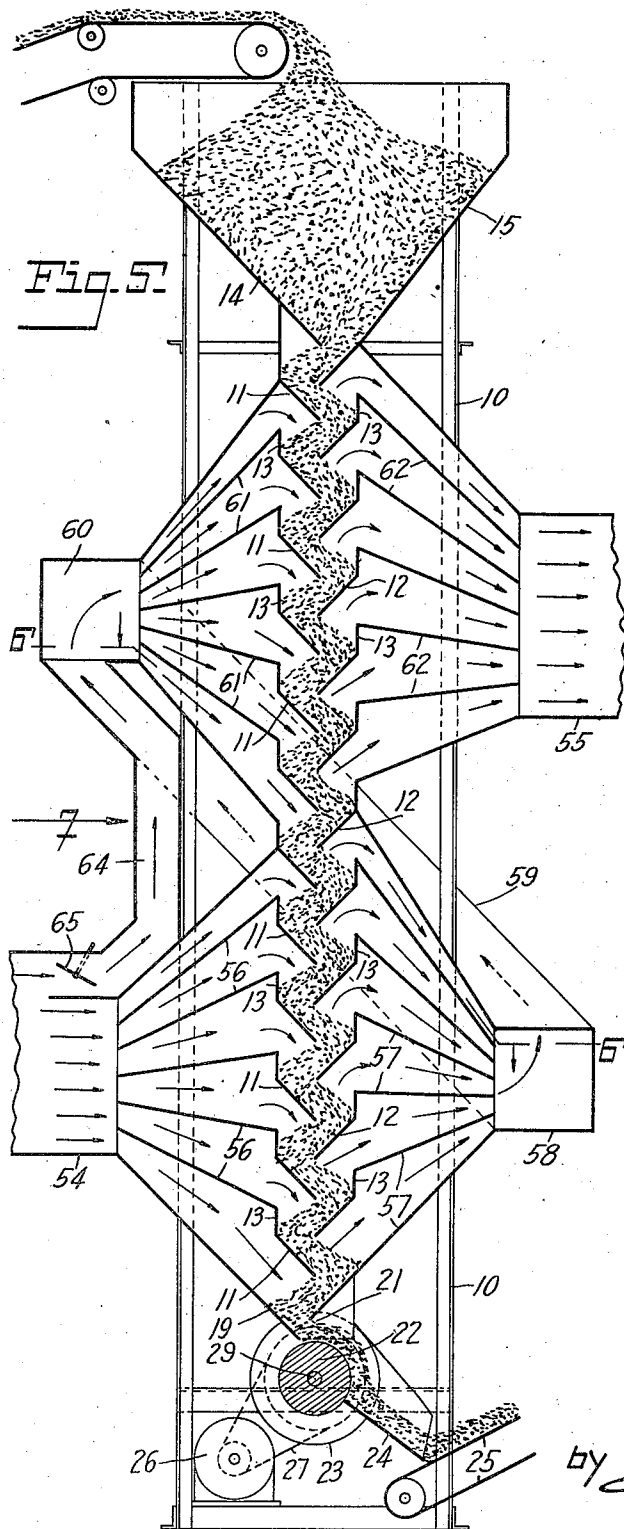
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DRIER

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,187,799

DRIER

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Application April 8, 1938, Serial No. 200,963

4 Claims. (Cl. 34—37)

This invention relates to an apparatus for drying loose material and is designed more particularly for drying coal of the smaller sizes after the coal has been washed.

5 One object of the invention is to provide a drier which will be simple in construction and efficient in operation and which will have few moving parts.

10 A further object of the invention is to provide a drier in which the circulation of the drying medium will be so controlled as to cause substantially equal quantities thereof to pass through all portions of the material being dried.

15 A further object of the invention is to provide such a drier in which each part of the drying medium will pass through the material at least twice during the passage of the drying medium through the apparatus, thus fully utilizing the heat of the drying medium.

20 A further object of the invention is to provide a material lowering device of such a character that the weight of the material will be distributed throughout the height of the device and the material will be so supported that it will have little or no tendency to pack.

25 A further object of the invention is to provide improved means for controlling the movement of the material through the lowering device.

30 A further object of the invention is to provide a drier having a material lowering device of such a character that the material will move gently through the drier, thus causing a minimum of degradation or breaking thereof.

35 Other objects of the invention may appear as the apparatus is described in detail.

In the accompanying drawings Fig. 1 is a vertical section of an apparatus embodying my invention, taken transversely to the lowering device; Fig. 2 is a transverse section taken on the 40 line 2—2 of Fig. 1; Fig. 3 is a vertical section taken on the line 3—3, through a portion of the apparatus of Fig. 1; Fig. 4 is a vertical section taken centrally through a modified form of the apparatus; Fig. 5 is a vertical section taken centrally 45 through another modified form of the apparatus; Fig. 6 is a section taken on the line 6—6 of Fig. 5; and Fig. 7 is a front elevation of a portion of the apparatus, showing the inlet conduit in section.

50 In these drawings I have illustrated certain embodiments of the invention, each of which is designed primarily for drying coal. It will be understood, however, that the apparatus may be utilized for drying loose materials of various kinds and that the construction and arrangement of 55 the apparatus may take various forms.

In each form illustrated the apparatus comprises a vertical frame or housing 10 within which is arranged a material lowering device adapted to permit the material to move downwardly at a relatively low speed and to expose the material 5 to the action of a drying medium. In its preferred form this material lowering device comprises two substantially vertical opposed series of shelves, 11 and 12, the shelves of the two series being arranged in staggered relation one to the 10 other and being in the present instance, secured at their ends directly to the respective side walls 10a of the housing. Each shelf of each series is arranged in an inclined plane which intersects the next lower shelf of the other series and has 15 its lower edge substantially in the same vertical plane as the lower edge of said next lower shelf. By reason of this arrangement each shelf extends entirely across the path of the moving column of material and the entire mass of material is caused 20 to move in a zigzag path, no part of the material being arranged in a straight vertical column. In this manner the entire weight of the column of material is distributed between the several shelves and there is little or no tendency of the material 25 to pack, as frequently results when any part of the material is arranged in a straight column. Further, this arrangement of the shelves imparts a very complete agitation to the moving column of coal and causes the component parts of the 30 mass to be turned over as the mass moves from one shelf to another, thereby exposing all parts of the material to the action of the drying medium. Preferably each inclined shelf is provided 35 at its upper and outer edge with an upwardly extending flange or wall 13 which serves both to increase the capacity of the shelf and to reinforce or stiffen the same.

The material to be dried is delivered to the lowering device by a hopper supported in the 40 upper part of the housing 10, and having downwardly converging bottom walls 14 and 15, the lower edges of which are spaced apart to provide a discharge opening. The lower edge portion of the bottom wall 15 projects beyond the 45 plane of the bottom wall 14 and is arranged to deliver the material from the hopper onto the uppermost shelf 11. The material may be supplied to the hopper in any suitable manner. In the present instance a conveyor 16 carries the 50 material from a suitable source of supply, such as a de-watering screen, to the hopper.

That portion of the housing in which the material lowering device is located constitutes a 55 drying chamber, which is closed at its upper end

by inclined partitions 17 and 18 extending between the bottom walls of the hopper and the front and rear walls respectively of the housing. The lower end of this drying chamber is defined by downwardly converging partitions or walls 19 and 20, the lower edges of which are spaced apart to provide a discharge opening 21 for the material from the lower device. The wall 20 is arranged in a plane intersecting the lower portion of the wall 19 and has its lower edge spaced from that wall. Thus the walls 19 and 20 in effect form a part of the material lowering device. Arranged beneath the discharge opening 21 is a feeding-out roller 22 which extends for the full width of the lowering device and is provided at its ends with flanges 23 to prevent the material from moving endwise of the roller. This roller is so arranged with relation to the discharge opening 21 that when the roller is stationary little or no material will pass through the opening but when the roller is rotated it will carry the material from the opening to a chute 24 which in turn discharges it onto a conveyor 25 which conveys it to a desired point of discharge. Thus the movement of the column of coal through the lowering device is controlled by the feeding-out roller and the speed at which the column of coal moves may be regulated by varying the speed at which the roller operates. The roller may be operated in any suitable manner and, in the present instance, is driven by an electric motor 26 which is connected by a belt 27 with a pulley 28 on the shaft 29 of the roller. In case of an emergency it is sometimes desirable that the feeding-out mechanism should be operated by hand to remove the material from the drier. For example, in the event of the failure of power for operating the mechanism the movement of the column of coal through the lowering device would be interrupted and the heat of the drying medium might in some instances be sufficient to ignite the coal if the latter was allowed to remain stationary for any substantial length of time. I have therefore provided means whereby the feeding-out roller may be manually operated and for this purpose a clutch 30 is interposed between the shaft 29 and the belt pulley 28 and the shaft is provided with a square end 31 adapted to receive a hand crank 32. Thus in the event of the failure of power the roller may be disconnected from the motor and rotated by hand to remove the material from the drier.

The drying medium may be of any suitable character and may be circulated through the drier in any suitable manner. In that form of the apparatus shown in Fig. 1 an inlet conduit 33 conducts the drying medium, such as hot gases, from the source of supply to the lower portion of the drier where it is passed through the material in the lower part of the material lowering device and then conducted to the upper portion of the drying chamber and passed through the material in the upper portion of the lowering device and discharged through an outlet conduit 34. In the arrangement shown in Fig. 1 the inlet and outlet conduits both communicate with the front wall of the drying chamber. In order to distribute the incoming drying medium substantially equally to the various parts of the column of material in the lower portion of the lowering device the inlet conduit is provided with a flared end portion which is arranged within the housing and is of such size as to embrace a substantial part of the shelves on the adjacent side of the lower portion of the

lower device. In the arrangement shown the bottom wall 19 of the drying chamber constitutes the lower wall of this flared portion of the inlet conduit and the upper wall is shown at 35. A plurality of transverse partitions 36 divided the interior of the end portion of the inlet conduit into a corresponding plurality of passageways which communicate with the spaces between different shelves on the adjacent side of the lowering device. In the present arrangement there is a separate passageway for each pair of shelves, each partition 36 being attached at its inner edge to the flange 13 of the adjacent shelf 11. The passageways being of substantially equal capacity it will be apparent that the incoming drying medium will be distributed uniformly throughout the lower portion of the lowering device. The drying medium passes between the shelves 11, through the mass of material supported by the shelves and then out between the shelves 12 into the rear portion of the drying chamber where it is conducted to the upper portion of that chamber.

In order to secure a substantially uniform delivery of the drying medium to all parts of the upper portion of the lowering device the rear part of the drying chamber is divided by partitions 37 into a plurality of upright conduits, in the present instance three, which at their lower ends communicate with spaces between different shelves 12 in the lower portion of the lowering device and at their upper ends communicate with spaces between shelves 12 in the upper portion of the lowering device. In the arrangement shown each conduit embraces at each end the spaces between two pairs of shelves. After passing through the material in the upper portion of the lowering device the drying medium passes to the outlet conduit 34. When, as in the present instance, the outlet conduit is connected with an exhaust fan or the like, to cause the drying medium to circulate through the drier, it is desirable that the suction created by the fan shall be distributed substantially equally over that part of the drier with which the outlet conduit communicates, in the present instance the upper portion thereof. For this purpose the outlet conduit is provided with a flared end portion which extends into the drying chamber and is of such size as to embrace a substantial number of shelves in the upper portion of the lowering device. As here shown, the wall 17 at the top of the drying chamber constitutes one wall of this flared end of the outlet conduit and a downwardly and inwardly inclined wall 38 forms the bottom wall thereof. This end portion of the conduit is divided by transverse partitions 39 into a plurality of passageways, similar to those provided in the inlet conduit, which communicate respectively with the spaces between adjacent shelves 11 of the lowering device, there being in the present instance a separate passageway for each pair of shelves. Inasmuch as the exhaust fan forms no part of the present invention I have shown a portion only thereof, at 40.

Thus, it will be apparent that the incoming drying medium passes first through the lower and drier portions of the material and then through the upper and wetter portions of that material. The drying medium will of course lose some of its heat and take up some moisture as it passes through the material and in some cases it may be desirable to add additional heat to this drying medium before it is passed through the upper portion of the material, and this may

be conveniently accomplished by bypassing a portion of the drying medium from the inlet conduit 33 directly to the upright conduits in the rear portion of the drying chamber. As here shown, the top wall 35 of the flared portion of the inlet conduit is provided with an opening 41 which is connected by a passageway 42 with transverse conduits 43 which have open communication with the upright conduits formed by the partitions 37. Preferably a valve 43a is provided to control the passage of the drying medium from the inlet conduit to the upright conduits. It is also desirable that means be provided to regulate the flow of the drying medium through the upright conduits whereby the flow may be either expedited or retarded and the flow in the different conduits may be varied. For this purpose dampers 44 are arranged within the respective upright conduits and are provided exteriorly of the housing with separate means, such as levers 45, for operating the same.

In that form of the apparatus shown in Fig. 4 the means for lowering and controlling the movement of the material is substantially identical with that shown in Fig. 1 but the inlet and outlet conduits are on opposite sides of the lowering device and the drying medium passes but once through the material. It is desirable therefore that both the inlet and the outlet conduits should embrace substantially the entire length of the material lowering device. In the arrangement shown the inlet 46 has an enlarged end portion of a vertical dimension approximately equal to the vertical length of the lowering device, the lower wall of the enlargement being secured to the flange 13 of the lowermost shelf 11 and the upper wall of the enlargement being secured to the bottom wall 14 of the hopper. The end portion of the conduit is divided by a partition 47 into upper and lower portions so that the incoming drying medium is divided into two parts, one of which is directed into the upper portion of the drying chamber and the other of which is directed into the lower portion of the drying chamber. Preferably the passageways above and below the partitions 37 are provided with separately operable dampers 48 for regulating the flow of the drying medium there-through.

The outlet conduit 49 also has an enlarged end portion of a size to embrace substantially the entire length of the lowering device, the upper wall of this enlargement being secured to the bottom wall 15 of the hopper and the lower wall of the enlargement being secured to the flange 13 of the lowermost shelf 12. Arranged within this enlarged end of the outlet conduit and connected with the lowering device are a plurality of partitions 50 forming between the same passageways which communicate with the spaces between adjacent shelves, there being in the present instance a partition for each shelf, thereby providing a separate passageway for the space between each pair of shelves. These passageways lead directly into the enlarged portion of the outlet conduit, which is preferably divided by transverse partitions 51 into upper and lower parts, so that the suction created therein, as by an exhaust fan 52, will be divided substantially equally between the upper and lower parts of the drying chamber and will be distributed by the partitions 50 to the several parts of the lowering device. The passageways formed by the partitions 50 are separately controlled by dampers 52a so that the effective size of each passage-

way with relation to the others may be regulated to secure the desired distribution of the suction in the drying chamber. The two parts of the outlet conduit may also be provided with dampers 53 to further regulate the action of the suction in the drying chamber.

In that form of the apparatus shown in Figs. 5, 6 and 7, the inlet conduit 54 is connected with the lower part of the drying chamber and the outlet conduit 55 is connected with the upper part of the drying chamber on that side of the material lowering device opposite the inlet conduit. Inwardly diverging partitions 56 divide the inner end portion of the inlet conduit into a plurality of separate passageways leading to spaces between different shelves 11 of the lower portion of the lowering device. On the opposite side of the lower portion of the lowering device similar inwardly diverging partitions 57 provide passageways leading from the spaces between adjacent shelves 12 to a transverse conduit 58 which is connected at its ends with upwardly inclined conduits 59 which extend across the housing 10 and are connected at their upper ends with a second transverse conduit 60 which is arranged on that side of the lowering device opposite the outlet conduit 55. Passageways, formed by inwardly diverging partitions 61, connect the conduit 60 with the respective spaces between adjacent shelves 11 in the upper portion of the lowering device. The inner end portion of the outlet conduit 55 is flared and is divided by partitions 62 into separate passageways communicating respectively with the spaces between different shelves 12. Thus the drying medium is passed first through the material in the lower portion of the lowering device, then carried upward and passed through the material in the upper portion of the lowering device in the same direction that it passed through the lower portion thereof and is then delivered to the outlet conduit on that side of the apparatus opposite the inlet conduit. The conduits 58, 59 and 60 are arranged exteriorly of the housing to avoid interference with the lowering device. In this case also means are provided for supplying additional heat to the drying medium after it has passed through the lower portion of the material. For this purpose passageway 64 leads from the inlet conduit 54 to the upper transverse conduit 60 and is controlled by a damper 65.

While I have shown and described certain embodiments of my invention I wish it to be understood that I do not desire to be limited to the details thereof as various modifications may occur to a person skilled in the art.

Having now fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a drier, a material lowering device comprising two substantially vertical series of downwardly and inwardly inclined shelves, the shelves of the two series being arranged in staggered relation to form a plurality of oppositely inclined passageways through which the material moves by gravity, the longitudinal edges of adjacent shelves of each series being spaced one from the other to provide lateral openings communicating with the respective passageways on each side of said lowering device, an inlet conduit communicating with a relatively large group of passageways in one longitudinal portion of said lowering device through lateral openings in one side of said lowering device, an outlet conduit communicating with a relatively large group of passageways in

another longitudinal portion of said lowering device through lateral openings in one side of said lowering device, a plurality of partitions arranged on that side of said lowering device opposite said inlet to form a plurality of channels which communicate respectively with separate parts of the passageways of the first mentioned group through lateral openings on the adjacent side of said lowering device and with the passageways of the last mentioned group through lateral openings on that side of said lowering device opposite said outlet conduit, and means for circulating a drying medium through said conduits, passageways and channels.

2. In a drier, a material lowering device comprising two substantially vertical series of downwardly and inwardly inclined shelves, the shelves of the two series being arranged in staggered relation to form a plurality of oppositely inclined passageways through which the material moves by gravity, the longitudinal edges of adjacent shelves of each series being spaced one from the other to provide lateral openings communicating with the respective passageways on each side of said lowering device, an inlet conduit communicating with a relatively large group of passageways in one longitudinal portion of said lowering device through lateral openings in one side of said lowering device, an outlet conduit communicating with a relatively large group of passageways in another longitudinal portion of said lowering device through lateral openings in one side of said lowering device, a plurality of partitions arranged on that side of said lowering device opposite said inlet conduit to form a plurality of channels, each of said channels communicating at one end with a separate part of the passageways of the first mentioned group through lateral openings on that side of said lowering device opposite said inlet conduit and communicating at its other end with a separate part of the passageways of the last mentioned group through lateral openings on that side of said lowering device opposite said outlet conduit, and means for circulating a drying medium through said conduits, passageways and channels.

3. In a drier, a material lowering device comprising two substantially vertical series of downwardly and inwardly inclined shelves, the shelves of the two series being arranged in staggered relation to form a plurality of oppositely inclined passageways through which the material moves by gravity, the longitudinal edges of adjacent shelves of each series being spaced one from the other to provide lateral openings communicating with the respective passageways on each side of said lowering device, an inlet conduit communicating with a relatively large group of passageways in one longitudinal portion of said lowering

device through lateral openings in one side of said lowering device, an outlet conduit communicating with a relatively large group of passageways in another longitudinal portion of said lowering device through lateral openings in one side of said lowering device, a plurality of partitions arranged on that side of said lowering device opposite said inlet to form a plurality of channels which communicate respectively with separate parts of the passageways of the first mentioned group through lateral openings on the adjacent side of said lowering device and with the passageways of the last mentioned group through lateral openings on that side of said lowering device opposite said outlet conduit, means for circulating a drying medium through said conduits, passageways and channels, and means for by-passing a portion of said drying medium from said inlet conduit to said channels to further heat that portion of said drying medium which has passed through the material in the passageways of the first mentioned group.

4. In a drier, a material lowering device comprising two substantially vertical series of downwardly and inwardly inclined shelves, the shelves of the two series being arranged in staggered relation to form a plurality of oppositely inclined passageways through which the material moves by gravity, the longitudinal edges of adjacent shelves of each series being spaced one from the other to provide lateral openings communicating with the respective passageways on each side of said lowering device, an inlet conduit communicating with a relatively large group of passageways in one longitudinal portion of said lowering device through lateral openings in one side of said lowering device and having a plurality of channels each of which is connected with a separate part of the passageways of said group, an outlet conduit communicating with a relatively large group of passageways in another longitudinal portion of said lowering device through lateral openings on one side of said lowering device and having a plurality of channels each of which is connected with a separate part of the passageways of the last mentioned group, partitions arranged to form a plurality of channels, each of the last mentioned channels communicating at one end with a separate part of the passageways of the first mentioned group through lateral openings on that side of said lowering device opposite said inlet conduit and communicating at its other end with a separate part of the passageways of the last mentioned group through lateral openings on that side of said lowering device opposite said outlet conduit and means for circulating a drying medium through said conduits, passageways and channels.

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