Jan. 6, 1953

H. F. IRVING

ROTARY DRIER

2,624,124

Filed Sept. 16, 1948

2 SHEETS—SHEET 1

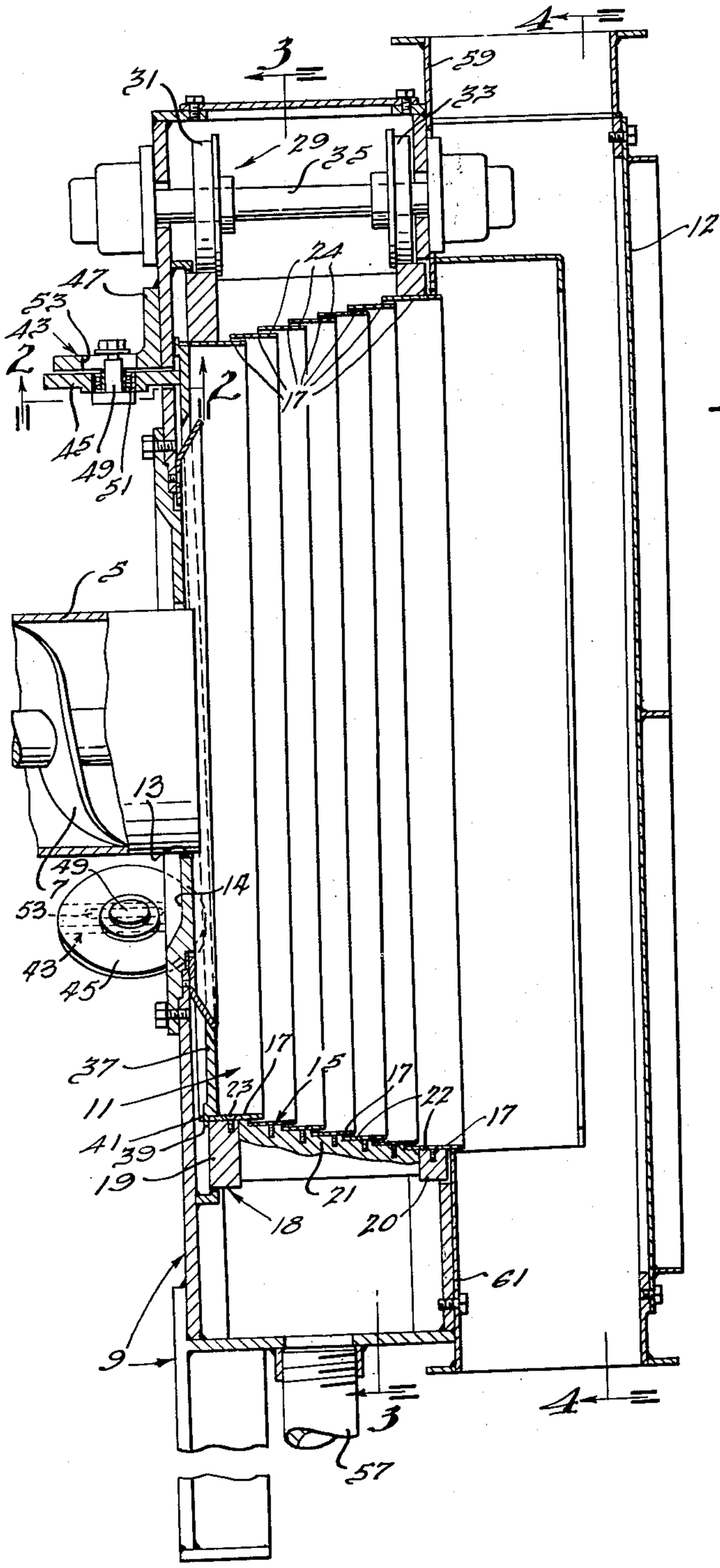

FIG. 1.

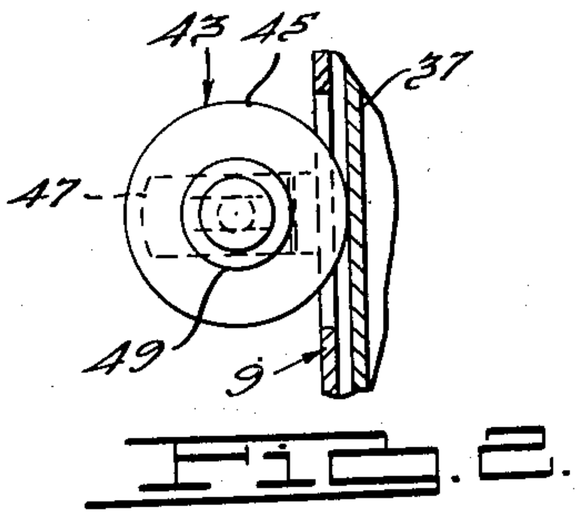

FIG. 2.

INVENTOR.

Henry F. Irving.

BY

Harness, Dickey & Pierce

ATTORNEYS

Jan. 6, 1953

H. F. IRVING

ROTARY DRIER

2,624,124

Filed Sept. 16, 1948

2 SHEETS—SHEET 2

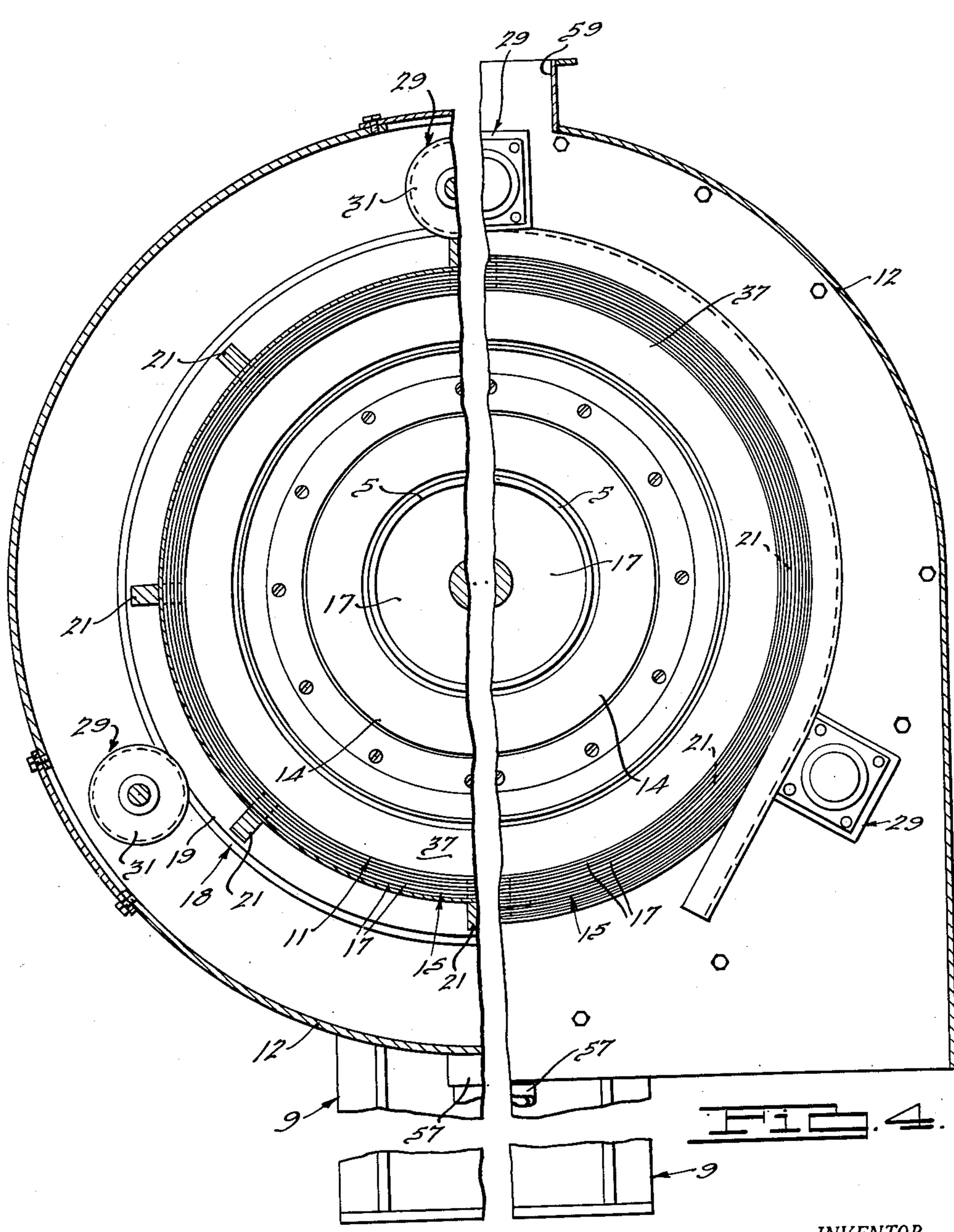

Fig. 4.

Fig. 3.

INVENTOR.

Henry F. Irving.

BY

Harness, Dickey & Pierce

ATTORNEYS

Patented Jan. 6, 1953 2,624,124

UNITED STATES PATENT OFFICE

2,624,124

ROTARY DRIER

Henry F. Irving, Saginaw, Mich., assignor to Baker Perkins, Inc., Saginaw, Mich., a corporation of New York

Application September 16, 1948, Serial No. 49,613

8 Claims. (Cl. 34—135)

1

This invention relates to apparatus for removing moisture from solid materials such as salt or other crystalline or granular materials.

It is an object of this invention to provide apparatus of the aforementioned type which is constructed as a compact machine so as to remove such moisture in a much more efficient and economical manner than has been heretofore known in the art.

It is a further object of this invention to provide in apparatus of the aforementioned type an improved final drying mechanism, into which partially dried solid materials may be fed by any suitable feed mechanism, and which will completely dry the solid materials in a rapid, efficient and inexpensive manner.

It is a further object of this invention to provide a mechanism of the aforementioned type in which the partially dried material is fed into a rotatable, drying drum and axially moved through the drum while heated air or gas is passed therethrough so as to completely dry it before it is discharged from the drum.

A further object of this invention is to provide in apparatus of the aforementioned type, novel means for axially feeding or moving the material through the rotatable drum.

A further object of this invention is to provide in apparatus of the aforementioned type, novel means for rotatably supporting and driving said drum.

It is a still further object of this invention to provide an improved arrangement for directing and conducting heat from exteriorly of the drum through the drum wall and the material therein so as to completely dry the material as it is fed through the container, and so that the heated air passed through the material can be recirculated, thus saving power and fuel consumption to the user.

A still further object of this invention is to provide in a rotatable drum of the aforementioned type, a novel peripheral wall construction which will break up the material being axially fed therethrough so as to facilitate the passage of the heated air therethrough for drying the material.

Other objects of this invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

Figure 1 is a fragmentary sectional view of the final drying device of this invention, and of the means for feeding partially dried material thereto;

2

Fig. 2 is a sectional view of the structure illustrated in Fig. 1 taken along the line 2—2 thereof;

Fig. 3 is a fragmentary sectional view of the structure illustrated in Fig. 1 taken along the line 3—3 thereof; and

Fig. 4 is a fragmentary sectional view of the structure illustrated in Fig. 1 taken along the line 4—4 thereof.

In removing moisture from solid materials, particularly salts such as ammonium-sulphate, sodium-chloride, potash, etc., it is common practice to employ centrifugal driers which are effective to remove a substantial quantity of liquid by centrifugal force but which cannot remove all of the liquid content. It is necessary, therefore, to complete the drying operation by other means which will remove the residual liquid, usually amounting to from about one to five percent of the mass. Machines for such final drying operations have been developed, but these have not been especially efficient and economical to operate, especially from the standpoint of power and fuel consumption. The drying apparatus of this invention has been developed for use in completing the drying of material which has been partially dried by other means such as any form of centrifugal drier. With such centrifugal devices, a slurry containing an appreciable percentage of liquid is fed into the device and the greater part of the liquid is separated from the solid material by centrifugal force. The material from the centrifugal or other form of preliminary drier may be fed into the final drying device by any suitable means.

The final drying device of the present invention includes a suitable stationary stand or framework 9 for rotatably supporting a drying drum 11. A housing 12 surrounds the drum and operating elements of the device. The drum 11 includes a peripheral wall 15 which is smaller in diameter at the inlet end thereof than at the outlet end thereof, so that the peripheral wall is of a generally frusto-conical shape.

The wall 15 is made up of a plurality of concentric, axially overlapping and radially spaced cylindrical rings 17, which are of progressively larger diameters from the inlet end to the outlet end of the drum. The rings 17 are positioned and retained in the aforementioned overlapping and spaced relationship by an annular retainer member 18 which includes a pair of annular track portions 19 and 20 and a plurality of circumferentially spaced axially extending ribs 21, each of which has the inner face thereof formed with a plurality of axially spaced steps

22. Each of the rings 17 is secured to its respective step portion of the ribs 21 by means of countersunk screws 23. It will thus be appreciated that each of the rings 17 overlaps its adjacent ring of a larger diameter so that the inner surface of the peripheral wall 15 is stepped from the inlet end to the outlet end thereof, and spaces 24 are provided between the overlapping portions of the rings.

In order to rotatably support the drum 11 on the framework 9, a plurality of circumferentially spaced roller devices 29 are provided which are supported by the framework adjacent the drum peripheral wall. Each of the roller devices 29 includes a roller 31 which engages the outer periphery of the annular track 19 and a roller 33 which engages the outer periphery of the annular track 20. The rollers 31 and 33 are rotatably supported in the framework 9 by means of a trunnion 35. One of the roller devices 29 is connected with suitable driving means, such as an electric motor, in any conventional manner so as to rotatably drive the annular tracks 19 and 20 and the drum 11 secured thereto. The roller devices 29 and 33 therefore both rotatably support and drive the drum 11.

The housing adjacent the small end of the drum 11 is partially closed by an annular plate 14 which defines a coaxial inlet opening 13 for the drum through which material to be dried is fed by any suitable means. A screw conveyor feed comprising a tubular housing 5 and a screw 7 is illustrated. However, if the preliminary drier is a centrifugal drier of the type in which material is moved axially along the interior surface of the rotating centrifugal drier drum and discharged off the open end or peripheral edge of that drum the centrifugal drier may be recounted coaxially, with respect to the drum 11 with the discharge edge of the centrifugal drier drum in the plane of the open end of housing 5 so that the centrifugal drier discharges directly into the final drier of the present invention.

An annular wobble plate 37 is positioned within the drum 11 at the inlet end thereof and projects radially inwardly from the peripheral wall 15 of the drum 11. The wobble plate 37 is provided on its outer periphery with one or more tabs 39 which fit into slots 41 in the innermost rings 17 so as to provide a driving connection between the wobble plate and drum while permitting the wobble plate to move axially of the drum within the predetermined limits defined by the axial extent of the slots 41.

In order to impart wobbling action to the wobble plate 37, a plurality of circumferentially spaced roller assemblies 43 are provided. Each of the assemblies 43 includes a roller 45 which engages the outer face of the wobble plate 37 and which is rotatably supported on a framework bracket 47 by means of a suitable bolt and nut 49 and bearing 51. The framework bracket 47 is provided with a slot 53 through which the bolt 49 extends so that the roller 45 can be adjusted inwardly or outwardly with respect to the wobble plate 37. The axes of the rollers 45 of all of the roller devices 43 lie in a plane which is inclined with respect to a plane normal to the drum axis so that as the drum 11 and wobble plate 37 are rotated, the rollers 45 will cause the plate to wobble axially with respect to the drum.

In order to completely dry the material which is moved through the rotatable drum 11, as will be hereinafter described, an air inlet conduit or passageway 57 is provided in the lower portion

of the housing 9 which directs heated air into the space within the housing and surrounding periphery of the drum. The heated air passes through the spaces 24 in the peripheral wall 15 and into the interior of the drum 11 through the layer of material carried by the drum wall. A hot air outlet conduit or passageway 59 is provided in the housing 12 in an opposed relationship with respect to the inlet passageway 57 so that the heated air from the interior of the drum flows through the open end of the drum and out through the outlet passageway 59. Any desired portion of the discharged air may be reheated and recirculated in order to reduce the amount of power and fuel necessary to heat the air. A material outlet passageway 61 is provided in the housing 12 adjacent the outlet end of the drum 11, into which the solid material, in its fully dried condition, is discharged by the drum for delivery into a screw conveyor or the like, not shown, which will not permit passage of the air.

In operation, the partially dried material is fed into the rotatable drum through the conduit 5 by means of feed screw 7, or otherwise. The material drops out of the conduit 5 down onto the wall 15 of the drum 11, or, if the discharge is from the drum of a horizontal centrifugal drier, is thrown outwardly on to the wall 15. The drum 11 is rotated at a suitable speed to maintain the material therein in a layer against the peripheral wall. The action of the wobble plate 37 will move the layer or cake of material axially along the peripheral wall toward the outlet end of the drum.

An important feature of the invention resides in the fact that the material forms a layer which is stationary with respect to the drum wall except insofar as it may be fed axially by the action of the wobble plate. The rate of feed may be adjusted by adjusting the angle of action of the wobble plate and thus the period during which the material is retained in the drum may be adjusted as required to complete the drying action. The rings 17 are provided with internal cylindrical surfaces so that no movement of the material toward the open end of the drum occurs except as the result of the action of the wobble plate 37. It will be apparent, however, that the inner surfaces of the rings 17 may be made frusto-conical, so long as the conical angle is insufficient to cause the material to slide out the end of the drum as the result of centrifugal force.

It should be noted that while the drum and material therein are rotated, drying action results entirely from the flow of heated air through the layer of material. Accordingly, it is essential to prevent the layer of material from forming a solid cake which would prevent such air flow. This result is achieved with the minimum power requirements as a result of the fact that the drum is generally conical in form. Thus, as the layer is progressively moved from the small to the large end of the drum its diameter progressively increases. This keeps the layer broken up into a loose mass through which the air may flow. The stepped arrangement of the rings 17 is peculiarly advantageous in this connection since the layer breaks up as it moves off the discharge edge of each ring and it is at this point that the air inlet passages 24 are located. A further advantage of the stepped and overlapping arrangement of the rings 17 is that it provides air inlet openings which face in a direction parallel to the direc-

tion of flow of the material and hence cannot become clogged.

The speed of rotation of the drum is not critical so long as it is sufficient to retain the material in a relatively stationary layer on its inner surface. If the drier is connected directly to the discharge end of a centrifugal drier drum, which drums rotate at a very high speed, it is necessary to rotate the drum 15 at a speed sufficient to prevent the material from sliding helically out through the drum as the result of the high speed with which it is discharged tangentially by the centrifugal drier.

Satisfactory results have been achieved with drum speeds in the order of 170 R. P. M. for a drum having a maximum diameter of 24'' when the material to be dried was received directly from a centrifugal drier in the manner indicated above.

While the invention is illustrated as embodied in a machine having a drum mounted on a horizontal axis, the principles and advantages of the invention may be realized by a machine having a vertical axis drum since the force of gravity has negligible effect as compared with the centrifugal force holding the material against the drum wall. In the case of vertical axis machines in which the drum discharges upwardly the rings 17 may be made slightly frusto-conical so that they are of larger diameter at their upper edges in order to facilitate discharge of the material.

What is claimed is:

1. Apparatus for completely removing moisture from solid materials, including a frame, a drum rotatably supported on said frame and into one end of which such material is adapted to be fed, said drum having openings formed in the peripheral wall thereof, a mechanism connected with said drum for rotating said drum so that the material fed therein will be centrifugally held against the peripheral wall thereof when said drum is rotated, a member connected with said drum for rotation therewith and movable axially for moving the material therein from the inlet end thereof to the discharge end thereof, means for oscillating said member axially of said drum during the rotation thereof, and means for conducting and transmitting hot gases from exteriorly of the drum through the openings in the peripheral wall of the drum and layer of material supported thereon.

2. Apparatus for completely removing moisture from solid materials, including a frame, a drum rotatably supported on said frame and into one end of which such material is adapted to be fed, said drum including a peripheral wall of a generally frusto-conical shape which is smaller in diameter at the inlet end of said drum than at the opposite end, said peripheral wall having a plurality of openings therein, mechanism connected with said drum for rotating said drum so that the material which is fed therein will be held as a layer against the peripheral wall by centrifugal force when said drum is rotated, a member connected with said drum for rotation therewith and for axial movement relative thereto for axially feeding the material in said drum from the inlet end thereof towards the opposite end thereof, means for oscillating said member axially of said drum during the rotation thereof, said frusto-conical wall being stepped so as to cause said material layer to break up into a loose mass as it moves from the small diameter inlet end of said drum toward the larger diameter discharge end thereof, and facilitate the passage of hot gases therethrough, and means for conducting and transmitting hot gases from exteriorly of the drum through the openings in the drum peripheral wall and the layer of material supported thereon.

3. Apparatus for removing moisture from solid materials, including a frame, a drum rotatably supported on said frame and into one end of which such material is adapted to be fed and from the opposite end of which such material is adapted to be discharged, said rotatable drum including a peripheral wall which is smaller in diameter at the inlet end thereof than at the discharge end, said peripheral wall being made up of a plurality of concentric rings of progressively increasing diameter arranged in axially overlapping and radially spaced relationship, means connecting said rings in said overlapping and spaced relationship so that air passageways are provided between the overlapping portions of said rings, means operatively connected with said drum for rotating said drum so that the material which is fed therein will be centrifugally held against said peripheral wall in the form of a layer when said drum is rotated, a plate element connected to said drum adjacent the inlet end thereof for rotation therewith and axial movement relative thereto, means for axially actuating said plate element so as to axially move the material held against said peripheral wall from the inlet end of said drum to the outlet end thereof, and means for transmitting and conducting hot gases from exteriorly of said drum through said peripheral wall air passageways and the layer of material supported thereon for completely drying the latter as it is axially moved through said drum.

4. Apparatus for removing moisture from solid materials including a frame, a drum rotatably supported on said frame and into one end of which such material is adapted to be fed, said drum including a peripheral wall against which the material is adapted to be held in the form of a layer by centrifugal force when said drum is rotated, said peripheral wall having a plurality of openings therein, means for conducting and transmitting hot gases from exteriorly of the drum through said peripheral wall openings and the layer of said material supported thereon, a plate extending radially inwardly from said peripheral wall adjacent the end of said drum into which the material is fed, means operatively connecting said plate to said drum for rotation therewith while permitting relative axial movement between said plate and said drum peripheral wall within predetermined limits, and means engaging said plate for wobbling the same axially so as to move the material in such drum axially therethrough.

5. Apparatus for removing moisture from solid materials, including a frame, a drum rotatably supported on said frame and having an inlet end into which the material is adapted to be fed and an outlet end through which the material is adapted to be discharged, said rotatable drum including a peripheral wall made up of a plurality of rings of progressively increasing diameters which are arranged so that each overlaps its adjacent member in radially spaced relationship, means connecting said rings in said overlapping and spaced relationship so as to provide air passageways therebetween through which hot gases may flow, mechanism connected with said drum for rotating said drum so as to centrifugally maintain the material therein against the periph-

eral wall thereof, means for directing hot gases from exteriorly of said drum through the peripheral wall air passageways, in order to dry the layer of material in said drum, a plate element extending radially inwardly from said peripheral wall adjacent the inlet end thereof, means operatively connecting said plate to said drum wall so that said plate will rotate with said drum, while permitting relative axial movement between said plate and said drum within predetermined limits, and means engaging said plate for wobbling the same axially of said drum so as to move the layer of material axially along said peripheral wall and out the discharge end thereof.

6. Apparatus for removing moisture from solid materials including a drum having an inlet end into which the material is adapted to be fed and an outlet end through which the material is adapted to be discharged, said drum including a peripheral wall which is smaller in diameter at the inlet end thereof than at the discharge end, said peripheral wall being made up of a plurality of ring members of progressively increasing diameters which are arranged so that each member overlaps its adjacent member and is radially spaced with respect thereto, means securing said members in said overlapping and spaced relationship so as to provide air passageways between said rings through which gas may flow from the exterior to the interior of the drum, and a member connected with said drum for rotation therewith and for axial movement relative thereto for moving material through said drum and in contact with the walls thereof axially from the inlet end thereof to the discharge end thereof, and means for oscillating said axially movable member axially of said drum during the rotation thereof.

7. Apparatus for removing moisture from solid

materials, including a drum into one end of which such materials are adapted to be fed, a peripheral wall for said drum, a plurality of air passageways in said peripheral wall which extend substantially parallel to the axis of said drum, and a member supported by said drum for axial movement relative thereto for axially moving such materials through said drum from one end to the other, and means for oscillating said member axially of said drum during the rotation thereof.

8. Apparatus for removing moisture from solid materials, including a frame structuhe, a drum rotatably supported by said frame structure and including a peripheral wall, a plate like element supported for rotation with the drum and axial movement relative thereto, a plurality of circumferentially spaced roller devices supported by said frame structure and engaging said plate element at circumferentially spaced points, said rollers being in a plane which is inclined with respect to a plane normal to the drum axis so as to wobble said plate axially with respect to said drum when the latter is rotated.

HENRY F. IRVING.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
930,898	Steinmann	Aug. 10, 1909
2,112,492	Hoffman	Mar. 29, 1938
2,220,193	Ahlmaun	Nov. 5, 1940

FOREIGN PATENTS

Number	Country	Date
67,554	Austria	June 1, 1914
306,748	Germany	Jan. 26, 1916