O. S. SLEEPER.

VACUUM DRYING APPARATUS.

APPLICATION FILED AUG. 19, 1907.

980,444. Patented Jan. 3, 1911.

4 SHEETS—SHEET 1.

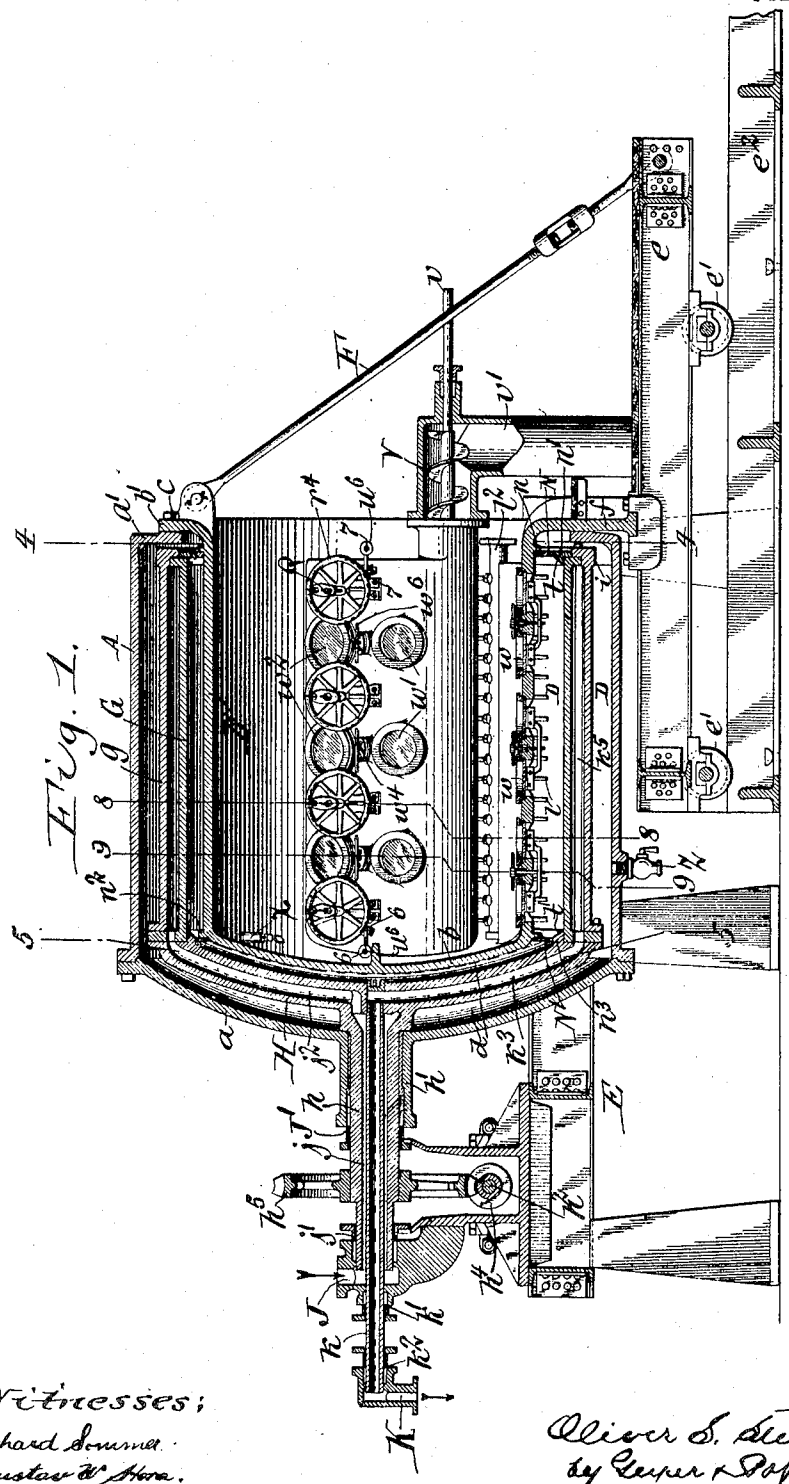

Fig. 1.

Witnesses;
Richard Sommer.
Gustav W. Hoss.

Inventor
Oliver S. Sleeper
by Cooper & Dolph
Attorneys

O. S. SLEEPER.

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4 SHEETS—SHEET 2.

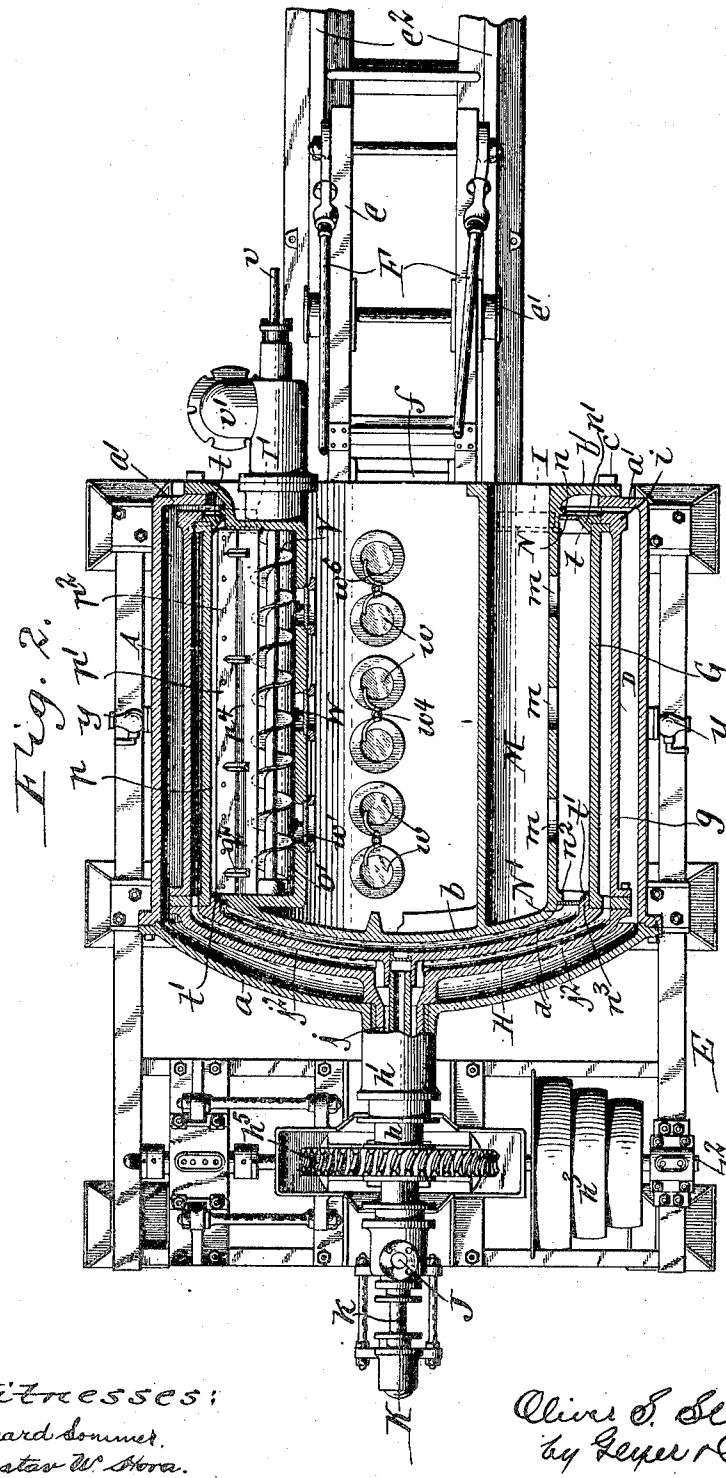

Fig. 2.

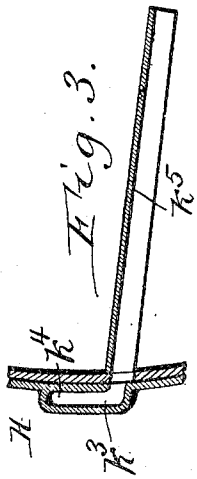

Fig. 3.

Witnesses:
Richard Sommer.
Gustav W. Hoya.

Inventor
Oliver S. Sleeper
by Geyer & Popp
Attorneys

O. S. SLEEPER.

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4 SHEETS—SHEET 3.

Fig. 5.

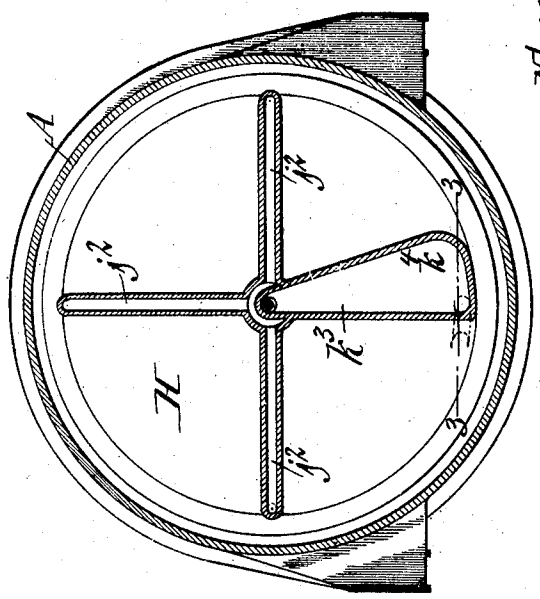


Fig. 6.

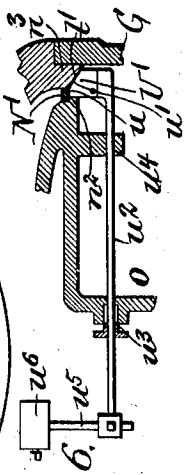


Fig. 7.

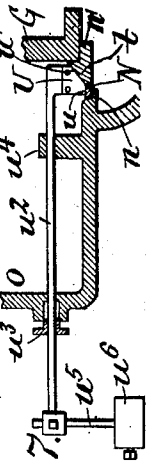
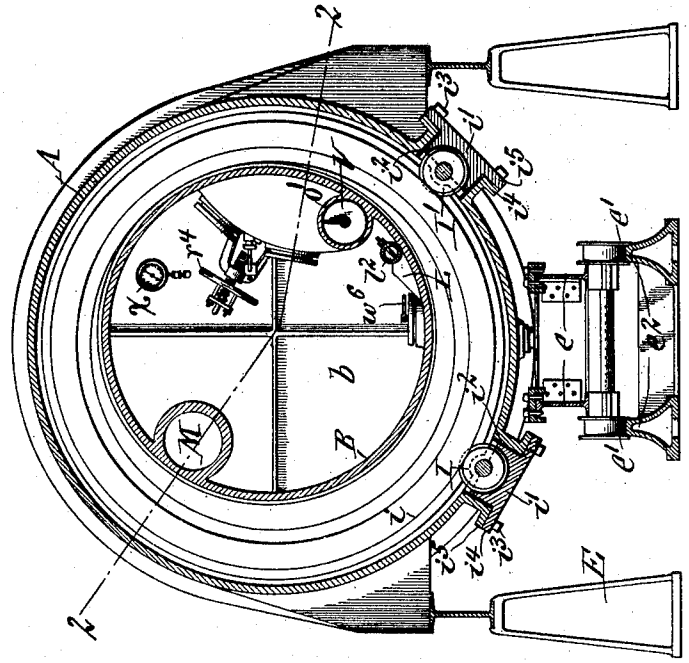


Fig. 4.



Witnesses:
Richard Sommer
Gustav W. Hora.

Inventor
Oliver S. Sleeper
by Geyer & Pahl
Attorneys

O. S. SLEEPER.

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APPLICATION FILED AUG. 19, 1907.

980,444. Patented Jan. 3, 1911.

4 SHEETS—SHEET 4.

Fig. 9.

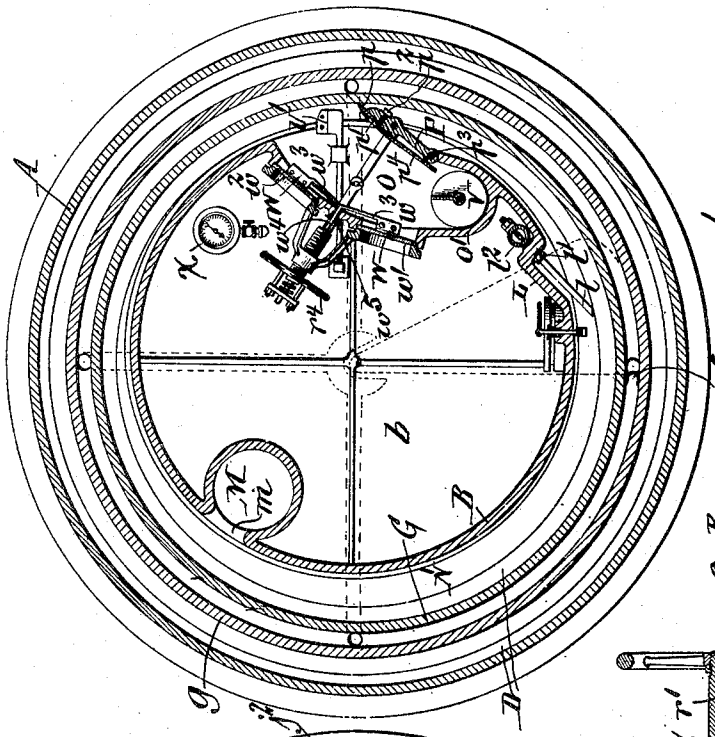


Fig. 11.

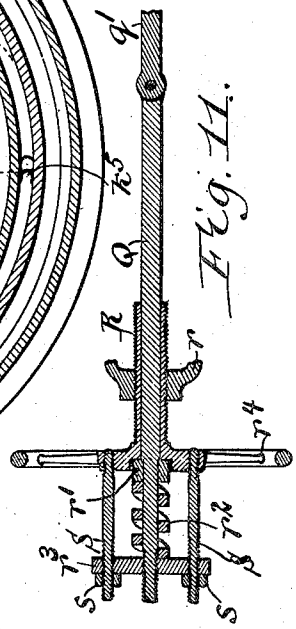


Fig. 8.

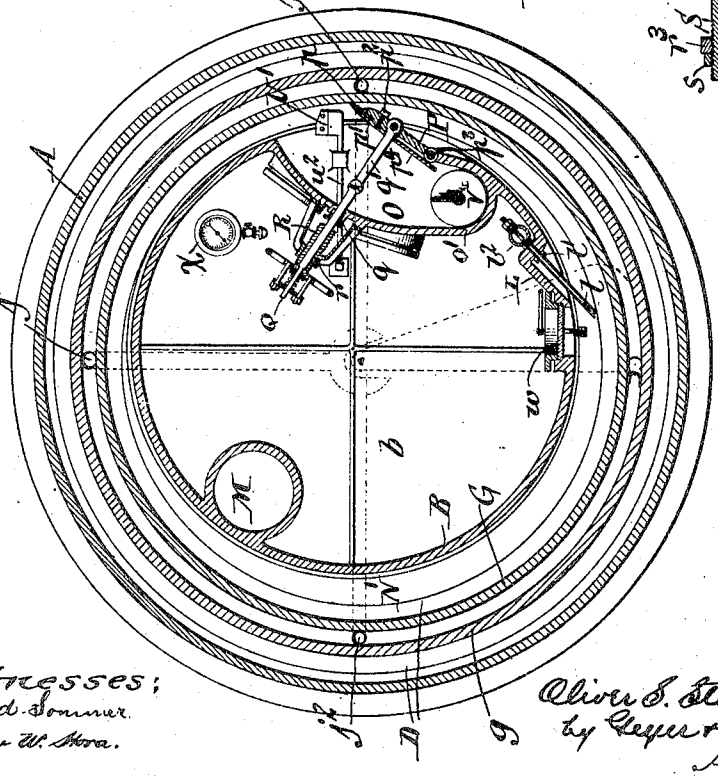
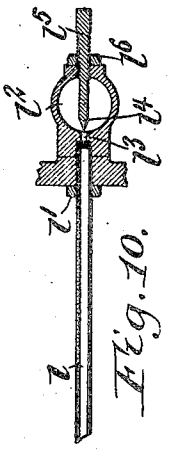


Fig. 10.



Witnesses;
Richard Sommer.
Gustav W. Hoya.

Inventor
Oliver S. Sleeper
by Geyer & Dosh
Attorneys.

UNITED STATES PATENT OFFICE.

OLIVER S. SLEEPER, OF BUFFALO, NEW YORK, ASSIGNOR TO BUFFALO FOUNDRY COMPANY, OF BUFFALO, NEW YORK, A CORPORATION OF NEW YORK.

VACUUM DRYING APPARATUS.

980,444. Specification of Letters Patent. Patented Jan. 3, 1911.

Application filed August 19, 1907. Serial No. 389,131.

To all whom it may concern:

Be it known that I, OLIVER S. SLEEPER, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented a new and useful Improvement in Vacuum Drying Apparatus, of which the following is a specification.

This invention relates to an apparatus whereby the operation of drying liquid solutions, emulsions or other flowing material *in vacuo* may be effected continuously.

The object of this invention is the production of a machine of this character which is efficient in operation, which has a large capacity, which can be readily regulated and controlled and which can be conveniently dismembered and assembled for cleaning or repairs.

In the accompanying drawings consisting of 4 sheets: Figure 1 is a vertical longitudinal section of my improved vacuum drier. Fig. 2 is a horizontal section of the machine in line 2—2, Fig. 4. Fig. 3 is a fragmentary horizontal section in line 3—3, Fig. 5. Figs. 4 and 5 are vertical transverse sections in lines 4—4 and 5—5, Fig. 1, respectively. Figs. 6 and 7 are fragmentary longitudinal sections, on an enlarged scale, taken in the correspondingly numbered lines in Fig. 1 and showing the end scrapers of the drying surface. Figs. 8 and 9 are vertical transverse sections, on an enlarged scale, taken in the correspondingly numbered lines in Fig. 1. Fig. 10 is a longitudinal section of one of the feed or supply nozzles and valves, on an enlarged scale. Fig. 11 is a detached longitudinal section, on an enlarged scale, of part of the main scraper adjusting mechanism.

Similar letters of reference indicate corresponding parts throughout the several views.

In its general organization this vacuum drier comprises an annular inclosing shell or housing, a drying drum rotating within the shell, means for delivering the material to be dried on the drum, means for removing the dried material from the drum, means for heating the drum, and means for creating a vacuum in a shell and carrying away the vapors evaporated from the material under treatment.

The inclosing shell preferably consists of outer and inner shell sections the outer shell section comprising a cylindrical body A which is arranged horizontally, a head a secured to the rear end of the body and an inwardly projecting annular flange a^1 arranged at the front end of said body, and the inner shell section comprising an inner cylindrical body B arranged eccentrically within the outer cylinder A so that its substantially horizontal opposite sides are one nearest to the outer cylinder and the other farthest from the outer cylinder, a rear head b closing the rear end of the inner cylinder and an outward projecting annular flange b^1 arranged at the front end of the inner cylinder and detachably secured by bolts c or otherwise to the outer side of the front flange on the outer cylinder. A drying chamber or space is thus formed between the two shell sections which is of cup-shaped form the main portion D of which is substantially cylindrical and one end of this cylindrical space being connected by a dome-shaped space d between the rear heads of the inner and outer shell sections. The outer shell section is stationary and rigidly supported upon a main frame E which may be of any suitable or approved construction. The inner shell section is preferably mounted upon a movable support so that the same when disconnected from the outer shell section may be moved into and out of its operative position when the machine requires dismembering and assembling for cleaning or repairing the same. This movable support preferably consists of a car, truck or carriage e provided on its under side with wheels e^1 which run on a track e^2 arranged upon the floor or ground. The lower front end of the inner shell section is connected with this car by means of a bracket f extending from this end of the inner shell section to the central part of the car and the upper front part of this shell section is connected with the front end of the car by means of a pair of tie rods or braces F, as shown in Figs. 1 and 2. The car extends rearwardly a sufficient distance so as to bring the center of gravity of the inner shell section relatively to the car in position to balance the weight and to prevent these parts from tipping while being moved into and out of their operative position. When the inner shell section is secured within the outer shell section that portion of the car in rear

of the bracket f extends rearwardly underneath the outer shell section, as shown in Fig. 1.

The drying drum comprises a cylindrical body G which is arranged between the outer and inner shell sections concentrically with the outer shell section. The drying cylinder G is surrounded by a cylindrical jacket g forming a heating space between these parts which receives steam or other heating medium for drying the material deposited upon the drying cylinder. At its rear end the drying cylinder is secured to a supporting head H which is arranged within the dome between the rear heads of the inner and outer shell sections of the drying chamber. This supporting head is provided centrally on its rear side in a rearwardly projecting trunnion h which is journaled in a bearing h^1 formed centrally on the rear head of the outer shell section. Motion may be transmitted to this trunnion by any suitable means for rotating the supporting head, drying cylinder and jacket, that shown in the drawings being suitable for this purpose and consisting of a transverse driving shaft h^2 journaled horizontally on the main frame, a driving pulley h^3 arranged on one end of the driving shaft and a worm h^4 secured to the driving shaft and meshing with a worm wheel h^5 on the rear end of the trunnion. At its front end the drying cylinder and jacket are supported by two rollers or wheels I, I^1 which are mounted on the lower part of the outer shell section and engage with the lower part of an external annular flange i at the front end of the jacket, as shown in Figs. 1, 2 and 4. These rollers are arranged on horizontally opposite sides of the axis of the drying chamber and drying cylinder but the right roller I^1 is arranged farther from said axis than the left roller I so as to compensate for the extra downward pressure which is exerted on this side of the inner shell section by the scraping devices which remove the dried product from the drying cylinder and which are located substantially on that side of the inner shell section where the same approaches most closely to the drying cylinder. Each of these supporting rollers is preferably mounted on a block i^1 which is inserted through an opening i^2 in the lower side of the outer shell section and which is held in place by means of bolts i^3 or similar fastenings connecting flanges i^4, i^5 formed on said block and on the outer shell section around the roller opening, as shown in Fig. 4.

The preferred means for conducting the steam into the heating jacket and withdrawing the water of condensation therefrom are constructed as follows:—J represents a stationary steam inlet chamber secured to the main frame and receiving the rear end of the trunnion. The latter is hollow so as to form a longitudinal supply conduit or passage j and turns at its rear end in a stuffing box j^1 at the front side of the steam inlet chamber and communicates therewith, steam being supplied to the inlet chamber from any suitable source. A stuffing box J^1 is arranged around the trunnion at the rear end of the bearing h^1. The inner end of the supply conduit in the trunnion is connected with the inner end of one or more laterally extending branch supply conduits or passages j^2 which are formed in the supporting head and communicate at their outer ends with the heating jacket, three of such branch conduits being preferably employed, as shown in Fig. 5. Arranged axially within the trunnion is a return pipe k for the water of condensation, this return pipe being of smaller diameter than the bore of the trunnion so as to leave an annular space between the same forming the passage j for the steam to the drying cylinder. The return pipe is secured at its front end to the supporting head so as to turn therewith while its intermediate part passes through and rotates within a stuffing box k^1 on the rear side of inlet chamber and its rear end passes through and turns in a stuffing box k^2 formed on a stationary outlet chamber K with which the rear end of the return pipe communicates. To prevent steam from escaping from the heating chamber or space of the machine and permit the water of condensation to escape therefrom a steam trap of any suitable and approved construction is connected with the outlet K in a manner well known in this type of machines and like machines in which the same conditions exist. Extending radially inward from the heating jacket to the front end of the return pipe is a branch return pipe k^3 which is formed in the supporting head of the drum. The steam entering the inlet chamber J passes through the trunnion, thence through the branch pipes j^2 into the heating jacket whereby the drying cylinder is heated. The water due to condensation of the steam gathers upon the lower part of the jacket and whenever the outer end of the branch return conduit sweeps along the lower part of the path of the drying cylinder the water in the jacket enters the branch return pipe at the outer end thereof. As the branch return pipe continues to rotate with the drum any water caught in the same will be gradually lifted up by the branch return pipe and caused to flow out of the same into the main return pipe and thence out through the outlet chamber K. In order to cause the water to be thus positively caught or trapped in the branch return pipe the outer end of the latter is extended or widened circumferentially from the inlet of this branch pipe backwardly or in a direction opposite to that in which it rotates and the front and rear walls of this branch passage converge

inwardly toward the main return pipe, as shown in Fig. 5. By this means a pocket k^4 is formed on the rear or trailing side of the branch return pipe in which the water lodges and is caught as the branch pipe rises, which water cannot again escape through the inlet of this branch pipe but is directed by the rear or trailing wall of the same toward the main return pipe.

In order to cause the water in the lower part of the jacket to be carried promptly into the inlet opening of the branch return passage or conduit, a gutter or scoop k^5 is arranged lengthwise between the jacket and drying cylinder and communicates at its rear end with the inlet of the branch return pipe or passage. This gutter or scoop is arranged at an angle to the axis of rotation so that as it rises with the drying cylinder and jacket on the upwardly moving left side of the same the front end of this scoop is higher than its rear end, thereby causing any water which it picks up while in its lowermost position to flow rearwardly and downwardly into the branch return pipe.

The means for delivering the liquid or material to be dried upon the drying cylinder are constructed as follows:—L represents an inwardly offset portion formed lengthwise on the lower part of the inner shell section of the drying chamber. l represents a plurality of liquid feed or supply nozzles which are arranged in a row lengthwise of the machine and each arranged tangentially relatively to the axis of rotation of the drying cylinder and jacket and terminating with its delivery end adjacent to the lowermost part of the bore or inner side of the drying cylinder while its receiving end passes through an opening in the offset of the inner shell section in which it is secured by a screw joint and by a jam nut l^1 applied to the nozzle and bearing against the under side of the offset. Above the offset is arranged a longitudinal manifold or main liquid supply pipe l^2 which is connected with the outer end of each feed nozzle by means of a port l^3 in its side while its front end is connected by any suitable means with a reservoir or other means for supplying the liquid or material which is to be dried. Coöperating with each port l^3 of the manifold l^2 is a needle valve l^4 which is formed on a threaded valve stem l^5 arranged diametrically in the manifold and working in a screw threaded opening formed in the same opposite the respective port. Upon turning this valve stem in one direction or the other its valve will be moved toward or from the seat formed around the corresponding port, thereby regulating the discharge of liquid from the manifold to the nozzle and upon the bore of the drying cylinder accordingly. After adjustment the needle valve is held in position by a jam nut l^6 applied to the outer part of its stem and bearing against the outer side of the manifold. As the drying cylinder rotates the several delivery nozzles deposit a continuous layer of the liquid or material to be dried on the lower part of its bore throughout its entire length which layer is carried upwardly on the left side of the machine and downwardly on the right side thereof, during which movement of the drying cylinder the liquid or material under treatment is dried by the heat of the steam in the jacket leaving the residue on the bore of the drying cylinder in the form of a thin film.

M represents an exhaust or vapor pipe arranged lengthwise within the inner shell section and communicating at one side by means of a number or openings m with the drying chamber or space while its outer or front end is adapted to be connected with a condenser, vacuum pump, or other exhausting device whereby a vacuum is created in the drying chamber and the vapors or moisture laden air are withdrawn from the interior of the drying chamber, thereby expediting the drying of the material under treatment. This exhaust pipe or conduit is located adjacent to the upper left side of the inner shell cylinder about one third of a circle from the place where the liquid is deposited upon the bore of the drying cylinder. By this means the material to be dried is deposited on the drying cylinder adjacent to one end of this wide space and the vapors are removed adjacent to the other end of this wide space, whereby the evaporation of the material in this location can proceed with the greatest freedom from the time the same is deposited on the drying cylinder by the nozzles until the same reaches the vapor pipe and the greatest exhausting area is available, thereby permitting the moisture or vapors given off from the drying liquid to be carried away promptly and enabling the drying of the material to be effected expeditiously. Although the bulk of the vapors from the evaporating material are carried away by the time the same reaches the vapor pipe the vapors continue to be subject to the suction of the exhausting device after passing the vapor pipe and while still in the drying chamber inasmuch as the exhausting device draws the vapors constantly from all parts of the annular drying chamber within the shell and the spaces connected therewith, thereby removing the vapors as soon as they evaporate from the material under treatment in any part of the drying space.

The vapors from the material to be dried are confined between the inner shell cylinder and the drying cylinder by means of stationary front and rear guard rings N, N^1. The front ring N is secured with its inner edge to an external annular flange n at the front end of the cylindrical body of the inner

shell and is fitted with its peripheral edge close to a filling ring n^1 secured to the front end of the drying cylinder.

The rear guard ring N^1 is secured at its inner edge to an external annular flange n^2 at the rear end of the inner shell cylinder and is fitted with its peripheral edge close to an internal annular flange n^3 formed on the rear head of the drying cylinder adjacent to the joint between these parts. The bore of the guard rings is concentric with the inner cylinder but the periphery thereof is concentric with the drying cylinder, as shown in Figs. 4, 8 and 9. Closures are thus formed between the inner cylinder and the drying cylinder at both ends thereof which confine the vapors between the same but permit the drying cylinder to rotate freely. Inasmuch as the exhausting device connected with the exhaust or vapor pipe constantly tends to produce a vacuum in the annular drying space between the drying cylinder and the inner cylindrical shell any looseness in the joints between the guard rings N, N^1 and the drying cylinder will not permit any vapors to escape from this space excepting to the vapor pipe, on the contrary, any leakage through these joints will permit the air between the head of the inner shell section and the head of the drying cylinder and the air between the outer shell section and the drying drum to enter the drying space and pass off with the vapors.

After the material to be dried is deposited on the drying cylinder by the supply nozzle the same remains thereon until this cylinder makes about three-quarters of a turn during which time all the vapors or moisture is removed from the material and then the dry residue is removed continuously from the drying cylinder by a scraping device and discharged from the machine. The scraping and delivery devices for this purpose shown in the drawings are constructed as follows:—O represents a longitudinal delivery chamber for the dried material which is arranged on the right side of the inner cylinder opposite the descending right side of the drying cylinder and above the place where the material to be dried is delivered on the drying cylinder by the nozzle *l*. This chamber is preferably formed integrally with the inner cylinder and its upper part communicates with the space between the inner cylinder and drying cylinder so that the interior of the delivery chamber is subject to the suction of the exhausting device and any vapors in said chamber are withdrawn therefrom. The lower part of the delivery chamber is constructed to form a longitudinal conveyer trough o^1. As the right side of the drying cylinder descends, the dried material on its bore is removed therefrom and directed into the conveyer trough by a scraper comprising an outwardly inclined supporting plate P which is hinged or pivoted lengthwise at its lower inner edge to the upper edge of the outer wall of the trough and a knife or blade *p* mounted on the upper outer edge of the supporting plate and bearing against the bore of the drying cylinder. The blade preferably rests on the upper side of the supporting plate and is held in place by a clamping plate p^1 engaging with the upper side of the blade and screws or bolts p^2 connecting the supporting and clamping plates, as shown in Figs. 2, 8 and 9. In order to prevent the pivot or hinge p^3 between the scraper supporting plate and the outer wall of the conveyer trough from becoming clogged and interfering with the operation of the machine, a deflecting plate p^4 is secured to the supporting plate so as to extend from the clamping plate inwardly beyond the hinge p^3, as shown in Figs. 2, 8 and 9.

A yielding pressure is applied to the scraper for holding the same reliably in engagement with the drying drum and also to compensate for any unevenness of surface and any lateral movement of the drying cylinder and shell relatively to each other which is liable to occur when the building containing the machine vibrates. The means for this purpose shown in the drawings, as an example, are preferred and constructed as follows:—Q represents a plurality of adjusting spindles or rods arranged in a longitudinal row and extending transversely through stuffing boxes *q* in the inner wall of the delivery chamber O, each adjusting rod being connected at its inner end with the adjacent part of the scraper supporting plate by a link q^1. These links have their upper edges tapered so as to form cutting edges, as shown at q^2 in Fig. 2, whereby the same are caused to cut or break the dried material if the same is of a character that it comes off the drying cylinder in a sheet. The outer part of each adjusting rod Q is arranged within a hollow adjusting screw R which works in a standard *r* mounted on the exterior of the delivery chamber. Upon the inner part of each adjusting rod is arranged a shoulder or screw nut r^1 which is adapted to engage with the inner end of the adjusting screw. r^2 represents a coil spring surrounding the inner part of each adjusting rod and bearing at its outer end against the respective screw nut r^1 and at its inner end against a cross piece r^3 movable lengthwise on the inner end of the adjusting rod. Tie rods S arranged on opposite sides of the adjusting rod connect at their outer ends with the adjusting screw R while their inner ends pass loosely through openings in opposite ends of the cross piece and are provided with adjusting screw nuts *s* bearing against

the inner side of said cross piece, as shown in Figs. 8 and 11.

An initial tension is placed on the springs by tightening the screw nuts s but this tension is ineffective when the scraper is out of engagement from the drying cylinder, inasmuch as the screw nuts r^1 at this time bear against the adjusting screws and cause the scraper to be positively moved forward and backward with the adjusting screw. Upon turning the adjusting screws R forward, the scraping blade moves with the same until the blade engages the bore of the drying cylinder but a continued forward turning movement of the adjusting screws R after the scrapers engage the drying cylinder causes the tension on the springs r^2 to be increased and the scrapers to bear with a yielding pressure against the drying cylinder. In the absence of means for permitting the scraper to yield, the swaying of the shell and drying cylinder during vibration of the building containing the machine would be liable to cramp or injure parts thereof. Each of the adjusting screws R is provided at its inner end with a handle or hand wheel r^4 for manipulating the same.

At opposite ends of the drying surface of the drum the same is provided with annular inclined faces or fillets t, t^1. The ends of the main scraper blade are correspondingly beveled to fit said faces, as shown in Fig. 2. The front fillet t is preferably formed on the filling ring n^1 and the rear fillet t^1 on the flange n^3 of the drum head H, as shown in Figs. 1 and 2. By thus inclining these fillets and the ends of the main scraper, it is possible to scrape the dried material more readily out of the corners between the fillets and drying cylinder.

In order to cause any material which may lodge and dry on the inner sides of the guard rings and fillets adjacent to the joints between the same to be removed therefrom and delivered into the conveyer, front and rear auxiliary scrapers U, U^1 are provided. These scrapers are arranged at the front and rear ends of the annular drying space immediately above the main scraper and have straight and bevel edges u, u^1 which engage with the straight inner side and the beveled face of the respective guard ring and fillet, as shown in Figs. 6 and 7, whereby these scrapers extend across the joints between said guard rings and the drying drum.

The auxiliary scrapers are inclined so as to direct the material which they remove from the guard rings and fillets to the main scraper and each auxiliary scraper is held yieldingly in its operative position by means of a transverse rod or shaft u^2 journaled in stuffing boxes and bearings u^3, u^4 on the inner shell section and carrying the respective scraper at its outer end, an arm u^5 secured to the inner end of the scraper rod, and a weight u^6 secured to said arm and operating to press the companion scraper against the respective guard ring and fillet.

Rotating within the conveyer trough is a longitudinal screw conveyer V which has its shaft v journaled in bearings at opposite ends of the trough. The outer or front end of the latter is provided with a depending discharge spout v^1. Upon turning the conveyer in the proper direction by any suitable means connected with the front end of its shaft, the material falling into the trough is carried forwardly therein and discharged through the spout thereof. The latter is provided with a trap or valve of any suitable construction which permits the dried material to escape but prevents the admission of air so that the vacuum in the drying space is not destroyed. The valve shown in the application for patent filed by myself July 20, 1907, Serial No. 384,744, is suitable for this purpose.

In order to permit of observing the working of the supply nozzles the scrapers and the conveyer, a longitudinal row of transparent observation panes or windows w, preferably of glass, are placed in the lower part of the inner shell cylinder, and similar rows of windows w^1, w^2 are arranged in the inner wall of the delivery chamber O below and above the scraper adjusting devices. The lower windows w permit of observing the discharge of the material to be dried from the supply nozzles and the intermediate and upper rows of windows w^1, w^2 enable the working of the scrapers and conveyer and the condition of the dried material to be observed so that the machine can be adjusted when this is found necessary. These windows are liable to become clouded or obscured by reason of vapors from the material being dried gathering on the inner side of the same. To permit of removing any deposits on the windows, wipers or cleaners W are provided which may be moved over the inner side of the window panes when required. Each of these wipers is connected by an arm w^3 with a rotatable spindle w^4 which is journaled in a bearing or stuffing box w^5 on the inner wall of the delivery chamber and provided outside of the shell with a handle w^6 for manipulating the wiper. As shown in the drawings, the arms of the wipers of two adjacent windows are connected with one operating spindle but if desired each wiper may be operated individually by an operating spindle.

x represents a vacuum gage which is connected with the drying space or vacuum chamber and indicates the atmospheric pressure under which the apparatus is working.

On one or both sides of the outer shell section is arranged a vent valve y by means of

which the drying space may be connected with the atmosphere when it is desired to destroy the vacuum in the machine.

In the bottom or lower part of the outer shell cylinder is placed a drain cock *z* for discharging any accumulations which may occur from washing the machine or otherwise.

It will be noted that the operation of the machine is wholly mechanical and that the drying proceeds continuously without necessitating handling of the material at any time. Furthermore, the machine can be readily cleaned when desired thus enabling the drying operation to be conducted under absolutely sanitary conditions.

I claim as my invention.

1. A drier comprising an inclosing shell, a rotatable drum arranged with said shell, means for delivering the material to be dried on the inner side of said drum simultaneously throughout the length thereof, and means for removing the dried material from the inner side of said drum simultaneously throughout the length thereof, substantially as set forth.

2. A drier comprising an inclosing shell, a rotatable drum arranged with said shell, means for heating the drum, means for delivering the material to be dried on the inner side of said drum simultaneously throughout the length thereof, and means for removing the dried material from the inner side of said drum simultaneously throughout the length thereof, substantially as set forth.

3. A drier comprising an inclosing shell adapted to be connected with an exhausting device, a drum rotatable in said shell, means for heating said drum, means for depositing the material to be dried on the inner side of said drum simultaneously throughout the length thereof, and means for removing the dried material from the inner side of said drum simultaneously throughout the length thereof, substantially as set forth.

4. A drier comprising an inclosing shell adapted to be connected with an exhausting device, a drum rotatable in said shell, means for heating said drum, means for depositing the material to be dried on the inner side of the drum simultaneously throughout the length thereof, and means for removing the dried material from the inner side of said drum simultaneously throughout the length thereof, substantially as set forth.

5. A drier comprising an inclosing shell adapted to be connected with an exhausting device, a drum rotatable in said shell, means for heating said drum, a plurality of supply nozzles for depositing the material to be dried on the inner side of the drum simultaneously throughout the length thereof, and a scraper for removing the dried material from the inner side of said drum simultaneously throughout the length thereof, substantially as set forth.

6. A drier comprising a horizontal cylindrical shell, a horizontal cylindrical drum rotatable in said shell, means for heating said drum, means for depositing the material to be dried on the inner lower side of said drum simultaneously throughout the length thereof, and means for removing the dried material from the inner lateral side thereof simultaneously throughout the length thereof, substantially as set forth.

7. A drier comprising a horizontal cylindrical shell, a horizontal cylindrical drum rotatable in said shell, means for heating said drum, comprising a heating jacket surrounding the drum, means for depositing the material to be dried on the inner lower side of said drum simultaneously throughout the length thereof, and means for removing the dried material from the inner lateral side thereof simultaneously throughout the length thereof, substantially as set forth.

8. A drier comprising a horizontal cylindrical shell, a horizontal cylindrical drum rotatable in said shell and provided with a heating jacket, a trunnion connected with one end of the drum and journaled in a bearing at one end of the shell and provided with a longitudinal conduit for supplying the heating medium to said jacket, rollers supporting the drum at the opposite end of its periphery, means for depositing the material to be dried on the inner side of said drum, and means for removing the dried material from the inner side of said drum, substantially as set forth.

9. A drier comprising a horizontal cylindrical shell, a horizontal cylindrical drum rotatable in said shell, a trunnion connected with one end of the drum and journaled in a bearing in the adjacent end of the shell, a heating jacket surrounding the drum, means for conducting the heating medium to said jacket comprising conduits arranged in said trunnion, means for depositing the material to be dried on the inner side of said drum and means for removing the dried material from the inner side of said drum, substantially as set forth.

10. A drier comprising a horizontal cylindrical shell having a head, a horizontal cylindrical drum rotatable in said shell and having a head, a trunnion arranged on the drum head and journaled in a bearing in the shell head, a heating jacket surrounding the drum, means for conducting the heating medium into said jacket comprising conduits arranged in said trunnion and drum head, means for depositing the material to be dried on the inner side of said drum, and means for removing the dried material from the inner side of said drum, substantially as set forth.

11. A drier comprising a horizontal cylindrical shell having a head, a horizontal cylindrical drum rotatable in said shell and having a head, a trunnion arranged on the drum head and journaled in a bearing in the shell head, a heating jacket surrounding the drum, means for conducting steam into said jacket and delivering the water of condensation therefrom comprising a main steam supply conduit arranged lengthwise within the trunnion, a branch steam supply conduit extending laterally in said drum head from the main steam supply conduit to said jacket, a main condensation delivery conduit arranged within the main steam supply conduit and a branch condensation delivery conduit extending laterally in said drum head from the main condensation delivery conduit to said jacket, means for depositing the material to be dried on the drum and means for removing the dried material from the drum, substantially as set forth.

12. A drier comprising a horizontal cylindrical shell having a head, a horizontal cylindrical drum rotatable in said shell and having a head, a trunnion arranged on the drum head and journaled in a bearing in the shell head, a heating jacket surrounding the drum, means for conducting steam into said jacket and delivering the water of condensation therefrom comprising a main steam supply conduit arranged lengthwise within the trunnion, a branch steam supply conduit extending laterally in said drum head from the main steam supply conduit to said jacket, a main condensation delivery conduit arranged within the main steam supply conduit, a branch condensation delivery conduit extending laterally in said drum head from the main condensation delivery conduit to said jacket, a stationary steam supply chamber which communicates with said main steam supply conduit, and a stationary condensation delivery chamber which communicates with said main condensation delivery conduit, means for depositing the material to be dried on the drum and means for removing the dried material from the drum, substantially as set forth.

13. A drier comprising a horizontal cylindrical shell having a head, a horizontal cylindrical drum rotatable in said shell and having a head, a trunnion arranged on the drum head and journaled in a bearing in the shell head, a heating jacket surrounding the drum, means for conducting steam into said jacket and delivering the water of condensation therefrom comprising a main steam supply conduit arranged lengthwise within the trunnion, a branch steam supply conduit extending laterally in said drum head from the main steam supply conduit to said jacket, a main condensation delivery conduit arranged within the main steam supply conduit, a branch condensation delivery conduit extending laterally in said drum head from the main condensation delivery conduit to said jacket, and having an enlargement extending backwardly from its inlet, means for depositing the material to be dried on the drum and means for removing the dried material from the drum, substantially as set forth.

14. A drier comprising a horizontal cylindrical shell having a head, a horizontal cylindrical drum rotatable in said shell and having a head, a trunnion arranged on the drum head and journaled in a bearing in the shell head, a heating jacket surrounding the drum, means for conducting steam into said jacket and delivering the water of condensation therefrom comprising a main steam supply conduit arranged lengthwise within the trunnion, a branch steam supply conduit extending laterally in said drum head from the main steam supply conduit to said jacket, a main condensation delivery conduit arranged within the main steam supply conduit a branch condensation delivery conduit extending laterally in said drum head from the main condensation delivery conduit to said jacket, and a scoop arranged lengthwise in said jacket and communicating at one end with the inlet of said branch condensation delivery conduit, means for depositing the material to be dried on the drum and means for removing the dried material from the drum, substantially as set forth.

15. A drier comprising a horizontal cylindrical shell having a head, a horizontal cylindrical drum rotatable in said shell and having a head, a trunnion arranged on the drum head and journaled in a bearing in the shell head, a heating jacket surrounding the drum, means for conducting steam into said jacket and delivering the water of condensation therefrom comprising a main steam supply conduit arranged lengthwise within the trunnion, a branch steam supply conduit extending laterally in said drum head from the main steam supply conduit to said jacket, a main condensation delivery conduit arranged within the main steam supply conduit a branch condensation delivery conduit extending laterally in said drum head from the main condensation delivery conduit to said jacket, and a scoop arranged lengthwise in said jacket and at an angle to the axis of the drum and communicating at one end with the inlet of said branch condensation delivery conduit, means for depositing the material to be dried on the drum and means for removing the dried material from the drum, substantially as set forth.

16. A drier comprising an inclosing shell adapted to be connected with an exhausting device and having an outer cylinder, an in-

ner cylinder, heads at the rear ends of said cylinders and a connection between the front ends of the cylinders, a drying drum having a cylinder rotatable between said shell cylinders, means for heating said drum, means for depositing on the drum the material to be dried, and means for removing the dried material from the drum, substantially as set forth.

17. A drier comprising an inclosing shell having an outer cylinder, an inner cylinder, heads at the rear ends of said cylinders and a connection between the front ends of the cylinders, a drying drum having a cylinder rotatable between said shell cylinders, means for heating said drum, means for depositing on the drum the material to be dried, means for removing the dried material from the drum, and an exhaust pipe arranged lengthwise of the inner shell cylinder and connected at its side with the interior of the shell and adapted to be connected at one end with an exhausting device, substantially as set forth.

18. A drier comprising an inclosing shell having an outer cylinder, an inner cylinder, heads at the rear ends of said cylinders and a connection between the front ends of the cylinders, a drying drum having a cylinder rotatable between said shell cylinders, means for heating said drum, means for depositing on the drum the material to be dried, means for removing the dried material from the drum, an exhaust pipe arranged lengthwise of the inner shell cylinder and connected at its side with the interior of the shell and adapted to be connected at one end with an exhausting device, and guard rings mounted at opposite ends of the inner shell cylinder and forming closures at these points between the inner shell cylinder and the drum, substantially as set forth.

19. A drier comprising an inclosing shell having an outer cylinder, an inner cylinder, heads at the rear ends of said cylinders and a connection between the front ends of the cylinders, a drying drum having a cylinder rotatable between said shell cylinders, means for heating said drum, means for depositing on the drum the material to be dried, means for removing the dried material from the drum, an exhaust pipe arranged lengthwise of the inner shell cylinder and connected at its side with the interior of the shell and adapted to be connected at one end with an exhausting device, a filling ring arranged at the front end of the drum cylinder, a front guard ring arranged at the front end of the inner shell cylinder and extending close to the filling ring, and a rear guard ring mounted on the rear end of the inner shell cylinder and extending to a flange within the rear part of the drum, substantially as set forth.

20. A drier comprising an inclosing shell adapted to be connected with an exhausting device and having an outer cylinder, an inner cylinder, heads at the rear ends of the cylinders and a connection between the front ends of said cylinders, a drying drum having a cylinder rotatable between the shell cylinders, means mounted on the inner shell cylinder for depositing the material to be dried on the drum cylinder, and means mounted on the inner shell cylinder for removing the dried material from the drum cylinder, substantially as set forth.

21. A drier comprising an inclosing shell adapted to be connected with an exhausting device and having an outer cylinder, an inner cylinder, heads at the rear ends of the cylinders and a connection between the front ends of said cylinders, a drying drum having a cylinder rotatable between the shell cylinders, means mounted on the inner shell cylinder for depositing the material to be dried on the drum cylinder, comprising a plurality of supply nozzles projecting through the lower part of the inner shell cylinder, a supply manifold connecting said nozzles and individual valves for said nozzles, and means mounted on the inner shell cylinder for removing the dried material from the drum cylinder, substantially as set forth.

22. A drier comprising an inclosing shell adapted to be connected with an exhausting device and having an outer cylinder, an inner cylinder, heads at the rear ends of the cylinders and a connection between the front ends of said cylinders, a drying drum having a cylinder rotatable between the shell cylinders, means mounted on the inner shell cylinder for depositing the material to be dried on the drum cylinder and means for removing the dried material from the drum cylinder comprising a delivery chamber communicating with the interior of the shell, and a scraper for removing the dried material from the drum cylinder and directing the same into said chamber, substantially as set forth.

23. A drier comprising an inclosing shell adapted to be connected with an exhausting device and having an outer cylinder, an inner cylinder, heads at the rear ends of the cylinders and a connection between the front ends of said cylinders, a drying drum having a cylinder rotatable between the shell cylinders, means mounted on the inner shell cylinder for depositing the material to be dried on the drum cylinder, and means for removing the dried material from the drum cylinder comprising a delivery chamber communicating with the interior of the shell, a scraper for removing the dried material from the drum cylinder and directing the same into said chamber, and a longitudinal conveyer for removing the material from the delivery chamber, substantially as set forth.

24. A drier comprising an inclosing shell adapted to be connected with an exhausting device and having an outer cylinder, an inner cylinder, heads at the rear ends of the cylinders and a connection between the front ends of said cylinders, a drying drum having a cylinder rotatable between the shell cylinders, means mounted on the inner shell cylinders for depositing the material to be dried on the drum cylinder, and means for removing the dried material from the drum cylinder comprising a longitudinal delivery chamber which opens with its upper part into the side of the inner shell cylinder and has a conveyer trough in its lower part, a scraper operating to remove the dried material from the bore of the drum cylinder and direct the same into the conveyer trough and a screw conveyer arranged in said trough and operating to remove the material therefrom, substantially as set forth.

25. A drier comprising an inclosing shell adapted to be connected with an exhausting device and having an outer cylinder, an inner cylinder, heads at the rear ends of the cylinders and a connection between the front ends of said cylinders, a drying drum having a cylinder rotatable between the shell cylinders, means mounted on the inner shell cylinder for depositing the material to be dried on the drum cylinder, and means for removing the dried material from the drum cylinder comprising a longitudinal delivery chamber communicating with the interior of the shell, and a scraper pivoted at one edge on said chamber while its other edge bears against the bore of the drum cylinder, substantially as set forth.

26. A drier comprising an inclosing shell adapted to be connected with an exhausting device and having an outer cylinder, an inner cylinder, heads at the rear ends of the cylinders and a connection between the front ends of said cylinders, a drying drum having a cylinder rotatable between the shell cylinders, means mounted on the inner shell cylinder for depositing the material to be dried on the drum cylinder, and means for removing the dried material from the drum cylinder comprising a longitudinal delivery chamber communicating with the interior of the shell, a scraper pivoted at one edge on said chamber while its other edge bears against the bore of the drum cylinder, and means for removing the scraper into and out of its operative position, substantially as set forth.

27. A drier comprising an inclosing shell adapted to be connected with an exhausting device and having an outer cylinder, an inner cylinder, heads at the rear ends of the cylinders and a connection between the front ends of said cylinders, a drying drum having a cylinder rotatable between the shell cylinders, means mounted on the inner shell cylinder for depositing the material to be dried on the drum cylinder and means for removing the dried material from the drum cylinder comprising a longitudinal delivery chamber communicating with the interior of the shell, a scraper pivoted at one edge on said chamber while its other edge bears against the bore of the drum and means for holding the scraper yieldingly in engagement with the bore of the drum cylinder, substantially as set forth.

28. A drier comprising an inclosing shell adapted to be connected with an exhausting device and having an outer cylinder, an inner cylinder, heads at the rear ends of the cylinders and a connection between the front ends of said cylinders, a drying drum having a cylinder rotatable between the shell cylinders, means mounted on the inner shell cylinder for depositing the material to be dried on the drum cylinder, and means for removing the dried material from the drum cylinder comprising a delivery chamber communicating with the interior of the shell, a scraper pivoted at one edge on said chamber while its other edge bears against the bore of the drum cylinder, and means for adjusting said scraper and holding the same yieldingly in position comprising a plurality of adjusting rods, links connecting said rods with the scraper, adjusting screws working in a wall of the delivery chamber and receiving said adjusting rods, respectively, and a tension device interposed between said adjusting screw and rod, substantially as set forth.

29. A drier comprising an inclosing shell adapted to be connected with an exhausting device and having an outer cylinder an inner cylinder, heads at the rear ends of the cylinders and a connection between the front ends of said cylinders, a drying drum having a cylinder rotatable between the shell cylinders, means mounted on the inner shell cylinder for depositing the material to be dried on the drum cylinder, and means for removing the dried material from the drum cylinder comprising a delivery chamber communicating with the interior of the shell, a scraper pivoted at one edge on said chamber while its other edge bears against the bore of the drum cylinder, and means for adjusting said scraper and holding the same yieldingly in position comprising a plurality of adjusting rods, links connecting said rods with the scraper, adjusting screws working in a wall of the delivery chamber and receiving said adjusting rods, respectively, a screw nut or shoulder arranged on the intermediate part of each rod and adapted to bear against a shoulder on the adjusting screw, a cross piece mounted on the inner end of each rod and connected with the adjusting screw, and a spring mounted on each

rod between the cross piece and nut thereof, substantially as set forth.

30. A drier comprising an inclosing shell adapted to be connected with an exhausting device, a drying drum rotatable within the shell, means for depositing the material to be dried on said drum, means for removing the dried material from the drum, windows arranged in the shell to permit of observing the interior, and a wiper operating to clean the inner side of said window, substantially as set forth.

31. A drier comprising an inclosing shell adapted to be connected with an exhausting device, a drying drum rotatable within the shell, means for depositing the material to be dried on said drum, means for removing the dried material from the drum, windows arranged in the shell to permit of observing the interior, a wiper for cleaning the window arranged on the inner side of the same, and a rocking spindle which is journaled on the shell, and which carries said wiper, substantially as set forth.

32. A drier comprising an inclosing shell adapted to be connected with an exhausting device and having inner and outer cylinders, heads at the rear ends of the cylinders and a connection at the front ends of the cylinders, a drying drum rotatable within said shell, means for depositing the material to be dried on the drum, means for removing the dried material from the drum and a movable support on which the inner shell cylinder and its head are mounted, substantially as set forth.

33. A drier comprising an inclosing shell adapted to be connected with an exhausting device and having inner and outer horizontal cylinders, heads at the rear ends of the cylinders and a detachable connection between the front ends of the cylinders, a drying drum rotatable between said cylinders, means for depositing the material to be dried on the drum, means for removing the dried material from the drum, and a carriage supporting said inner cylinder and its head and movable partway underneath said outer cylinder, substantially as set forth.

34. A drier comprising an inclosing shell having an outer cylinder and an inner cylinder arranged eccentrically within the outer cylinder forming a drying space between same which is narrow on one side and wide on the other side, a drying cylinder rotatable between said inclosing cylinders, means for feeding the material to be dried on the drying cylinder adjacent to one end of the wide portion of the drying space, a vapor outlet arranged adjacent to opposite end of the wide part of said drying space, and means for removing the dried material arranged in the narrow part of said drying space, substantially as set forth.

35. A drier comprising an inclosing shell adapted to be connected with an exhausting device and having a horizontal outer cylinder and a horizontal inner cylinder which is arranged eccentrically within the outer cylinder so as to form a drying chamber or space between the same which is narrow on one side and wide on the other side, a horizontal drying cylinder rotatable in said space concentrically with said outer cylinder, means for feeding the material to be dried on the lower part of the drying cylinder adjacent to one end of said wide part of said space, a vapor outlet arranged adjacent to the opposite end of the wide part of said space, and means for removing the material to be dried from said drying cylinder arranged in the narrow part of said drying space, substantially as set forth.

36. A drier comprising an inclosing shell and having outer and inner sections which form an annular drying chamber between the same, one side of said chamber being narrow and the other side comparatively wide, a drying drum rotatable on said drying chamber, means for depositing the material to be dried on the drum adjacent to one end of the wide part of the drying chamber, and a vapor outlet arranged adjacent to the other end of the wide part of the drying chamber, and means for removing the dried material from the drum, substantially as set forth.

Witness my hand this 15th day of August, 1907.

OLIVER S. SLEEPER.

Witnesses:
THEO. L. POPP,
E. M. GRAHAM.