No. 730,564. PATENTED JUNE 9, 1903.

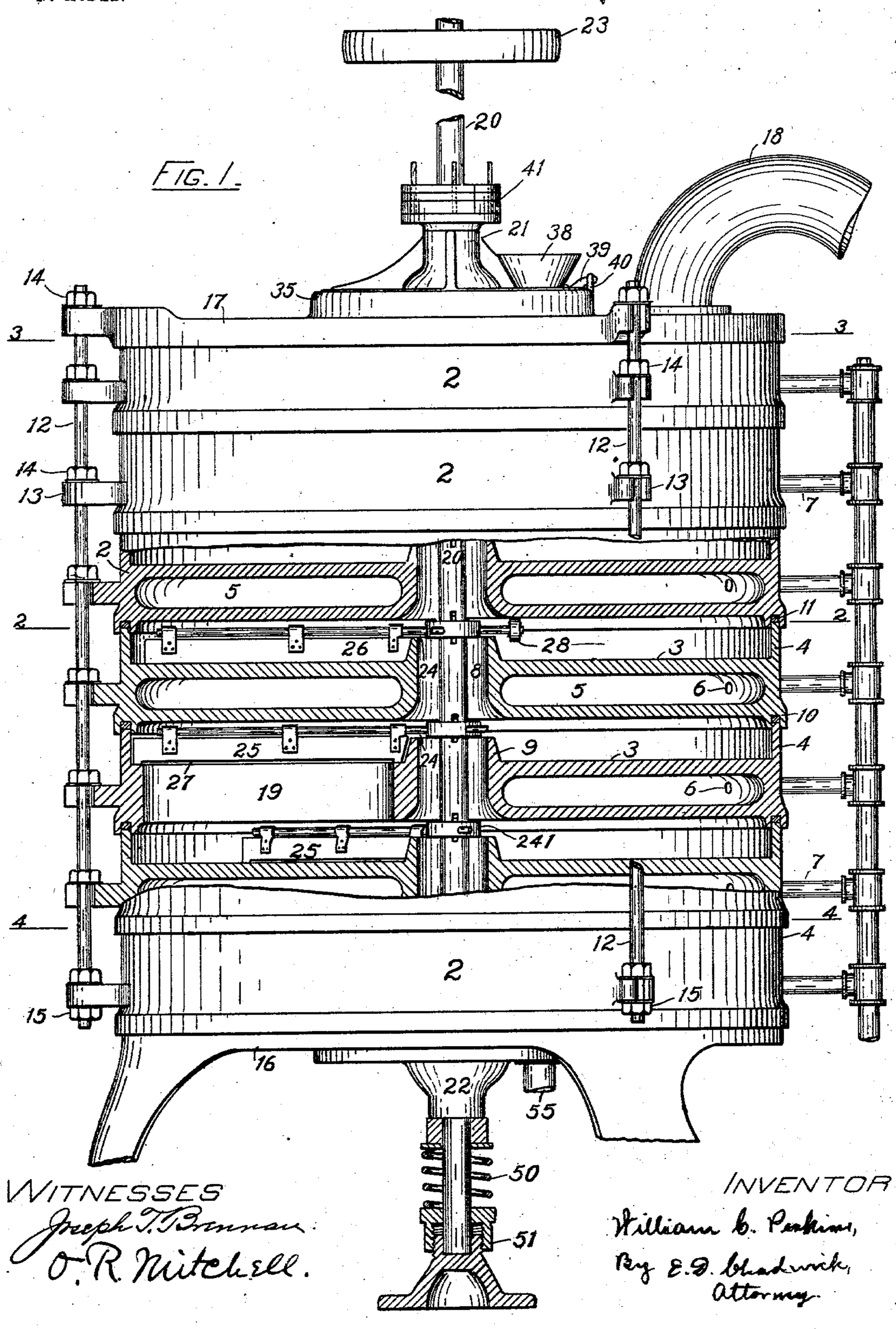
W. C. PERKINS.

VACUUM DRYING APPARATUS.

APPLICATION FILED APR. 23, 1901.

NO MODEL. 5 SHEETS—SHEET 1.

FIG. 1.




WITNESSES

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NO MODEL. 5 SHEETS—SHEET 2.

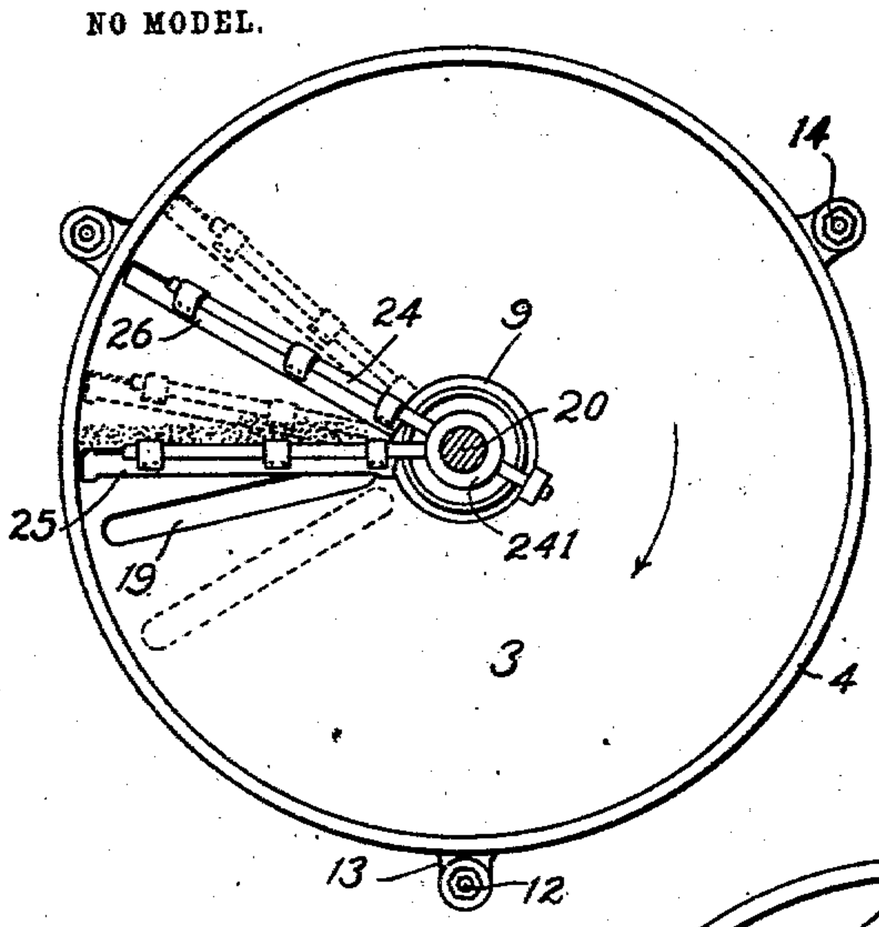



FIG. 2.

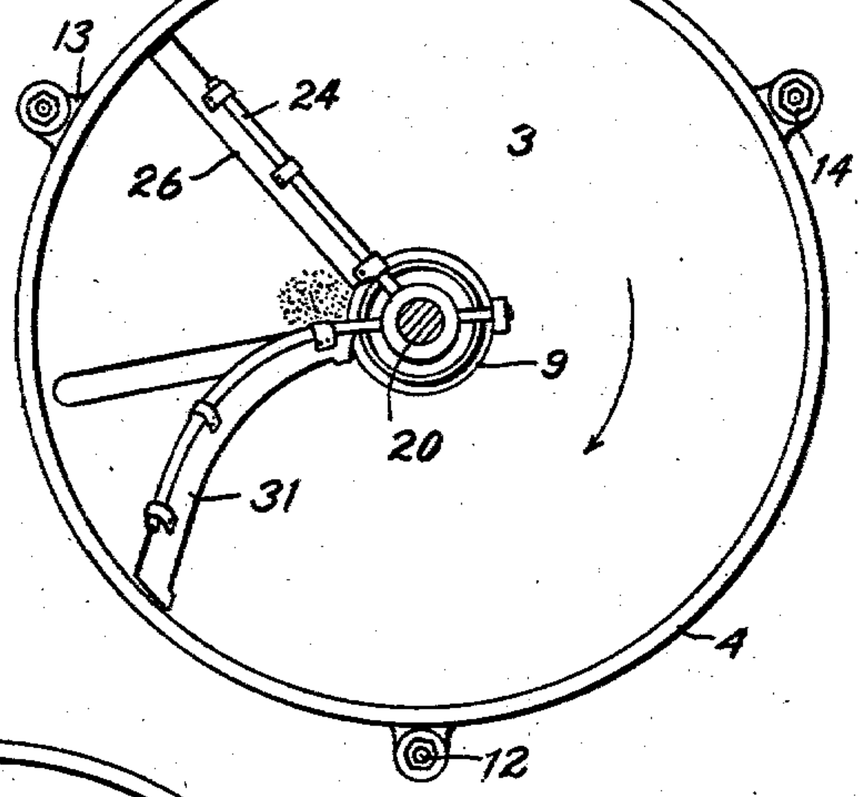



FIG. 3.

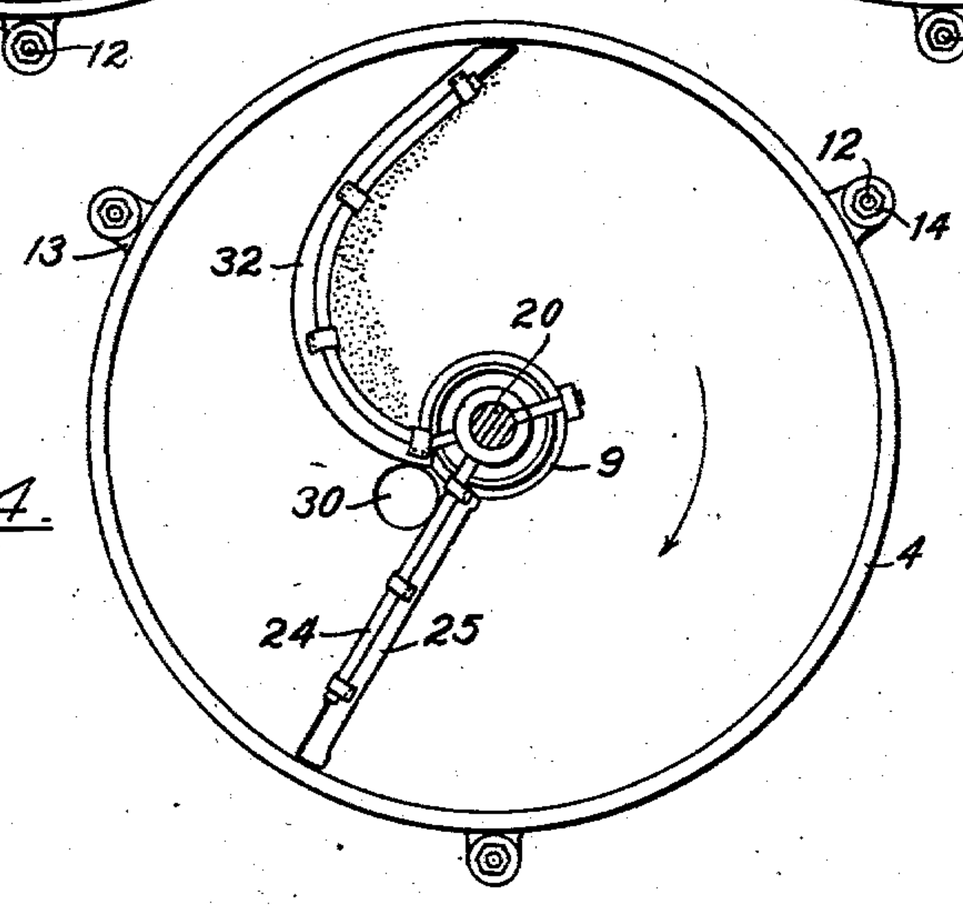
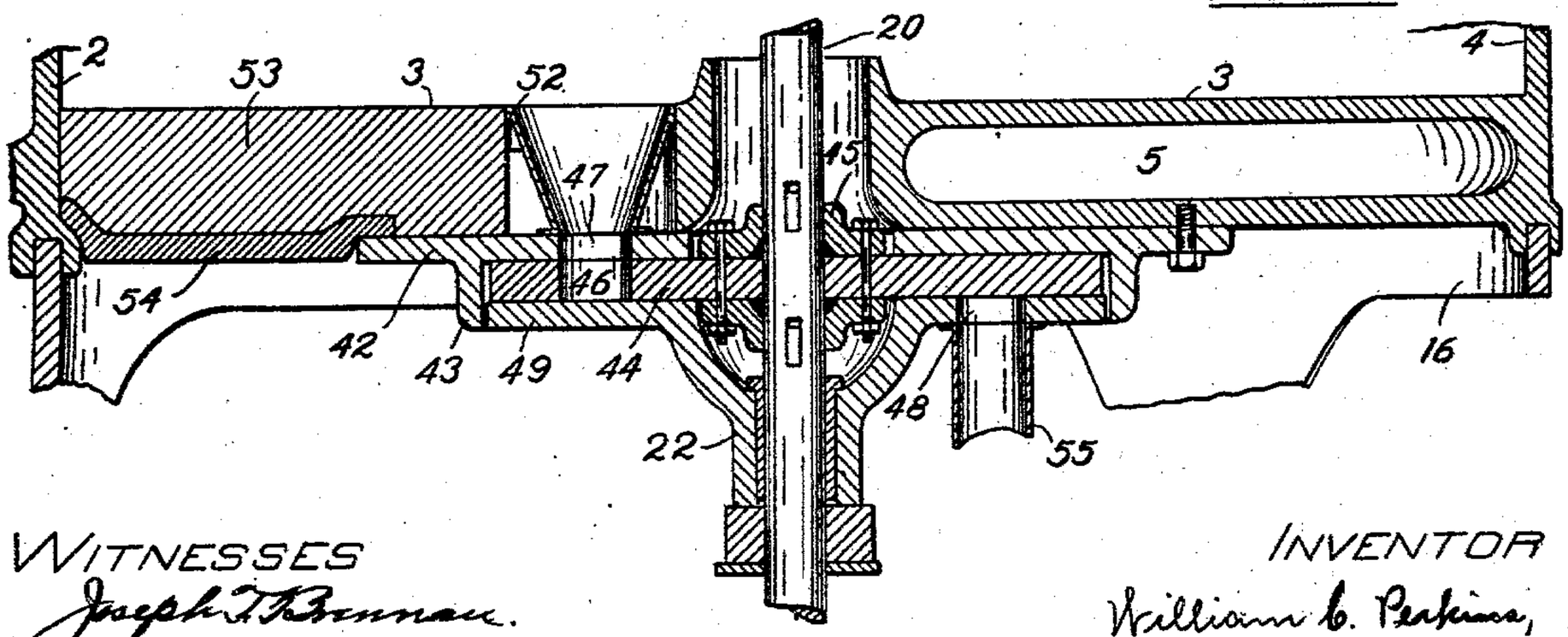



FIG. 4.

FIG. 5.

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NO MODEL. 5 SHEETS—SHEET 3.

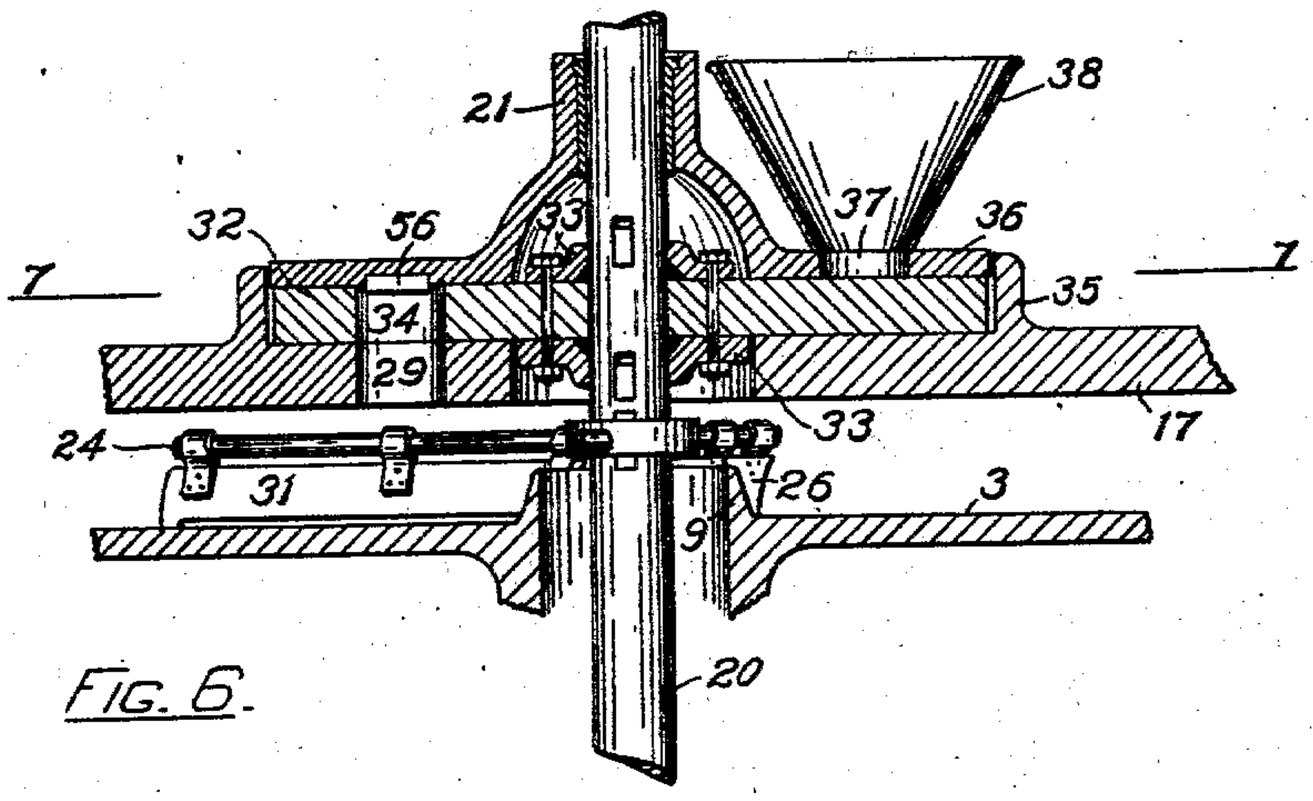


FIG. 6.

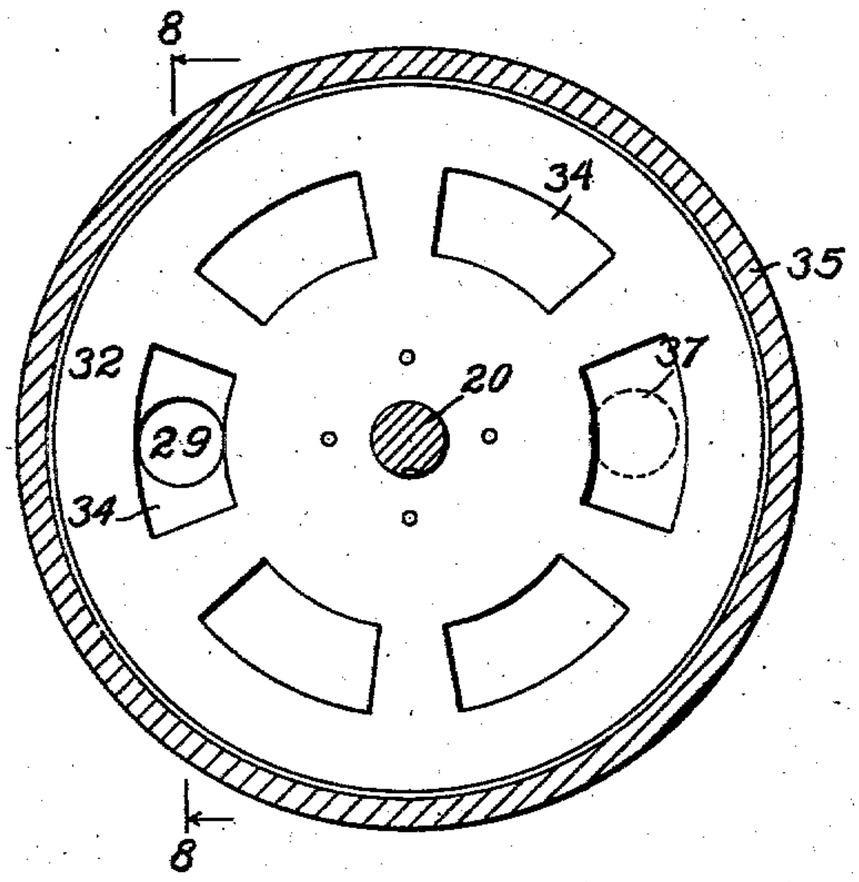


FIG. 7.

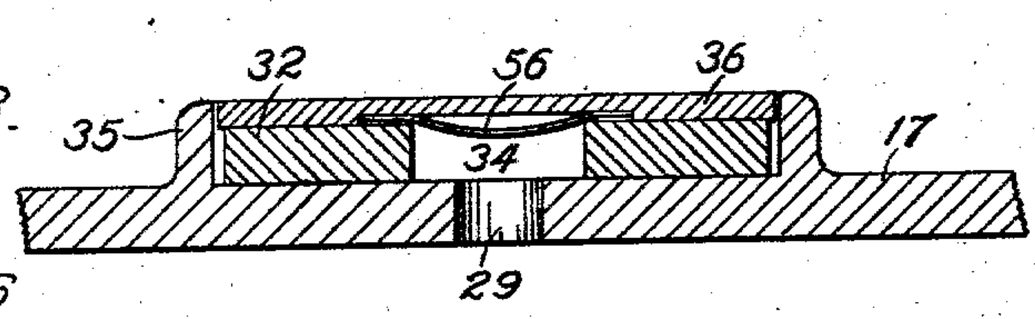


FIG. 8.

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## VACUUM DRYING APPARATUS.

APPLICATION FILED APR. 23, 1901.

NO MODEL. 6 SHEETS—SHEET 4.

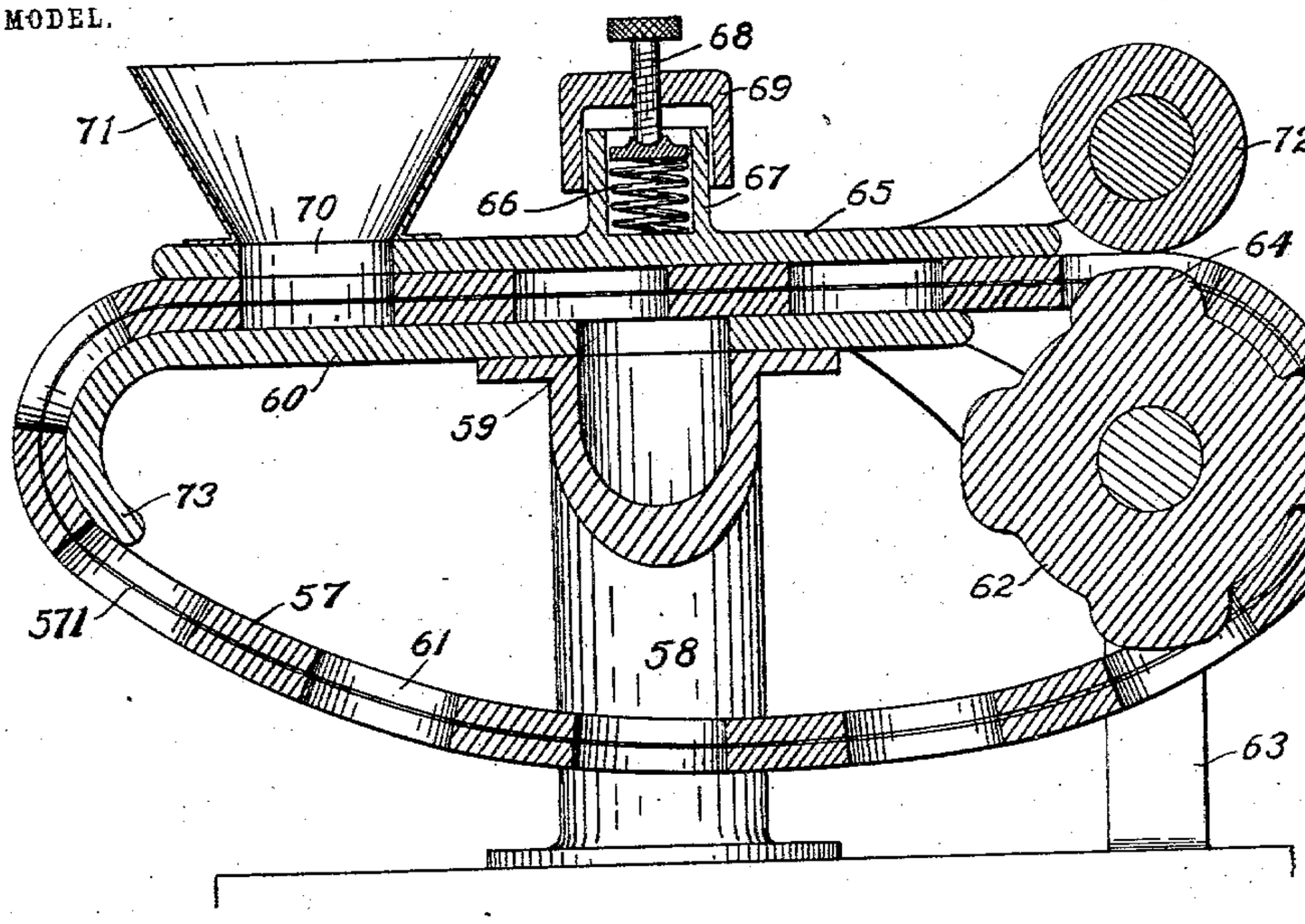


FIG. 9.

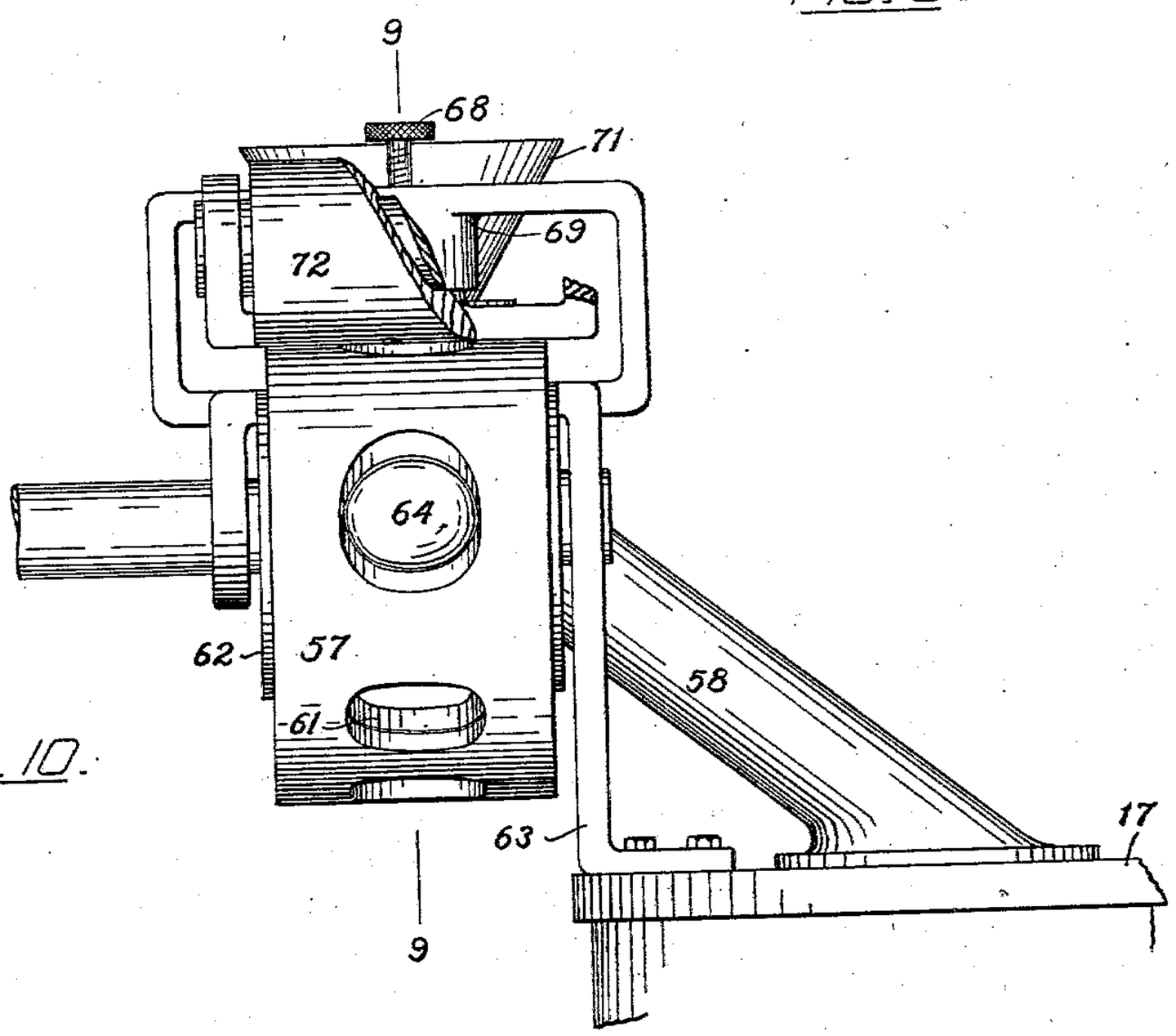


FIG. 10.

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NO MODEL. 6 SHEETS—SHEET 5.

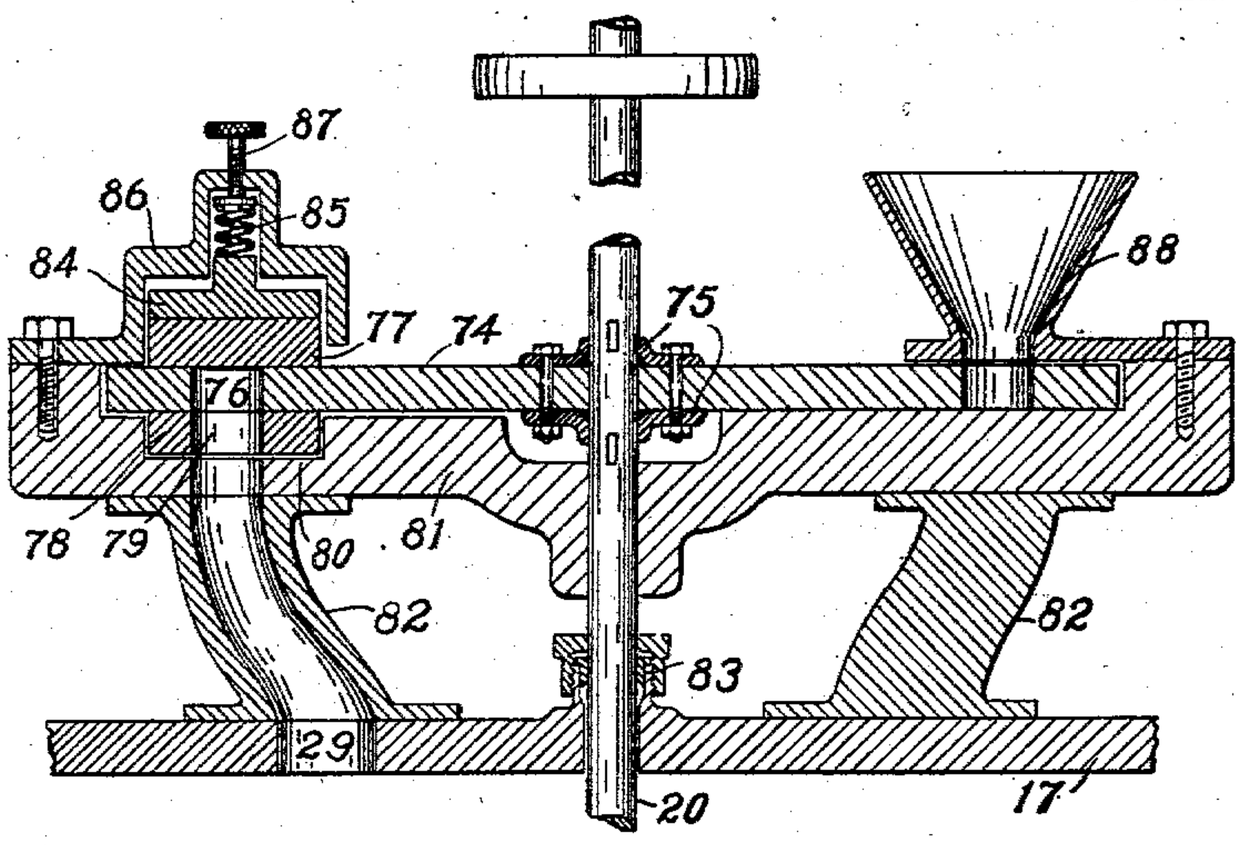


FIG. 11.

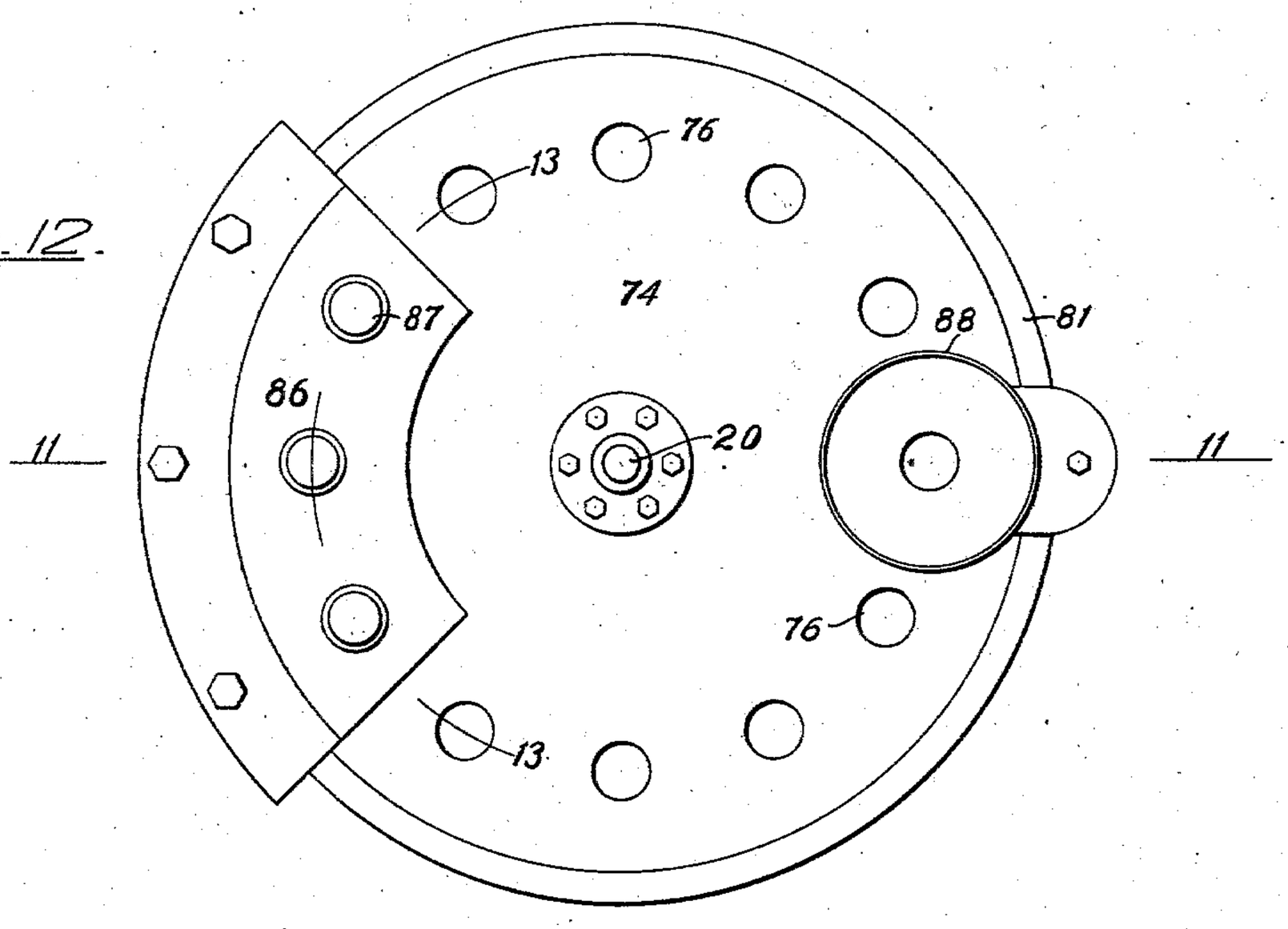


FIG. 12.




FIG. 13.

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# UNITED STATES PATENT OFFICE.

WILLIAM C. PERKINS, OF BROOKLINE, MASSACHUSETTS.

## VACUUM DRYING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 730,564, dated June 9, 1903.

Application filed April 23, 1901. Serial No. 57,057. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM C. PERKINS, a citizen of the United States, residing at Brookline, in the county of Norfolk and State of Massachusetts, have invented certain new and useful Improvements in Vacuum Drying Apparatus, of which the following is a specification.

My invention relates to apparatus for drying granular and similar materials, and more particularly to apparatus of that type in which the material is dried in a closed chamber from which the air and vapors are kept exhausted more or less perfectly in order that the drying process may be carried on more rapidly and effectively than under normal atmospheric pressure and without danger of overheating the material in those cases in which heated surfaces are employed to assist in the drying operation. It has heretofore been proposed to provide such apparatus with valves so constructed as to enable the material to be automatically introduced into and withdrawn from the apparatus without destroying or seriously diminishing the vacuum therein, with the object of making it possible to carry on the drying operation continuously and indefinitely; but in practice much difficulty has been experienced in getting satisfactory results from apparatus of this type, particularly in respect to the operation of said valves, and so far as I am aware no such apparatus has hitherto gone into practical and successful use.

A main object of my invention is therefore to provide efficient means for admitting material into the vacuum-chamber of a drying apparatus of the type referred to and for discharging the dried material therefrom without impairing the vacuum necessary to be maintained therein.

My invention is also intended to simplify and otherwise improve upon such prior apparatus, particularly with respect to the body portion thereof containing the vacuum-chamber and heating-surfaces when used and with respect to the means for causing the material to pass through the apparatus at a uniform rate and with the proper amount of exposure of every portion thereof to the drying agencies.

A preferred form of my invention is illustrated in the accompanying drawings, in which—

Figure 1 is a side view of the complete apparatus shown partly in elevation and partly in vertical section. Figs. 2, 3, and 4 are horizontal sections, on a reduced scale, taken, respectively, on the lines 2 2, 3 3, and 4 4 in Fig. 1. Fig. 5 is a central vertical section, somewhat enlarged, illustrating one form of valve through which the dried material may be withdrawn from the apparatus. Fig. 6 is a similar view illustrating a valve for introducing the material. Fig. 7 is a horizontal section taken on the line 7 7 in Fig. 6 and showing a slight modification. Fig. 8 is an enlarged section taken on the line 8 8 in Fig. 7. Fig. 9 is a central vertical section taken on the line 9 9 in Fig. 10, illustrating a modified form of valve for introducing the material. Fig. 10 is a side elevation thereof, partly broken away, looking from the right-hand end of Fig. 9. Fig. 11 is a central vertical section taken on the line 11 11 in Fig. 12, illustrating another form of valve for introducing material. Fig. 12 is a top plan view of the same, and Fig. 13 is a developed section taken on the line 13 13 in Fig. 12.

In the apparatus shown in the drawings the body portion has the external form, roughly speaking, of an upright cylinder, and its interior is divided by substantially horizontal partitions into a suitable number of compartments through which in succession the material to be dried is fed. In constructing said body portion I prefer to employ one or more similar unit-sections 2, each comprising a flat bottom 3 and a cylindrical outer wall 4, the top and bottom edges of which are adapted to be fitted air-tight to the bottom and top edges of the adjacent sections, respectively. When the material is to be exposed to heat as it passes through the apparatus, as is ordinarily the case, the bottom 3 is made hollow to form a heating-chamber 5, which is closed except at one or more points 6, where it communicates with a pipe 7, through which steam, hot water, or other suitable heating medium is introduced. The central portion of each unit-section 2 is left open, as at 8, for a purpose hereinafter explained, and an annular ledge 9 is formed around the opening 8 in order to prevent the material from fall-

ing over the inner edge of the bottom 3 through said opening when it is distributed over said bottom, as hereinafter set forth. In order to provide for the air-tight union of the meeting edges of the walls 3, I prefer to form in the thickened lower edge of each of said walls an annular groove 10, adapted to receive the top edge of the wall 3 of the unit-section next below it, a suitable packing 11 being provided in the bottom of said grooves. As thus constructed it will be seen that any desired number of the unit-sections 2 may be superimposed to form an apparatus of any desired height, according to the nature and quantity of the material which it is intended to handle, the spaces between said sections forming a corresponding number of compartments, within which the drying of the material is carried on. The sections 2 are firmly secured together, preferably by means of vertical rods 12, located between alined pairs of ears 13, secured to or cast integral with said sections, respectively, said rods being screw-threaded at suitable intervals and provided with nuts 14, adapted to bear against said ears 13, and thereby clamp the corresponding section 2 to the section next below it, the lower ends of the rods 12 being provided with opposing nuts 15, as shown. By means of this arrangement each section 2 may be tightened against its adjacent sections without disturbing any of the sections below it and the body portion of the whole apparatus may be made practically integral. The apparatus is supported on a suitable base 16, and its top is closed by a plate 17, provided with a groove 10, adapted to receive the top edge of the top section 2 and clamped thereto in the same manner that the sections themselves are clamped together.

A suitable valve is provided for introducing the wet material through the top plate 17 and depositing it on the bottom 3 of the top unit-section 2, and another valve is provided at the bottom of the apparatus for withdrawing the dried material therefrom. A pipe 18 opens at one end into the body portion of the apparatus and is connected at its other end to an air-pump and preferably to a condenser, by means of which air and the watery vapor given off by the material being dried are kept exhausted from the apparatus to the desired extent. By reason of the openings 8 the vacuum will be effective in all of the drying-compartments alike.

The bottom 3 of each unit-section 2 is provided with a vertical opening 19, which is preferably given the form of a radially-extending slot, as shown, the vertical walls of which close the cavity 5 within the bottom 3, and thus cut off communication between the same and the interior of the apparatus itself. Through these openings 19 the material is fed from each section 2 to the one next below it, and said sections are so arranged with reference to the direction of rotation of the feeding device hereinafter described that the opening 19 in any section will be located slightly behind the similar opening in the next section above it and slightly ahead of the opening in the next section below it, so that the arrangement of said openings going from the top to the bottom of the apparatus will be similar to that of a circular flight of stairs. The result of this arrangement is that when a quantity of material is fed from any section 2 through the opening 19 therein to the next section below it will fall upon the bottom 3 of the latter section at a point near its opening 19, but slightly ahead of the same, and it is thereupon acted upon by the feeding device and carried around the top surface of said bottom 3, so that it will have to pass over practically the whole of said surface before it reaches the opening 19 therein and falls through the same upon the bottom of the section 2 next below.

For effecting the feeding of the material through the apparatus in the manner just described I prefer to employ a vertical shaft 20, journaled in boxes 21 and 22, located at the top and bottom of the apparatus, at the center thereof, and adapted to be rotated continuously by means of a pulley 23 or otherwise. The shaft 20 is thus located within the central open space provided by the openings 8 in the alined unit-sections 2 adjacent to the compartments formed by and between the horizontal bottoms of said sections, and it is provided with means whereby each charge of material received in said compartments is first distributed or spread over the surface 3 on which it rests, thus exposing every portion of it to the drying agencies, and is subsequently collected and discharged through the corresponding opening 19 into the compartment next below. According to my preferred arrangement two horizontal arms 24 are rigidly secured to a collar 241, which is splined to the shaft 20 opposite each of said compartments, each arm carrying a depending blade extending downward into position to engage the material delivered to that compartment in which it moves. Said blades 25 and 26 are set at an angle to each other, as shown in Fig. 2, the lower edge of the rear blade 25, which I call the "distributing-blade," being cut away between its ends, thus providing a space 27 between it and the surface 3 below it, while the front blade 26, which I call the "scraping-blade," rests throughout its length upon said surface. Each pair of blades 25 and 26 is so arranged with respect to the pair of blades next above them that a quantity of material fed through any opening 19 will fall between the blades which cooperate with the surface 3 on which it falls, as indicated in Fig. 2, so that such quantity of material will immediately be engaged by the rear blade 25 and will be spread and distributed thereby over said surface 3, the effect of the space 27 being to leave a layer of material having a thickness equal to the height of said space evenly spread over the

surface 3 until the front blade 26 has made nearly one revolution, whereupon said blade 26 will gather up the material during its next revolution and push it in a mass over the edge of the corresponding opening 19.

The object of splining the collars 241 to the shaft 20 is to provide for the independent vertical movement of each of said collars with respect to the shaft, so that each pair of blades 25 and 26 may always rest with their own weight only on the corresponding surface 3, and it will be impossible for their operative position to be disturbed by tightening the unit-sections 2 or otherwise. In order to counteract any tendency of said collars to tilt and bind, each collar may be provided with a roller 28, located opposite to said blades and arranged to travel on the bottom surface of the unit-section next above.

The introducing and discharging valves of the apparatus shown in the drawings are so constructed that the material is delivered by the former valve to the top unit-section 2 through a circular opening 29 and is removed by the latter valve from the bottom unit-section 2 through a similar circular opening 30, and I therefore prefer to modify the distributing-blade which coöperates with said top unit-section and the scraping-blade which coöperates with said bottom unit-section by curving them laterally somewhat, as shown in Figs. 3 and 4, the former blade 31 having its convex side presented to the material upon which it acts, so that it will tend to distribute the same radially as well as circumferentially, and the latter blade 32 having its concaved side presented to the material upon which it acts, so that it will tend to collect the same near its inner end, where it will fall readily through the opening 30.

In apparatus of the type of which my invention relates the introducing and discharging valves must not only be so constructed as to be capable of admitting and withdrawing the material without permitting any substantial amount of air to enter the vacuum-chamber, but they should also be capable of operating efficiently without requiring to be packed or lubricated with oil or similar lubricant, because the external atmospheric pressure would tend to drive such a lubricant past the bearing-surfaces and into the interior of the apparatus to the injury of the material contained therein. I have discovered that if a hard smooth surface, as of metal, and a semiyielding fibrous surface be pressed together and made to slide one upon the other the combination of such surfaces will be exceedingly efficient to prevent the passage of air between them, the fibrous surface being sufficiently flexible to enable it to adapt itself to the opposing hard surface and conform very perfectly thereto, so that what may be called a "self-packing valve" may thus be produced, which will be air-tight and effective for its purpose without requiring the use of any supplementary packing device or oil or other lubricant. That portion of my invention which relates to admission and discharge valves for a vacuum drying apparatus is based upon the above discovery, my valve being composed, generally speaking, of a plate or member which is intermediate to the vacuum-chamber and a supply-hopper and is provided with a pocket adapted to receive a limited quantity of the material, in combination with means for causing said pocket to register alternately with two openings, one leading from said bin or hopper from which the material is supplied and the other leading to the interior of the apparatus, and with means for keeping the latter opening tightly closed at all other times, the construction being such that of each pair of relatively moving adjacent surfaces one is hard and smooth and the other is semiyielding and fibrous, as above specified. For a semiyielding fibrous material I prefer to employ what is known as "diamond buffers' felt," stiffened with a suitable filling material, which is unaffected by heat and moisture, such as solution of shellac mixed with about one-fourth of its bulk of gum-arabic, as I have found that a piece of such felt impregnated with this mixture is very efficient for the purpose described, provides a surface which wears well, and is unaffected by the heat and moisture attendant upon the operation of the apparatus. My preferred form of introducing-valve is that shown in Fig. 6, in which 32 is a flat disk of stiffened felt such as above described, through the center of which the shaft 20 passes, said disk being secured to said shaft, preferably by means of packed collars 33 splined thereto, between which collars the disk is clamped. Said disk is provided with a perforation 34, forming a pocket adapted to contain a limited quantity of material, and rests upon the flat top of the plate 17, preferably within a circular flange 35, cast integral therewith, being covered by a plate 36, which carries the journal-box 21, and is provided with a perforation 37, located beneath the open lower end of a supply-hopper 38, through which the material is delivered to the apparatus. According to the construction shown in the drawings the plate 36 fits easily within the flange 35, thus serving to center the shaft 20, and is prevented from rotating by suitable means, such as a finger 39, (see Fig. 1,) secured thereto and arranged to engage a lug 40, cast on said flange 35, and an adjustable weight 41 is carried by the top of the journal-box 21 and causes the plate 36 to press the disk 32 firmly against the plate 17, thus insuring a tight sliding fit between the fibrous faces of said disk and the smooth metal faces between which it slides. The perforations 29 and 37 are non-coincident, being preferably situated on opposite sides of the shaft 20, and they and the pocket 34 are located at equal distances from said shaft, so that said pocket will register with each of the perforations alternately as the disk 32 is

rotated. As thus constructed, when the pocket 34 in the disk 32 passes under the hopper 38 enough material falls from the latter into said pocket to fill the same, and is carried therein by the rotation of the shaft 20 around to the point where said pocket registers with the opening 29, leading to the interior of the apparatus, whereupon the material thus transferred falls upon the topmost unit-section 2 and is fed from the same through the apparatus, while no air can enter through the opening 29 except such small quantity as is mingled with the material thus introduced.

The discharge-valve may be made precisely similar to the introducing-valve, as illustrated in Fig. 5, in which is shown a flat plate 42, secured to the bottom of the apparatus and provided with a flange 43, similar to the flange 35 on the top plate 17. A flat disk 44 of the stiffened felt is secured to the shaft 20 by means of packed collars 45, splined thereto, and is provided with a perforation 46, forming a pocket adapted to register alternately, as the shaft 20 rotates, with a perforation 47, formed in the plate 42, and a perforation 48, formed in a plate 49, which corresponds to the plate 36 above the introducing-valve and carries the journal-box 22, said plate 49 being pressed upward by suitable means, such as a spring 50, supported upon an adjustable block 51, which may also form a step adapted to center the lower end of the shaft 20 and carry its weight. The perforation 47 is located at the lower end of a funnel 52, leading from the surface 3 of the bottom unit-section 2, said funnel being preferably located at the inner end of the opening 19 in said unit-section and the rest of said opening 19 being filled by a solid block 53, the top edge of which is flush with the surface 3 and which is held in place by a bottom piece 54, as shown in Fig. 5. The perforation 48 delivers into a spout 55, through which the dried material is conveyed to any desired point.

The operation of the apparatus above described will be readily understood from the foregoing description and may be briefly described as follows: The interior of the body portion of the apparatus is exhausted of air through the pipe 18, and steam or other source of heat is admitted to the pipes 7 and through them to the chambers 5, whereby the surfaces 3 are kept heated to the required temperature. The shaft 20 is then set in rotation, and a constant supply of the material to be dried is furnished to the hopper 38, whereupon by the rotation of the disk 32 successive limited quantities of the material are transferred from said hopper to the opening 29, through which they fall successively upon the bottom surface 3 of the top unit-section 2, the disk 32 being secured to the shaft 20 in such a position relative to the blades 26 and 31, which coöperate with said top unit-section, that the pocket 34 will coincide with the opening 29 just after said blade 26 has passed beneath said opening, so that each quantity of material delivered through the same will fall behind said blade and in front of the distributing-blade 31, as indicated in Fig. 3. In case the material is of such a nature that it is liable to stick within the pocket 34 a thin strip of spring metal 56 may be secured in a recess formed in the under side of the plate 36 directly above the opening 29, said strip 56 being adapted to be pressed into its recess by the disk 32 at all times except when the pocket 34 is brought below it, at which times its central portion will press downward upon the mass of material held within said pocket and loosen the same so that it will fall readily through the opening 29. With each rotation of the shaft 20 the charge of material last delivered to the top unit-section 2 is spread and distributed over the surface 3 of said section in a thin and uniform layer, so that every portion of said charge is exposed to the vacuum and to the heating effect of the surface on which it rests until the corresponding scraping-blade 26 during the next succeeding rotation of the shaft gathers up said material and carries it over the edge of the opening 19, through which it falls upon the unit-section next below. Here it is again spread out into a thin layer and exposed to the heating and drying agencies until it is collected and discharged into the next compartment in a similar manner. Each charge of material delivered by the introducing-valve is thus fed from one compartment to the next and is spread out and dried therein successively until it reaches the bottom unit-section, where it is finally collected by the scraping-blade 32 and delivered thereby through the funnel 52 just as the pocket 46 in the discharging-valve is brought over the bottom of the funnel, so that it is received in said pocket and carried around to the opening 48, through which it falls into the spout 55 and is delivered therefrom in its dried condition. Thus there will occur concurrently the introduction of a charge through the introducing-valve, the delivery of previous charges through all the openings 19, and the withdrawal of a charge through the discharge-valve, the operation of the apparatus being thus made practically continuous.

It will be seen that the body portion of my apparatus forms, in effect, but a single vacuum-chamber, the walls of which are the walls of the apparatus itself, so that there is much less liability to leakage than where a number of vacuum-chambers are connected in series, and it is also one of the features of my apparatus that the several compartments in which the material is dried open separately into the central portion of said chamber instead of being arranged in series, and hence the vapor discharged from one charge of material is not caused to pass over the other charges before it is withdrawn from the apparatus, and all the charges are exposed to precisely the same conditions as regards heat and vacuum. Another feature of my pre-

ferred form of apparatus is the concentric arrangement of the valves and feeding devices, whereby they may all be secured to and operated by a single shaft, and this feature of my invention is evidently independent of the kinds of material of which the valves are constructed.

The disks 32 and 44 may each be provided with more than one pocket, if desired, such a modification of the disk 32 being shown in Fig. 7. When so constructed, a number of charges of material will be introduced into the apparatus at each rotation of the shaft 20, and in such case the distributing-blade 31 may be omitted, since it would not act upon all of said charges. All the charges, however, which are introduced during one rotation of the shaft 20 will be fed simultaneously through the topmost opening 19 and also through the succeeding similar openings. When the disks 32 and 44 are provided with a number of pockets, the funnel 52 should have a capacity sufficient to hold as much material as will be fed into it by one rotation of the shaft 20.

In Figs. 9 and 10 I have shown a modified form of valve for introducing the material to the vacuum-chamber in which the rotating disk (shown in Fig. 6) is replaced by an endless belt 57, made of the same material or faced therewith. According to this modification an inclined tube 58 is secured air-tight to the top plate 17, with its lower end located above the opening 29 and with its upper end registering with a perforation 59, formed in a plate 60, which is tightly secured to the top of said tube. The belt 57, which rests upon the plate 60, is provided with a number of perforations forming pockets 61 and is driven by suitable means, such as a cylinder 62, journaled in a bracket 63 and having on its periphery a number of projections 64, so shaped and spaced that they will enter the perforations 61 successively and carry the belt with said cylinder as it rotates, suitable means (not shown) being provided for driving it. In order to prevent said belt from being stretched, I prefer to construct it of a thin flexible strip of metal 571, with a facing of felt applied to each side thereof, as shown. On the top of the belt, above the plate 60, rests a plate 65, which is pressed against said belt by means such as a spring 66, carried within a socket 67, formed on the top of said plate. The pressure exerted by the spring 66 may be regulated by means of a screw 68, carried by a cross-piece 69, which is secured at its ends to the plate 60 and is spaced therefrom to provide for the reception of the plate 65 and belt 57 beneath it. The plate 65 is provided with a perforation 70, adapted to register with the pockets 61 successively as the belt 57 passes beneath it, and a hopper 71, adapted to hold a supply of material, is secured to the top of said plate 65 above the perforation 70. The plate 65 is preferably provided with a roller 72, adapted to bear against the belt 57 opposite the cylinder 62 and hold the same in proper engagement with the projections 64. I also prefer to bend the opposite end of the plate 60 downward, as shown at 73, to form a guide for that portion of the belt 57. The operation of this form of valve will be readily understood without further description, and it will be evident that a similar valve may be used for discharging the material from the apparatus.

In Figs. 11, 12, and 13 I have shown still another modification of my introducing-valve, according to which instead of employing a felt disk sliding between two metal plates I employ a metal disk sliding between two felt plates, the arrangement being similar in other respects to that of the valve shown in Fig. 6. In this modified form of valve a flat disk 74, of metal or similar hard and smooth material, is mounted at its center on the shaft 20 and rigidly clamped thereto by means of collars 75 or otherwise and is provided with one or more perforations 76, forming pockets for the reception of the material. A portion of the disk 74 is covered by a plate 77 of material having a fibrous surface, such as above described, and a similar plate 78 is provided below the plate 77 and on the other side of the disk 74, said plate 78 being provided with a perforation 79, communicating with the interior of the apparatus. These plates 77 and 78 may, if desired, extend entirely across or around the circumference of the disk 74; but since it suffices to make an air-tight joint for a limited distance from the perforation 79 I prefer to make said plates in the form of segments, as shown in Fig. 12, and as in this case the central part of the disk 74 will not be provided with the air-tight packing formed by the fibrous plates I prefer instead of supporting the plate 78 directly on the top 17 of the apparatus to locate it in a recess 80, formed in the flat top of a supplementary plate 81, which is supported above the top 17 by standards 82, of which one is hollow and serves as an air-tight chute to convey material from the perforation 79 to the opening 29 in the top plate 17. The shaft 20 will then be made to pass through a suitable packing-box 83 as it leaves the body portion of the apparatus, and this will also be the case when the valve shown in Figs. 9 and 10 is used. For the purpose of pressing together the adjacent surfaces of the plates 77 and 78 and the disk 74 to make an air-tight sliding fit between these parts I provide a supplementary plate 84, resting upon the plate 77 and arranged to be pressed against the latter by suitable means, such as springs 85, held within a hood 86, which is secured to the plate 81, screws 87 being preferably employed to provide for regulating the pressure exerted by the springs 85. A hopper 88 is carried by the rim of the plate 81 at any convenient point and preferably opposite to the perforation 79, the open bottom of which hopper is adapted to register with the pockets 76 as the latter are successively presented beneath it by the rotation

of the shaft 20, and the material is thereby transferred from the hopper to the vacuum-chamber in successive charges in the manner previously described.

I do not consider my invention to be limited to those forms of valves which are herein specifically described, as so far as I am aware I am the first to discover that an air-tight valve for the purpose herein set forth can be made by constructing those parts of the valve which have a sliding movement upon one another of metal and felt alternately arranged, and it will be evident that many other mechanical structures may be devised for utilizing this distinguishing feature of my valve. Furthermore, I do not limit myself to the employment of the specific fibrous material herein described, as other materials which have a sufficiently yielding and fibrous surface and are unaffected by the heat and the moisture to which they are liable to be subjected may be substituted for the felt, which is my preferred material for the purpose. For example, plates or disks of rawhide may be used in place of the felt plates or disks, or layers of canvas secured together and suitably stiffened may be employed. The body portion also of my apparatus may be modified in many ways, both in respect to its external form and also in respect to the arrangement of its internal compartments and the manner in which the material is fed from one compartment to another. It will also be evident that the body portion of my apparatus may be combined with different valves for admitting and discharging the material and that my valves may be employed with differently-constructed body portions, these main features of my invention being to a certain extent independent of each other, although they are particularly adapted and intended to be used in combination.

I claim as my invention—

1. In a vacuum drying apparatus, a unit-section adapted to form part of the body portion of the apparatus, and comprising an outer wall adapted to be fitted air-tight to the walls of similar adjacent sections and an internal portion surrounded by said walls and adapted to receive a quantity of material and expose it to the drying agencies.

2. In a vacuum drying apparatus, a unit-section adapted to form part of the body portion of the apparatus, comprising a vertical outer wall adapted to make an air-tight joint with the walls of the adjacent sections and a hollow bottom portion having its top surface horizontal and provided with an opening for the discharge of material.

3. In a vacuum drying apparatus, a unit-section adapted to form part of the body portion of the apparatus, comprising a vertical outer wall adapted to make an air-tight joint with the walls of the adjacent sections, and a circular horizontal bottom portion provided with a central opening and with a ledge surrounding said opening, and also provided with an opening for the discharge of material.

4. In a vacuum drying apparatus, a unit-section adapted to form part of the body portion of the apparatus, comprising a vertical outer wall adapted to make an air-tight joint with the walls of the adjacent sections, and a circular hollow bottom portion having its top surface horizontal, and provided with a central opening and with a ledge surrounding said opening, and also provided with an opening for the discharge of material.

5. In a vacuum drying apparatus, a closed body portion forming a vacuum-chamber and comprising a number of similar unit-sections, each having a vertical outer wall fitted air-tight to the walls of the adjacent sections and a hollow bottom portion having its top surface horizontal and provided with an opening for the discharge of material.

6. In a vacuum drying apparatus, a closed body portion forming a vacuum-chamber and comprising a number of similar unit-sections, each having a vertical outer wall fitted air-tight to the walls of the adjacent sections and a circular horizontal bottom portion provided with a central opening and with a ledge surrounding said opening, and also provided with an opening for the discharge of material.

7. In a vacuum drying apparatus, a closed body portion forming a vacuum-chamber and comprising a number of unit-sections, each having a vertical outer wall making an air-tight joint with the walls of the adjacent sections, and a hollow bottom portion having its top surface horizontal, and provided with a central opening and with a ledge surrounding said opening, and also provided with an opening for the discharge of material.

8. In a vacuum drying apparatus, a body portion comprising a number of similar unit-sections, each adapted to make an air-tight joint with the walls of the adjacent sections and provided with external ears 13, and rods 12 held between said ears and provided with nuts 14 and 15, whereby each unit-section may be independently clamped to the adjacent section.

9. In a vacuum drying apparatus, the combination with superposed unit-sections forming drying-compartments and each having a central opening, of a rotatable shaft located in said central openings, a series of collars splined to said shaft opposite the respective drying-compartments, and feeding devices carried by said collars.

10. In a vacuum drying apparatus, the combination with superposed unit-sections each having a central opening, of a rotatable shaft located in said central openings, arms carried by said shaft and extending between each pair of unit-sections on opposite sides of the shaft, feeding devices carried by one end of each of said arms, and a roller 28 mounted on the opposite end of each of said arms, substantially as described.

11. In a vacuum drying apparatus, the combination of a closed body portion forming a vacuum-chamber and containing a series of horizontal surfaces forming drying-compartments, each of said surfaces being provided with a central opening and with an opening so located as to deliver material onto the surface next below, a rotatable shaft located in said central openings and provided with means for feeding material through said drying-compartments and delivery-openings successively, and admission and discharge valves carried by said shaft at the top and bottom respectively of said body portion, each of said valves comprising two plates located one above the other and provided with non-registering perforations, and a disk secured to said shaft and located between said plates in sliding contact therewith, said disk being provided with one or more pockets adapted to register with said perforations alternately.

12. In a vacuum drying apparatus, the combination of a drying-compartment provided with a discharge-opening, a rotatable shaft centrally located in said compartment and provided with two arms extending laterally into said compartment, and a blade suspended from each of said arms, the lower edge of one of said blades being cut away between its ends, as at 27, for the purpose set forth.

13. In a vacuum drying apparatus, the combination of a drying-compartment provided with a discharge-opening, means for introducing material therein, means for distributing said material over the bottom of said compartment in a substantially uniform layer, and means for subsequently collecting said material and discharging it through said opening, said distributing and said collecting and discharging means being simultaneously active.

14. In a vacuum drying apparatus, the combination of a drying-compartment provided with a discharge-opening, a rotatable shaft centrally located in said compartment and provided with a distributing-blade and a scraping-blade arranged at an angle to each other, the scraping-blade being located ahead of the distributing-blade, and means for delivering material between said blades.

15. In a vacuum drying apparatus, the combination with a circular drying-compartment provided with a discharge-opening and with a limited opening near its center for the admission of material, of a rotatable shaft and distributing and scraping blades secured thereto, said distributing-blade being located behind the scraping-blade and curved horizontally, with its convex side presented in the direction of its movement.

16. In a vacuum drying apparatus, the combination of a circular drying-compartment provided with a limited discharge-opening near its center, means for admitting material to said compartment, means for distributing material over the bottom of said compartment, a rotatable shaft, and a curved blade secured thereto with its concave side presented in the direction of its movement.

17. In a vacuum drying apparatus, the combination of a drying-compartment provided with a discharge-opening, means for admitting material thereto, a rotatable shaft centrally journaled in said compartment, and feeding devices secured to said shaft and arranged to move over the bottom surface of the compartment, said devices being set at an angle with each other and adapted respectively to distribute and collect said material.

18. In a vacuum drying apparatus, the combination of a closed body portion forming a vacuum-chamber and composed of a number of superposed unit-sections which provide a series of horizontal surfaces forming drying-compartments, each of said surfaces being provided with a central opening vertically alined with the openings in the other surfaces, a rotatable shaft located in said alined openings and journaled in said body portion, means carried by said shaft for transferring material from one compartment to another, and valves for introducing and withdrawing said material without impairing the vacuum maintained in said body portion.

19. In a vacuum drying apparatus, the combination of a closed body forming a vacuum-chamber and comprising a series of unit-sections providing drying-compartments, each unit-section being composed of an outer wall making an air-tight joint with the walls of the adjacent sections and a horizontal hollow bottom portion provided with a central opening and with an opening for the discharge of material, the latter opening in each of said bottom portions being located a short distance ahead of the opening in the bottom portion next below it, a rotatable shaft located in said central opening, a distributing-blade and a scraping-blade located in each of said compartments and secured to said shaft, each pair of blades forming an angle with each other and having the same relative location to the pair of blades next below it that the discharge-openings in the corresponding bottom portions have, pipe connections with said hollow bottom portions, connections between the vacuum-chamber and an exhauster, and valves adapted to introduce and withdraw the material without impairing the vacuum.

20. In a vacuum drying apparatus, a valve comprising two plates located one above another and provided with non-registering perforations, a disk located between said plates in sliding contact therewith and provided with one or more pockets adapted to register with said perforations alternately, and means for rotating said disk.

21. In a vacuum drying apparatus, a valve comprising metal plates provided with non-communicating perforations, a sheet of stiffened felt located between said plates and pro-

vided with one or more pockets adapted to register with said perforations alternately, means for pressing said parts together, and means for operating said felt sheet.

22. In a vacuum drying apparatus, a valve comprising metal plates located one above another and provided with non-registering perforations, a disk of stiffened felt located between said plates in sliding contact therewith and provided with one or more pockets adapted to register with said perforations alternately, and a rotatable shaft to which said disk is secured.

23. In a vacuum drying apparatus, the combination of a body portion forming a vacuum-chamber and having perforations in its top and bottom surfaces, a shaft extending vertically through the center thereof and having disks of stiffened felt secured to it and bearing against the top and bottom surfaces of said body portion respectively, supplementary plates located above and below said disks respectively and each provided with a perforation, a collar secured to said shaft and supported on the top supplementary plate, a spring adapted to force the bottom supplementary plate upward, one or more pockets in each of said disks adapted to register alternately with the perforations in the adjacent surfaces, and means for feeding the material to be dried through said vacuum-chamber.

24. In a vacuum drying apparatus, a valve comprising two plates located one above another and provided with non-registering perforations, a rotatable shaft, a disk located between said plates in sliding contact therewith and having a splined connection with said shaft, said disk being provided with one or more pockets adapted to register with said perforations alternately, and means for pressing said plates toward each other.

25. In a vacuum drying apparatus, the combination of a body portion forming a vacuum-chamber and having passages leading through its top and bottom portions, a rotatable shaft extending through said body portion, two disks splined to said shaft and respectively located adjacent to the top and bottom of said body portion, each of said disks being provided with one or more pockets, supplementary plates located above and below said disks respectively and each provided with a perforation, means for pressing said supplementary plates toward each other, and means for feeding material through the vacuum-chamber.

26. In a vacuum drying apparatus, the combination of a body portion comprising a number of superposed unit-sections, and having passages leading through its top and bottom portions, means for clamping said sections together, a shaft centrally journaled in said body portion, two disks splined to said shaft and respectively located adjacent to the top and bottom of said body portion, each of said disks being provided with one or more perforations forming pockets, supplementary plates located above and below said disks respectively, and each provided with a perforation, means for pressing said plates toward each other, and means for feeding material through said vacuum-chamber.

In testimony whereof I have hereunto subscribed my name this 18th day of April, 1901.

WILLIAM C. PERKINS.

Witnesses:
E. D. CHADWICK,
ALMEDIA F. HICHBORN.