

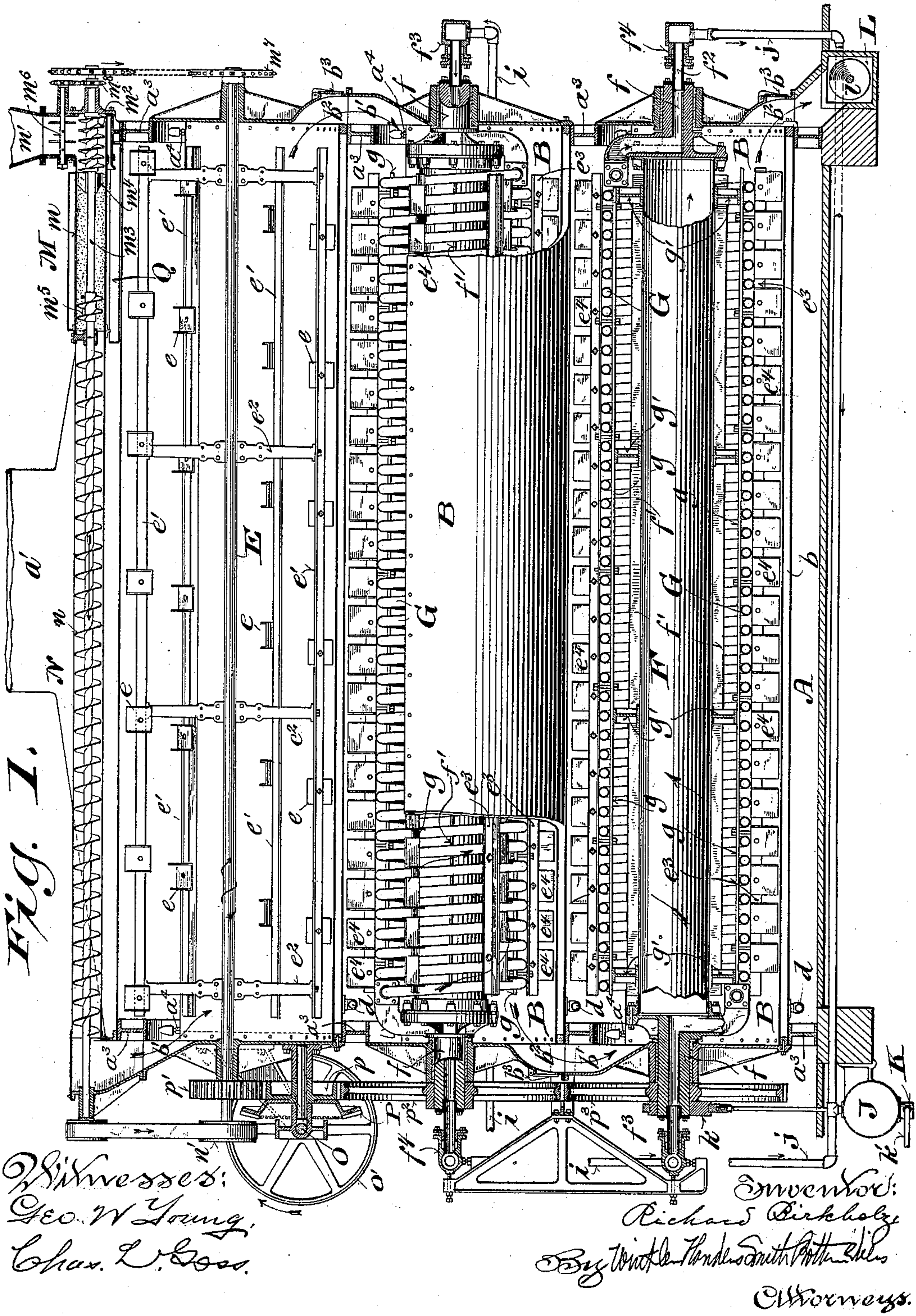
(No Model.)

4 Sheets—Sheet 1.

R. BIRKHOE.
 DRYING APPARATUS.

No. 583,021.

Patented May 25, 1897.

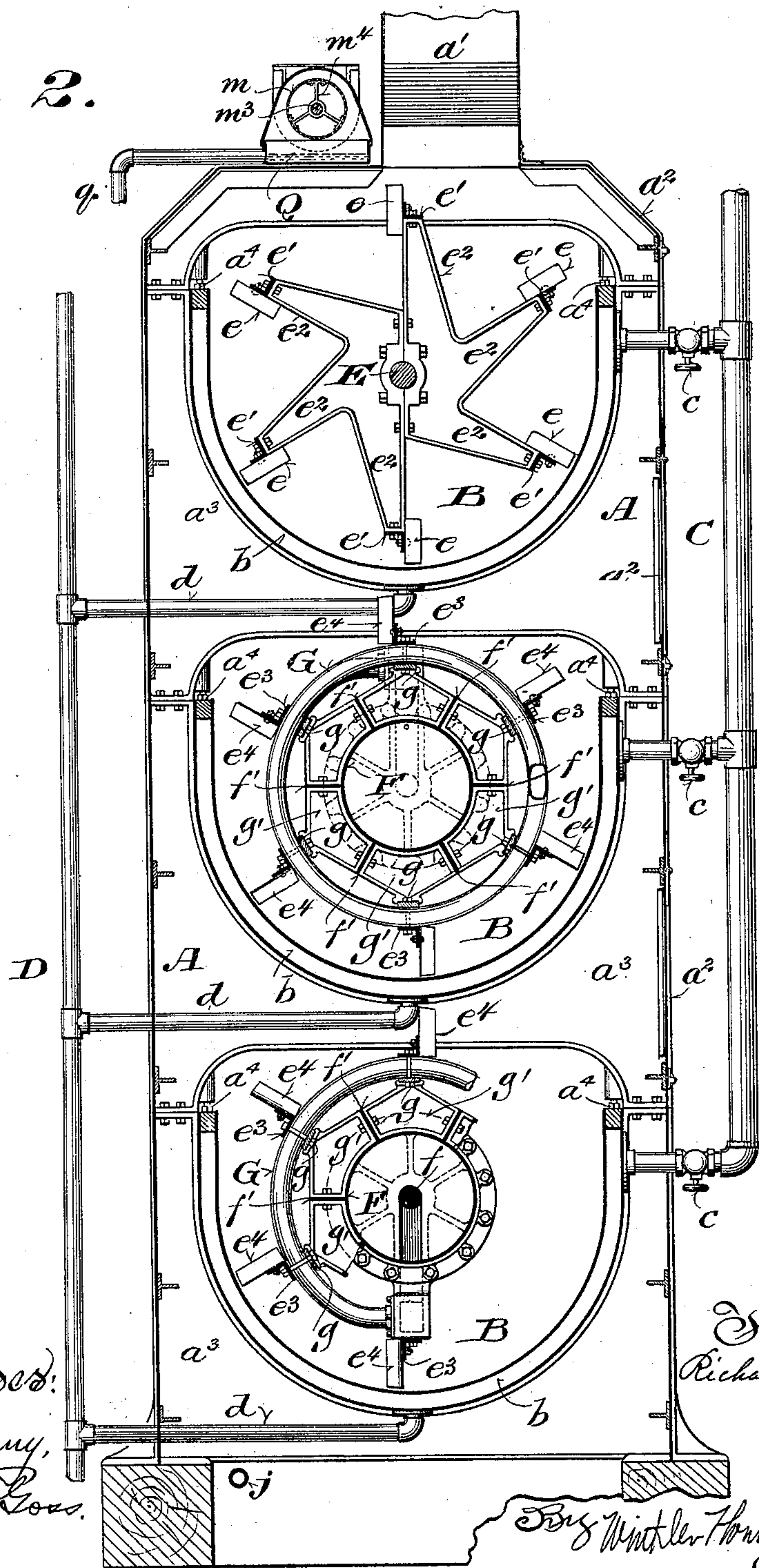


R. BIRKHOLZ.
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Patented May 25, 1897.

Fig. 2.



Witnesses:
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Richard Birkholz

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Attorneys

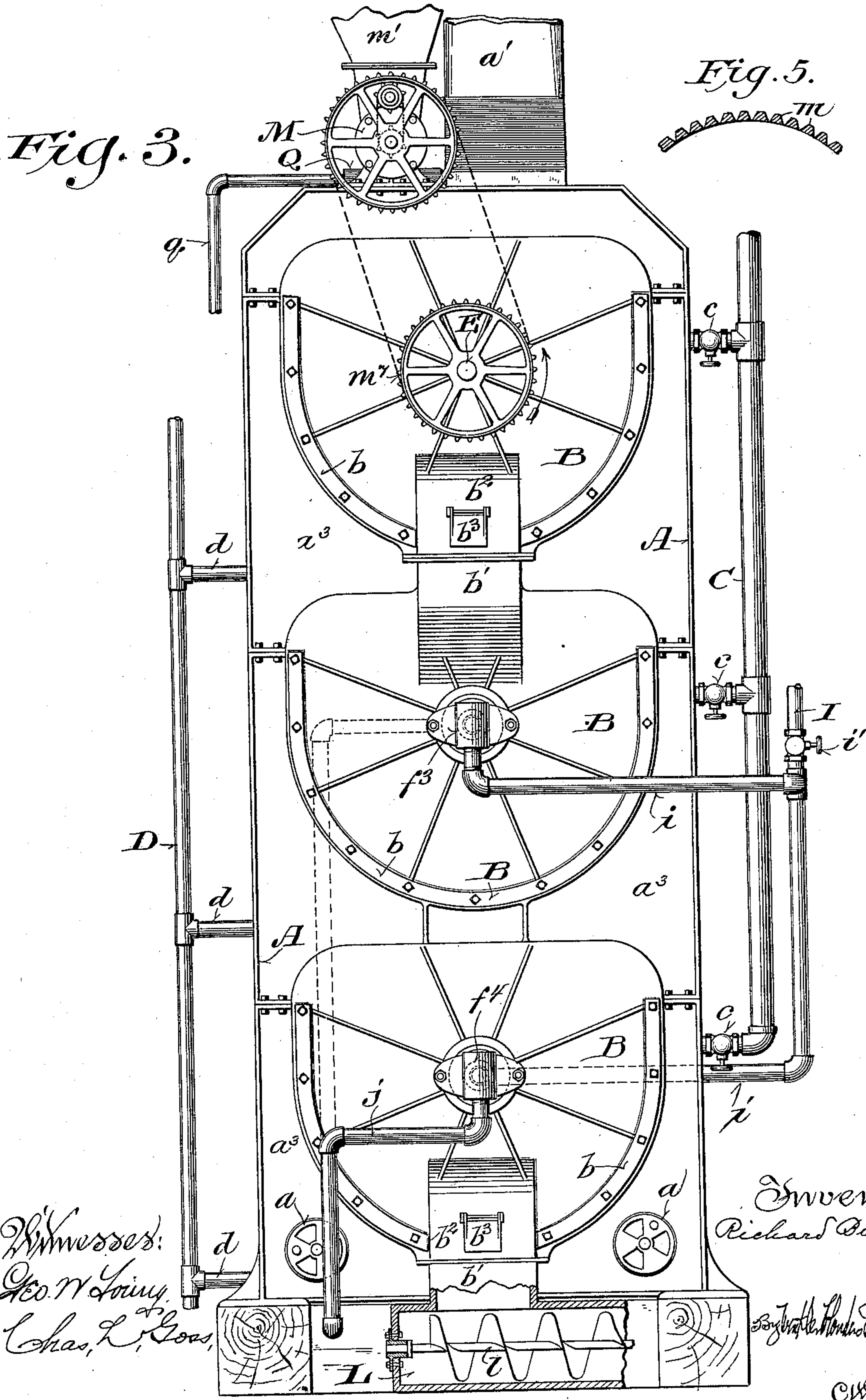
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4 Sheets—Sheet 3.

R. BIRKHOIZ.
DRYING APPARATUS.

No. 583,021.

Patented May 25, 1897.



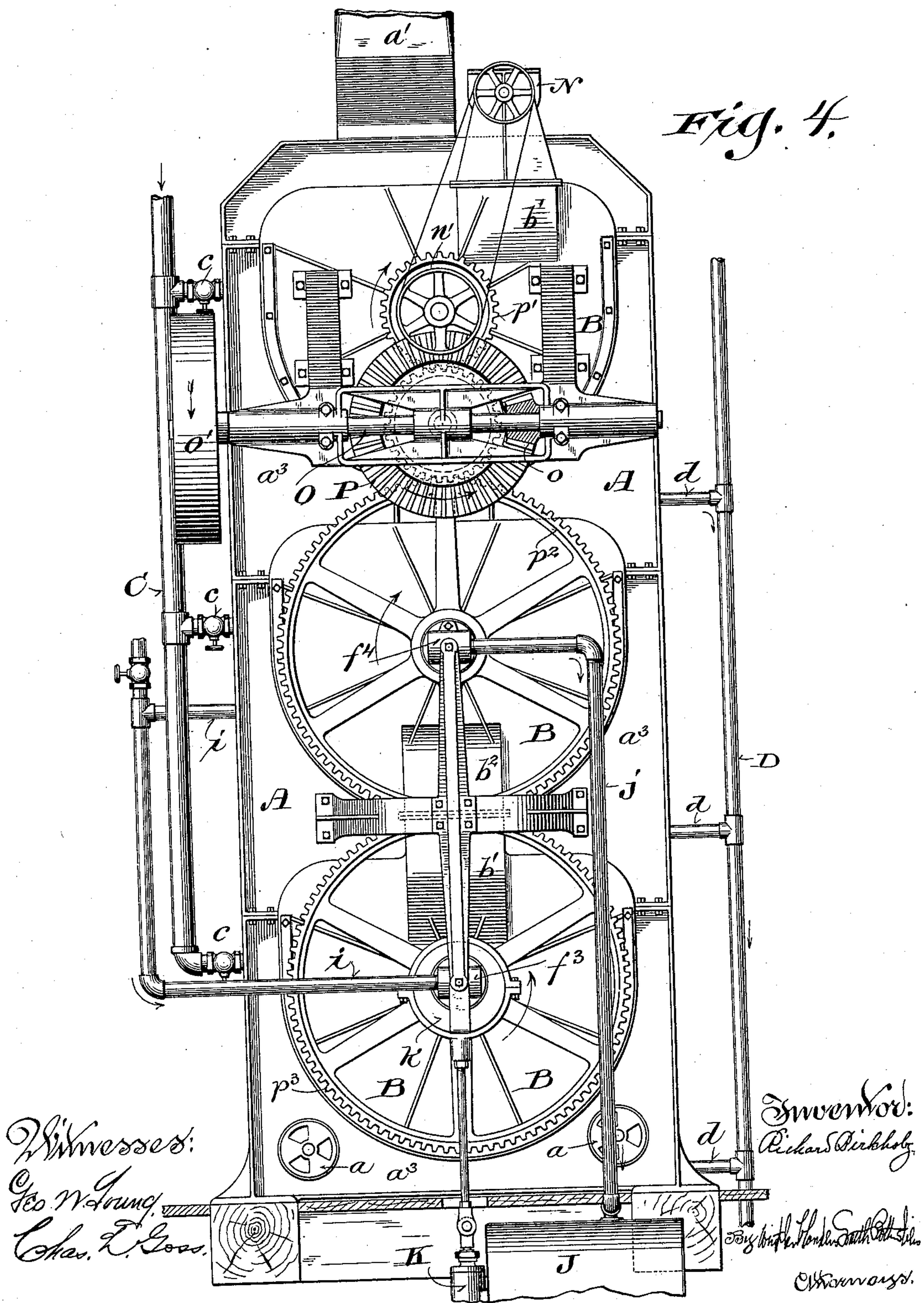
(No Model.)

4 Sheets—Sheet 4.

R. BIRKHOLZ.
DRYING APPARATUS.

No. 583,021.

Patented May 25, 1897.



UNITED STATES PATENT OFFICE.

RICHARD BIRKHOLOZ, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO PAWLING
& HARNISCHFEGER, OF SAME PLACE.

DRYING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 583,021, dated May 25, 1897.

Application filed June 24, 1895. Serial No. 553,777. (No model.)

To all whom it may concern:

Be it known that I, RICHARD BIRKHOLOZ, of Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Drying Apparatus; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it pertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

The main objects of my invention are to continuously evaporate the moisture from various materials, such as waste brewery-grains, and in the attainment of that end to dispense with a vacuum as heretofore proposed in apparatus described in United States Letters Patent No. 449,359, granted to me March 31, 1891. While such apparatus has been in successful use for a number of years, the injection-water required to maintain the vacuum is under some circumstances obtainable with difficulty or at such high cost as to render the employment of the apparatus impracticable; besides the original cost of such apparatus is considerable, and it requires constant and skilful care and attendance. By dispensing with the vacuum, which is indispensable to the successful operation of my former apparatus, I not only avoid the use of the injection-water required to maintain the vacuum, but also avoid the skilled attendance and much of the care required to keep the apparatus in working order, besides simplifying and reducing the cost of the apparatus.

My present invention consists in certain novel features in the construction and arrangement of the component parts of apparatus generally resembling that shown and described in my former patent above mentioned.

In the accompanying drawings like letters designate the same parts in the several figures.

Figure 1 is a vertical longitudinal section of my improved drier. Fig. 2 is a vertical cross-section of the same on an enlarged scale, viewed from the right with reference to Fig. 1.

Fig. 3 is an end elevation viewed from the right. Fig. 4 is an end elevation viewed from the left with reference to Fig. 1; and Fig. 5 is a cross-section, on a greatly-enlarged scale, of a portion of the perforated cylinder constituting a part of the feeding and compressing device.

A designates a casing the sides of which may be conveniently constructed of wood lined with zinc and the ends of cast-iron. It is provided near the bottom, in the ends, with air-inlet openings controlled and adjustable in area by valves or dampers *a a*, as shown in Figs. 3 and 4. A pipe or stack *a'*, opening out of the upper part thereof, serves to conduct off the vapors from the drying material and to produce an upward draft or current of air through the drier, the strength of such draft or current and the amount of air admitted to the drier being regulated by the dampers *a a*.

B B are a number of U-shaped troughs or retorts arranged horizontally one above another within said casing and open at the top in communication therewith. They are provided on the bottom and sides with jackets *b b*, which are supplied with steam or other heating medium through a pipe C and branches containing valves *c c*. A waste-pipe D is connected by branches *d d* with the bottoms of the several jackets and serves to conduct therefrom the water of condensation and with the supply-pipe C and its connections to maintain a circulation of the heating medium through said jackets.

The ends of the casing are made in sections *a³ a³*, having openings corresponding in shape with the cross-section of the troughs B B, which are seated therein at their ends and held down firmly against their seats by inverted bolts *a⁴ a⁴*, threaded in said sections and bearing at their heads against the upper edges of the troughs on both sides and at both ends, as shown in Figs. 1 and 2. The several sections *a³ a³* are flanged around their edges and the trough-openings and are joined and bolted together in horizontal planes coincident, or nearly so, with the tops of the troughs, as shown in Figs. 1, 2, and 3. The sides of troughs B are each constructed of

boiler-iron or sheet-metal plates riveted at the ends to U-shaped bars and along their upper edges to longitudinal bars, thus forming the heating-jackets *b b*, and the ends of the troughs are made of cast-iron plates bolted to the U-shaped bars in the ends of the jacket and formed with bearings for the journals or gudgeons of the stirrers. The troughs being thus constructed separately from the casing allow for their unequal expansion and contraction without subjecting the apparatus to injurious strain. Either of the several troughs or stirrers may also be removed from the casing for repairs or renewal without disturbing the others. The ends of the casing being made in sections corresponding with the several troughs admits of readily assembling any desired number of troughs one above another in a single machine and of constructing to order a machine of greater or smaller capacity, as required, without change or multiplication of patterns.

The upper trough or retort is provided with a rotary stirrer consisting of scoops or blades *e e*, formed with wings or flanges at the sides and adjustably attached to angle-bars *e' e'*, which are carried by the outer ends of arms or spiders *e²*, mounted upon a central shaft *E*, supported in bearings in the ends of said trough or retort. The scoops or blades *e e* project outwardly from their supporting-bars *e'* into close proximity with the trough, with their wings or flanges arranged radially with respect to the shaft *E*, about which they turn. They serve not only to loosen and agitate the material and prevent it from adhering to the heated walls of the trough, but also to move it slowly from end to end therein. The progressive movement of the material through the retort may be accelerated or retarded by adjusting the scoops *e e* so as to change the inclination of their wings or flanges with reference to the plane of rotation. The lower retorts or troughs are provided with hollow rotary stirrers which consist of a central hollow shaft or pipe *F*, attached at the ends to heads formed with hollow gudgeons *f f*, and a helical heating-coil *G*, surrounding said pipe from end to end and connected at the ends with said heads, through which it communicates with the hollow gudgeons *f f*. The pipe *F* communicates at one end through the head to which it is attached with the hollow gudgeon and adjacent end of the heating-coil, which is so constructed and arranged as to receive the water of condensation collecting therein and to conduct it to the opposite end of the stirrer and discharge it through the adjacent gudgeon *f*. The coil is supported on bars *g g*, connected at intervals with the pipe *F* by arms or brackets *g'*.

f' f' are radiating wings or plates arranged lengthwise of the pipe *F* with which they are in close contact at their inner edges throughout their entire length, so as to conduct the heat therefrom and communicate it to the

material with which they come in contact. They are secured and held in place between the brackets *g' g'*, as shown in Fig. 2. To the outer side of the coil *G* are secured angle-bars *e³*, parallel with its axis, and to these bars are adjustably attached outwardly-projecting scoops or blades *e⁴*, like or similar to those forming a part of the stirrer in the upper trough or retort. Both the scoops or blades *e* and *e⁴* are adjusted by loosening the nuts on the bolts by which they are secured to the angle-bars *e'* and *e³*, turning them on said bolts into the desired position, and when they are properly set tightening said nuts.

The coil *G* is formed with close turns, so as to present a large heating-surface, and it is made continuous from end to end without couplings or joints which are liable to become loose and leak. It also allows for expansion and contraction due to the great variations of temperature to which it is subjected without strain upon its supporting connections at the ends. It serves not only to heat the material with which it comes in contact, but also to advance it through the trough or retort from end to end. The scoops or blades *e⁴*, which project outwardly from said coil into close proximity with the walls of the trough or retort, carry the material upward from the lower part thereof and pitch it forward over and through the upper part of the coil *G* and upon the upper part of the pipe *F*, upon which it is retained by the wings *f'*. The scoops, which are formed on one or both sides with wings or flanges, may be adjusted so as to retard the progressive movement of the material produced by the helical coil *G*, more or less, as desired. The trunnions *f f* of the stirrers are provided with graphite bearings, which require no oil and are not affected by heat. They have tubular extensions *f² f²* at their outer ends, projecting through stuffing-boxes into hollow heads *f³* and *f⁴*. The heads *f³* are connected by branch pipes *i i* with a steam-supply pipe *I*, provided with a valve *i'*, and the heads *f⁴* are connected by pipes *j j* with a well or reservoir *J*, located below them. The coils *G* of the stirrers are constructed and arranged to take up the water of condensation collecting in the pipe *F* and its connections at the end of each stirrer adjacent to its steam-inlet connection and to discharge it through the hollow trunnion at the opposite end of the stirrer, from which it is conducted off through the outlet connections into the reservoir *J*. A force-pump *K*, (shown in Fig. 4,) driven by an eccentric *k* on one of the trunnions of the lower stirrer, takes the hot condensed steam from said reservoir *J* and forces it through a pipe *k'* (shown in Fig. 1) back into the boiler, from which steam is supplied to the drier. By thus connecting the pump the removal of the water of condensation from the heating-spaces of the drier and its return in a heated

condition to the boiler to be reëvaporated are insured while the machine is in operation.

Each trough or retort B is formed at the upper side of one end with an inlet-spout b' and at the lower side of the opposite end with an outlet-spout b^2 , the outlet-spout b^2 of each upper trough or retort being connected with the inlet-spout b' of the trough or retort next below it and constituting therewith a passage between the two retorts. The several discharge-spouts b^2 are formed in their outer sides with openings provided with gravitating doors b^3 , by means of which the condition of the material passing through them may be readily observed. The discharge-spout of the lower trough opens into a closed conduit or box L, provided with a screw conveyer l , as shown in Figs. 1 and 3, for removing the dried material as it is discharged from said trough. The casing A is provided with doors or removable sections a^2 adjacent to the upper open sides of the troughs or retorts B, thus affording easy access thereto for the purpose of making repairs, adjusting the scoops on the stirrers, observing the operation of the machine, &c.

M designates the feeding and compressing device for squeezing free or surplus water from the material to be dried and delivering it into the upper trough or retort. It consists of a hollow perforated cylinder m , open at one end and having a lateral opening at the opposite end through one side, with which the feeding hopper or spout m' communicates, a compressing-screw m^2 opposite the feed-hopper on a shaft m^3 passing axially through said cylinder, and at the delivery end of said screw a spider or one or more wings m^4 , projecting radially from said shaft to said cylinder and serving to prevent the material acted upon by said screw from partaking of its rotary movement.

m^5 is a screw of greater pitch than the screw m^2 , mounted upon and adjustable lengthwise of the shaft m^3 within the cylinder m between its open discharging end and the delivery end of the compressing-screw m^2 .

N is a conveyer trough or conduit constituting a continuation of the cylinder m , extending from its delivery end to the inlet-spout b' of the upper trough or retort B. It is provided with a screw conveyer n , arranged to agitate the material and move it forward from the compressor into the machine. The compressing and feeding device, including said conveyer, are placed lengthwise over the upper trough or retort, and the material to be dried is thus subjected to considerable heat before it enters the upper trough.

m^6 is an agitator consisting of a rotary shaft passing transversely through the throat of the feed hopper or spout m' and provided with radiating arms, by which any lumps in the material are broken up, and the clogging of the feed hopper or spout is prevented.

The perforations in the cylinder m are pref-

erably made of increasing size toward the outside, as shown in Fig. 5, so as to prevent their becoming clogged.

By moving the screw m^5 toward the screw m^2 the material will be removed faster from the cylinder, and less pressing action will be exerted thereon by the screw m^2 . By increasing the distance between the screw m^2 and the perforated cylinder a space is afforded for the accumulation of the material, which itself acts as a filter and admits of the use of larger perforations in the cylinder m .

The feeding and compressing device and the stirrers may be driven by various forms and arrangements of mechanism. I have shown as convenient and suitable for the purpose a cross-shaft O, provided with a bevel-pinion o , and a pulley o' for connection by a belt with any convenient source of power. The pinion o meshes with a bevel-gear P, formed with or attached to a gear p and mounted to turn upon a stud projecting from one end of the machine parallel with the axes of the stirrers. The gear p meshes on the upper side with a similar gear p' , mounted upon the shaft E of the upper stirrer, and on the lower side with a gear p^2 , mounted upon the trunnion of the stirrer in the trough or retort next below. The gear p^2 meshes directly with a similar gear p^3 , mounted on the projecting trunnion of the stirrer next below, and if there are more stirrers they are driven in like manner.

The screw n of conveyer N is driven by a belt from a pulley n' on the shaft E of the upper stirrer, and the screw m^2 of the feeding and compressing device is driven by a chain belt from a sprocket-wheel m^7 on the opposite end of said shaft E.

The agitator m^6 is driven by a chain belt from a sprocket-wheel m^8 on the shaft of screw m^2 .

Below the perforated cylinder m I provide a trough or pan Q, having a waste-pipe connection q for catching and conducting off the water squeezed from the wet material through the perforations in said cylinder.

My improved machine operates as follows: The wet material to be dried is fed through the hopper or spout m' at the top of the machine into the perforated cylinder m , any lumps contained therein being disintegrated by the agitator m^6 . The screw m^2 , engaging the material fed into said cylinder, compresses it against the perforated walls of the cylinder, squeezing the free or surplus water therefrom through the perforations in said cylinder into the trough or pan Q, from which it is conducted off through the waste-pipe q . In passing from the delivery end of said screw between the stationary wings of the spider m^4 the material is prevented from participating in the rotary movement of the compressing-screw m^2 and is, according to the position of the relieving-screw m^5 , more or less compacted and further freed from water in

the perforated cylinder beyond the delivery end of the screw m^2 . The screw m^5 , being of greater pitch than the screw m^2 engaging with the compacted material, advances it more rapidly and consequently loosens it up and delivers it to the conveyer N, where it is engaged by the screw n and moved forward into the opposite end of the trough B. In its passage over the upper trough it is subjected to considerable heat and its temperature raised, so that when it enters the upper trough it is in condition to more readily and quickly give off the moisture which it contains. Upon entering the upper trough it comes in contact with its heated walls and is constantly stirred and progressively moved from inlet to outlet by the scoops e of the upper stirrer. Brewery-waste containing in solution considerable quantities of saccharine matter during evaporation passes through a viscous or sticky stage, in which it tends to adhere tenaciously to heated surfaces. As the material is intended to pass through this stage in the upper trough I prefer not to heat the upper stirrer, and thus avoid the material sticking thereto. The scoops e , working in close proximity with the walls of the trough, prevent the material from adhering thereto and accumulating thereon. Both before and after the sticky stage is reached and passed no trouble is experienced with its sticking to heated surfaces, so that highly-heated stirrers may be used in the lower troughs or retorts to advantage. The material passing from the upper trough into the one next below it is carried upwardly in contact with its heated walls by the scoops e^1 , which, as they pass over the top of the stirrer, thrust the material forward over and between the turns of the upper portion of the heating-coil G. That portion of the material falling through the coil is caught by the wings f^1 and retained thereby in contact with themselves and the heated surface of pipe F during the upper part of its revolution. The turns of the coil are in close proximity with each other and thus permit only a portion of the material to fall between them, the rest being pitched forward over the heated surfaces of the coil, which forms, in effect, a cylinder having a helical slot through its periphery. The helical shape of the coil which dips into the material contained in the trough tends to move it forward from the inlet to the outlet end, while the wings of the scoops may be set to retard such progressive movement more or less, as desired, according to the nature and condition of the material.

During the operation of the machine while the hollow stirrers are constantly turned the water formed by the condensation of steam in the pipes F and coils G and their connections is taken up at one end of the coils, conducted through them to the opposite ends, where it is discharged through the adjacent hollow trunnions f and the hollow heads f^1

f^1 into the pipes j , by which it is conducted into the reservoir J, whence it is forced by pump K back into the boiler.

The machine may be provided with any number of troughs or retorts furnished with more or less plain or solid and hollow steam-heated stirrers, according to the nature of the material to be operated upon and the amount of work to be done.

The doors d^3 not only serve for inspecting the material, but also afford relief and prevent injury to the machine by opening and allowing the material to escape in case the connections between the retorts below them become choked or clogged.

Various changes in minor details of construction and arrangement may be made within the spirit and intended scope of my invention.

I claim—

1. In drying apparatus the combination of a casing having air inlet and outlet at or near the bottom and top respectively, a number of steam-jacketed troughs open at the top in communication with the interior of said casing and arranged one above another, a feeding device and conveyer extending over the upper trough from end to end and means of progressively moving the material to be dried through the several troughs, substantially as and for the purposes set forth.

2. In drying apparatus a trough or retort provided with a rotary helical heating-coil having its turns in close proximity with each other and scoops or blades projecting outside of said coil close to the walls of the trough or retort and adapted in their ascent to scoop up the material to be dried and pitch it forward over the outer surface of the coil, substantially as and for the purposes set forth.

3. In drying apparatus a trough or retort provided with a rotary helical heating-coil and scoops or blades having radially-disposed wings or flanges and adjustably connected with said coil so as to admit of varying the inclination of their wings or flanges to the plane of rotation, whereby the progressive movement of the material produced by said coil may be retarded more or less as desired, substantially as and for the purposes set forth.

4. The combination with a jacketed trough or retort of a rotary stirrer comprising a hollow shaft supported at the ends by hollow trunnions in the ends of the retort and provided with heat-conducting radiating wings or plates arranged lengthwise thereof and in contact therewith, a helical heating-coil surrounding said hollow shaft and its wings and connected at the ends with said trunnions, and scoops or blades projecting outside of said coil, substantially as and for the purposes set forth.

5. The combination with a trough or retort of a rotary stirrer comprising a hollow shaft or pipe provided with radially-disposed wings or plates arranged lengthwise thereof and

with hollow trunnions bearing in and projecting through the ends of the retort, a helical heating-coil surrounding said hollow shaft and its wings connected at the ends with said trunnions and communicating at one end with
 5 said pipe so as to receive and remove the water of condensation therefrom, scoops or blades having wings or flanges and adjust-
 10 ably attached to said stirrer outside of said coil so as to admit of varying the inclination of their wings or flanges to the plane of rotation of the stirrer and thus retard the
 15 progressive movement of the material more or less as desired, substantially as and for the purposes set forth.

6. In drying apparatus, the combination with a trough or retort of a rotary stirrer comprising a hollow shaft or pipe provided with hollow trunnions which have bearings in and
 20 project through the ends of said trough and having radially-disposed wings or plates arranged lengthwise thereof and in contact therewith, and scoops or blades constructed
 25 and arranged to lift the material from the bottom of the trough and pitch it over and upon the upper side of said pipe and its wings, substantially as and for the purposes set forth.

7. In drying apparatus a feeding device comprising a hollow perforated cylinder having feed and discharge openings at or near
 30 opposite ends, a screw conveyer placed therein adjacent to the feed-opening, and one or more radially-disposed wings located near the discharging end of said conveyer and arranged
 35 to prevent the rotation of the material acted upon by said conveyer, substantially as and for the purposes set forth.

8. In drying apparatus a feeding device and press for removing surplus water from the material to be dried, comprising a hollow perforated cylinder open at one end, a feed hop-
 40 per or spout opening into the side of said cylinder at or near its opposite end, a screw conveyer supported axially within said cylinder adjacent to the feed-opening, one or more stationary radiating wings placed in said cylinder
 45 at or near the discharge end of said conveyer, a screw conveyer of greater pitch located within said perforated cylinder between its discharging end and said radiating wing,
 50 substantially as and for the purposes set forth.

9. In drying apparatus a feeding device comprising a hollow perforated cylinder open at one end, a feed hopper or spout opening
 55 into the side of said cylinder at or near its opposite end, a compressing screw conveyer supported axially within said cylinder, a radiating wing or spider placed in said cylinder at or near the discharge end of said conveyer, a
 60 relieving screw conveyer of greater pitch mounted upon a shaft extending axially through said cylinder and adjustable lengthwise thereon between its discharging end and said compressing conveyer, substantially as
 65 and for the purposes set forth.

10. In drying apparatus a feeding and automatic compressing device for removing surplus water from the material to be dried, comprising a horizontally-disposed perforated
 70 cylinder open at its discharging end, a feed hopper or spout opening into the upper side of said cylinder, an agitator placed in the throat of said spout or hopper, a compressing screw conveyer mounted axially in said cylinder, a stationary spider or wing placed with-
 75 in said cylinder at or near the discharge end of said conveyer, a relieving conveyer of greater pitch mounted upon a shaft extending axially through said cylinder and adjustable lengthwise thereon, and a trough or basin
 80 placed below said cylinder and provided with a waste connection, substantially as and for the purposes set forth.

11. In drying apparatus the combination with one or more retorts, each provided with
 85 a stirrer, of a feeding and compressing device for removing surplus water from the material to be dried, comprising a horizontally-disposed perforated cylinder open at one end and provided at or near the opposite end with
 90 a feed hopper or spout opening into the upper side thereof, a rotary shaft extending axially through said cylinder, a compressing-screw mounted upon said shaft opposite or adjacent to the feed-opening into said cylinder,
 95 a retarding spider or wing placed in said cylinder at or near the discharge end of said screw, a relieving-screw of greater pitch adjustably mounted upon said shaft between said spider and the discharge end of said cylinder, and a conveyer extending from the discharge end of said cylinder over said retort to the inlet at its opposite end, substantially as and for the purposes set forth.

12. In drying apparatus, a feeding and automatic compressing device for removing water from the material to be dried, comprising
 105 a hollow perforated cylinder, a compressing-screw arranged axially within said cylinder, a feed hopper or spout opening into said cylinder and means for regulating the discharge of material from said cylinder and thereby
 110 subjecting it to greater or less compression by said screw as desired, substantially as and for the purposes set forth.

13. In drying apparatus the combination of a number of jacketed troughs or retorts provided with stirrers, a casing inclosing said
 120 troughs or retorts on the sides and formed in the ends with openings in which the ends of the troughs are fitted and seated, and end plates attached to and closing the ends of said troughs independently of the casing, whereby endwise expansion and contraction of the troughs is permitted without injurious
 125 strain on the apparatus, and the removal of any trough or stirrer from the casing is facilitated, substantially as and for the purposes set forth.

14. In drying apparatus, the combination 130

of a number of jacketed troughs or retorts,
a casing formed in the ends with openings in
which the ends of the troughs are fitted and
seated, screws threaded in the ends of the
5 casing and bearing downwardly against the
upper edges of the troughs which are thereby
held snugly against the bottoms of said open-
ings, and end plates attached to and closing
the exposed ends of said troughs independ-

ently of said casing, substantially as and for 10
the purposes set forth.

In testimony that I claim the foregoing as
my own I affix my signature in presence of
two witnesses.

RICHARD BIRKHOLZ.

Witnesses:

CHAS. L. GOSS,
D. A. KELLEY.