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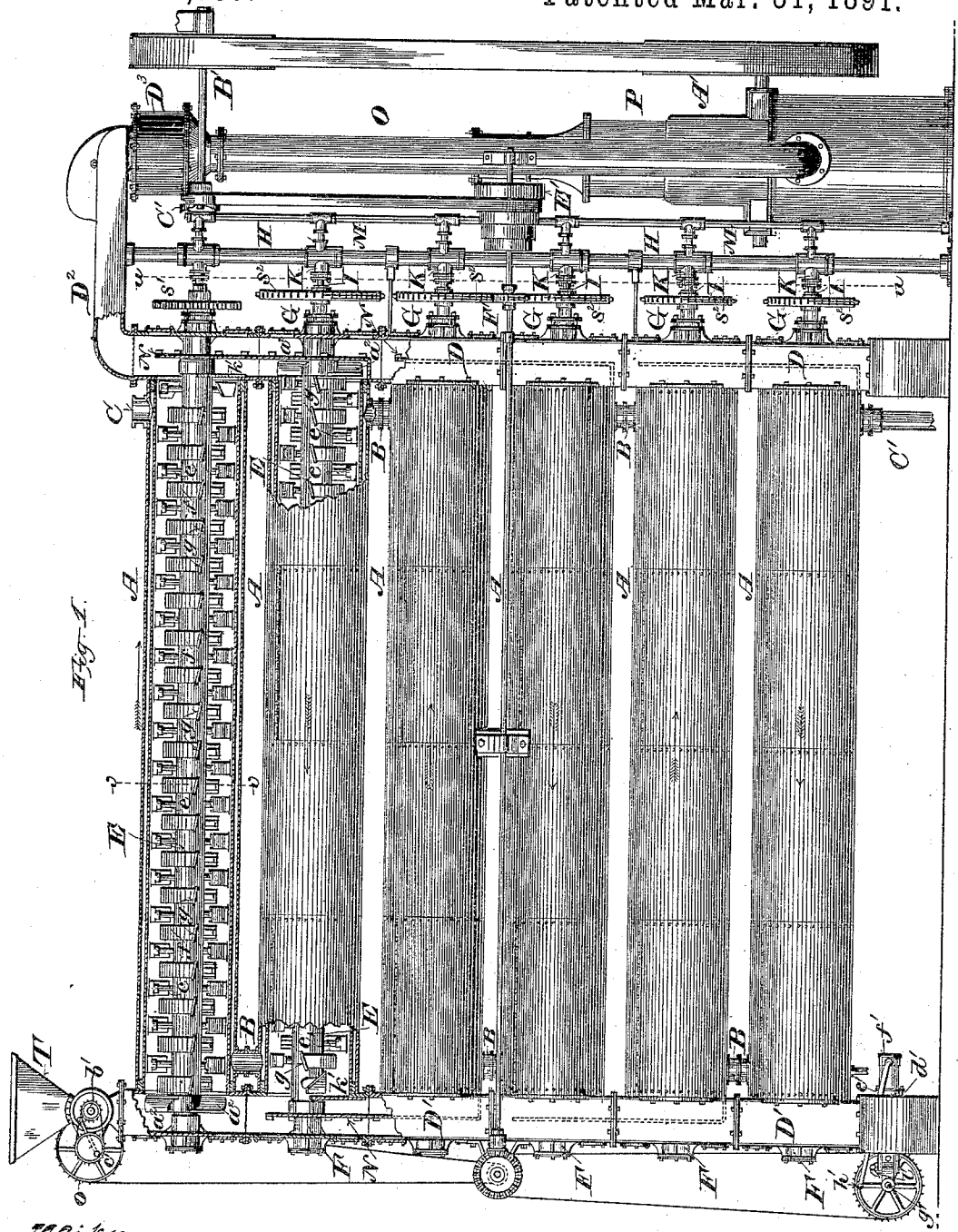
R. BIRKHOLZ.

DESICCATING APPARATUS.

No. 449,359. Patented Mar. 31, 1891.



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DESICCATING APPARATUS.

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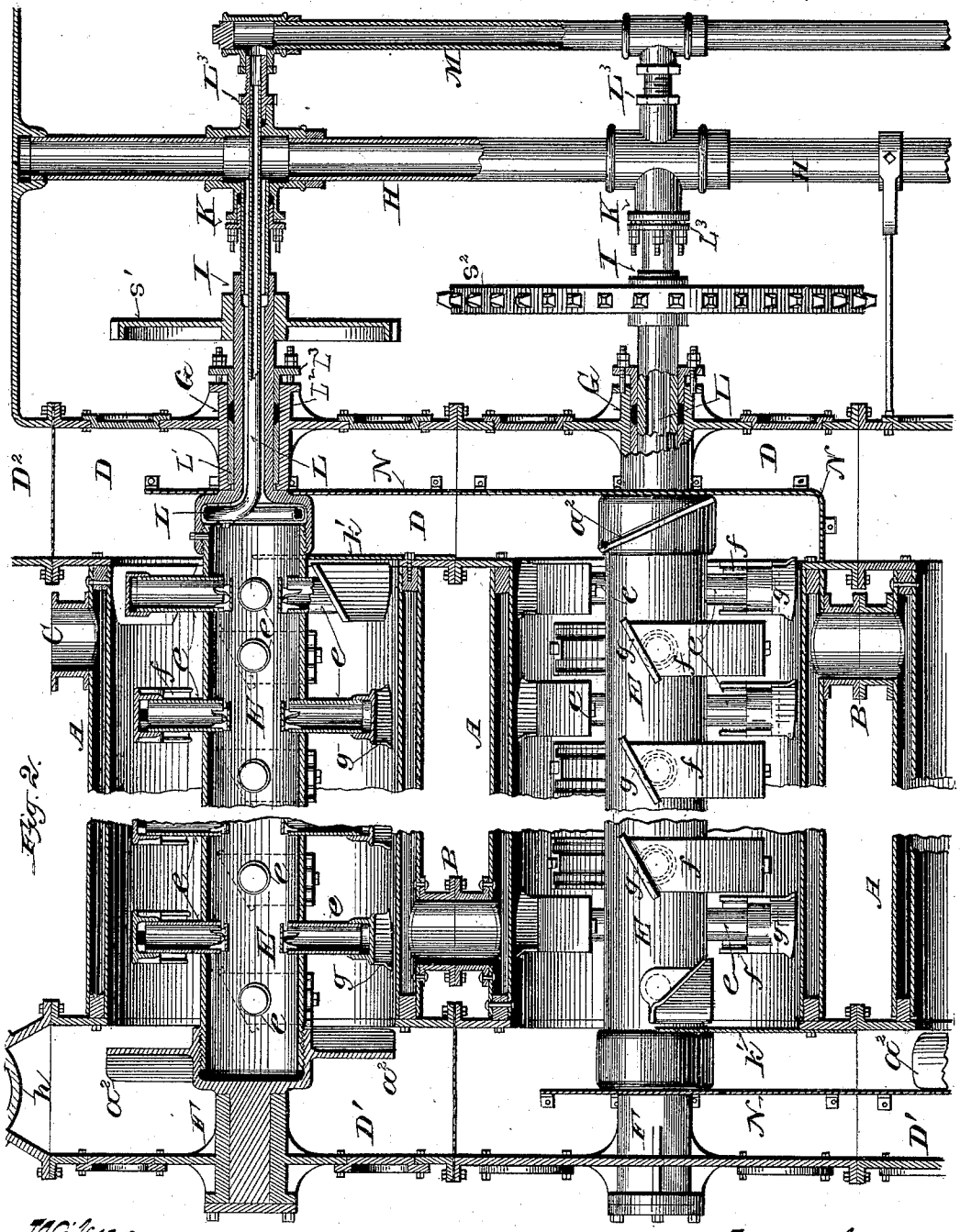

Fig. 2.

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(No Model.) 5 Sheets—Sheet 3.

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DESICCATING APPARATUS.

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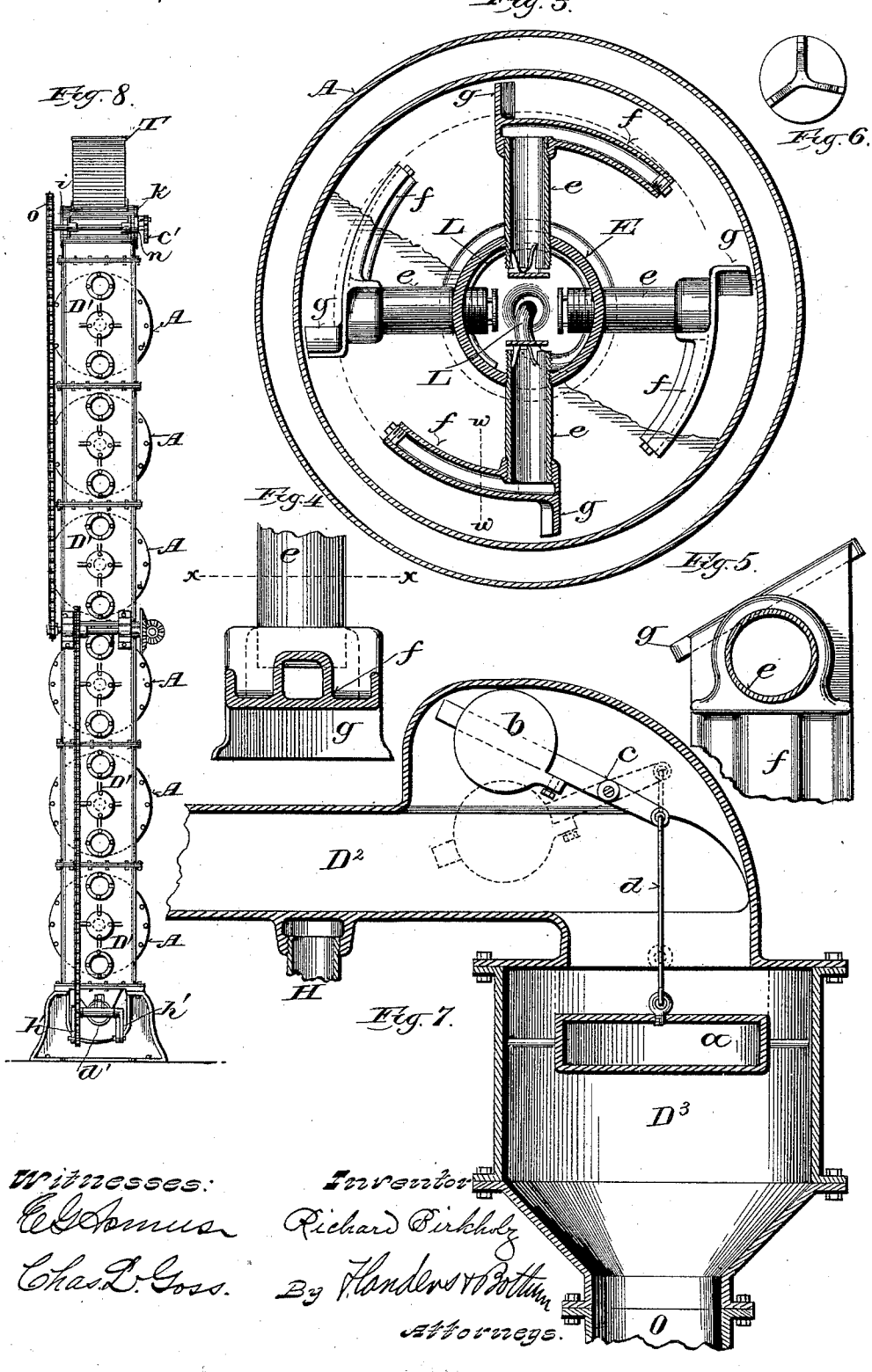

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(No Model.) 5 Sheets—Sheet 4.

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DESICCATING APPARATUS.

No. 449,359. Patented Mar. 31, 1891.

Fig. 9.

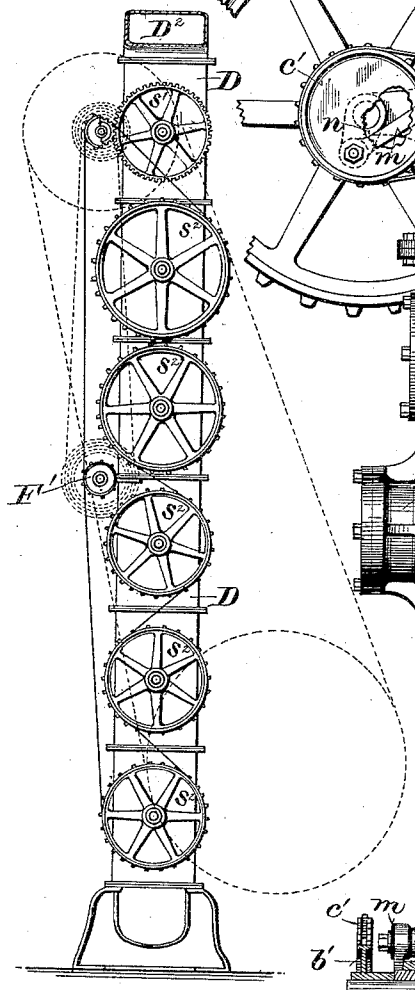


Fig. 10.

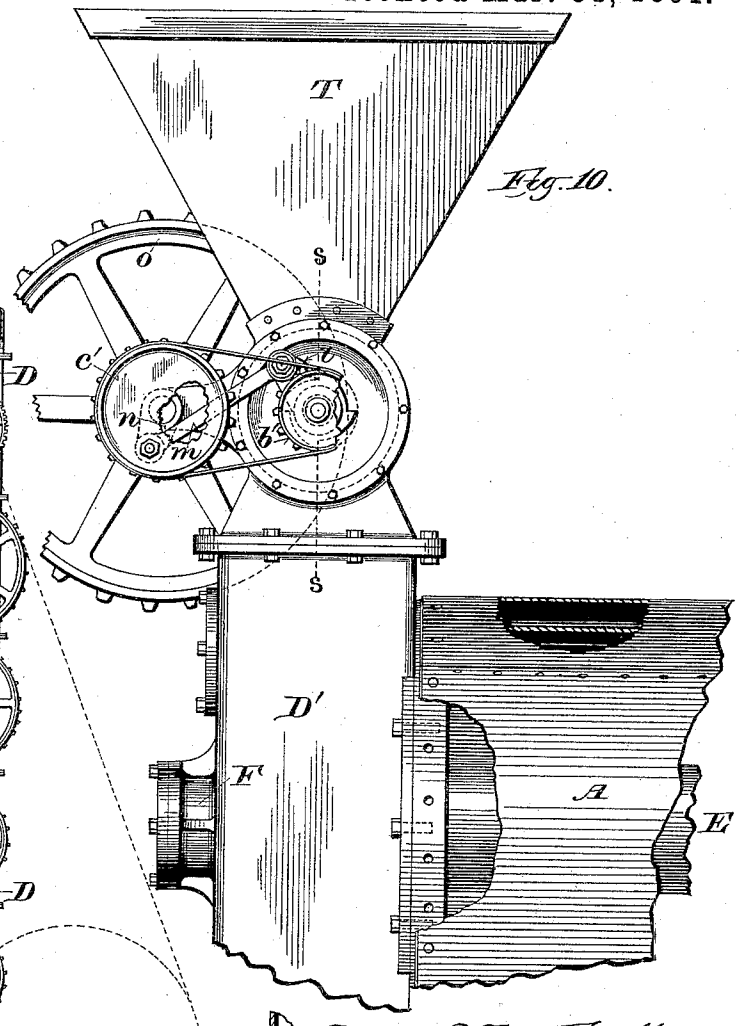
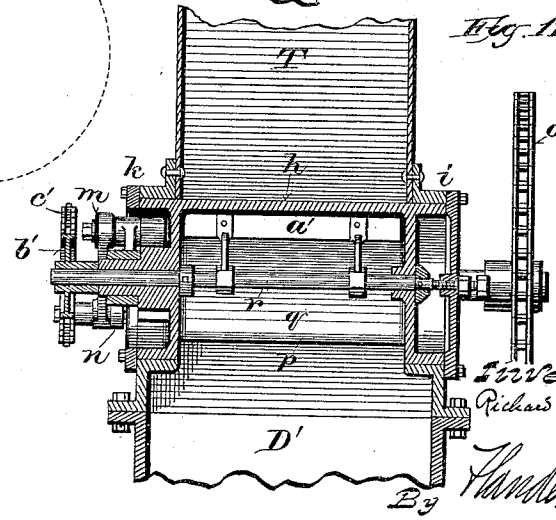


Fig. 11.



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(No Model.) 5 Sheets—Sheet 5.

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DESICCATING APPARATUS.

No. 449,359. Patented Mar. 31, 1891.

Fig. 12.

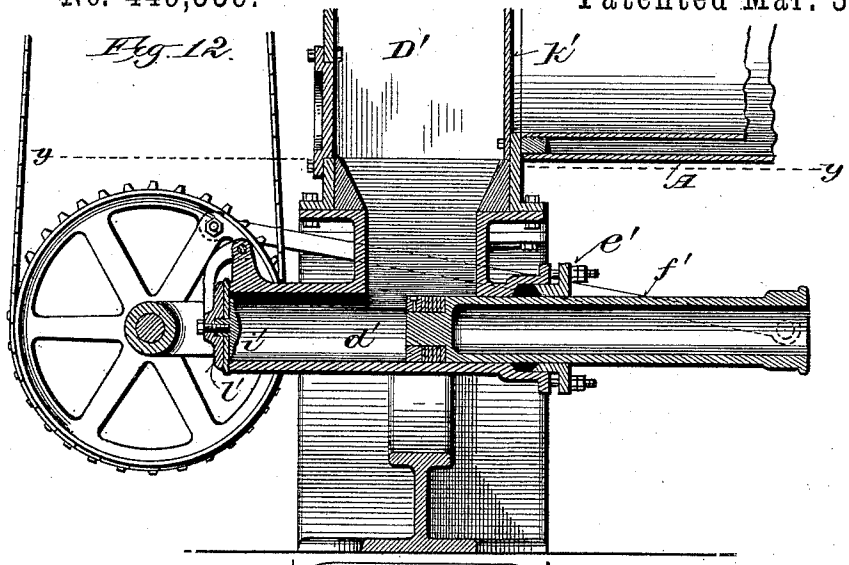


Fig. 13.

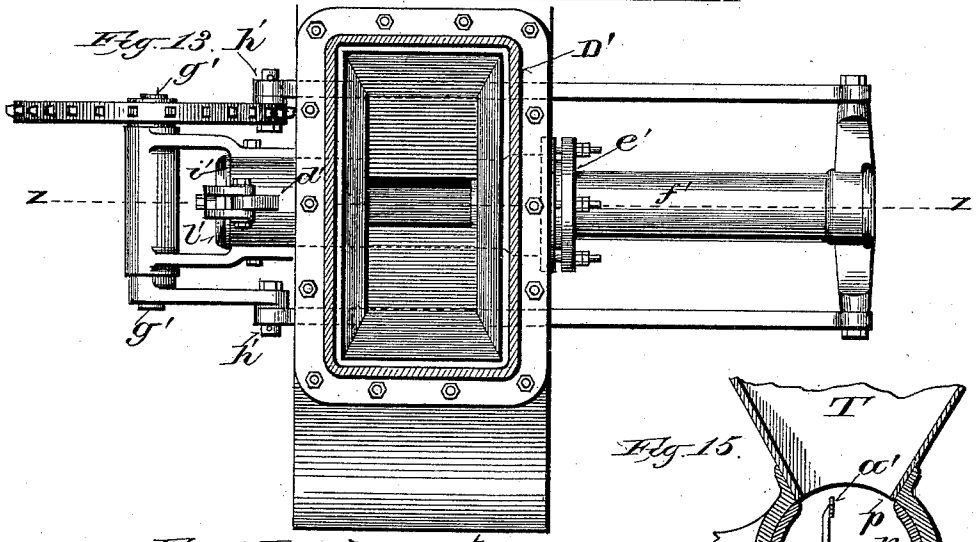


Fig. 15.

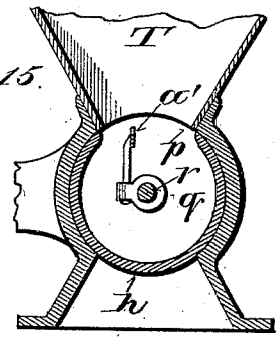
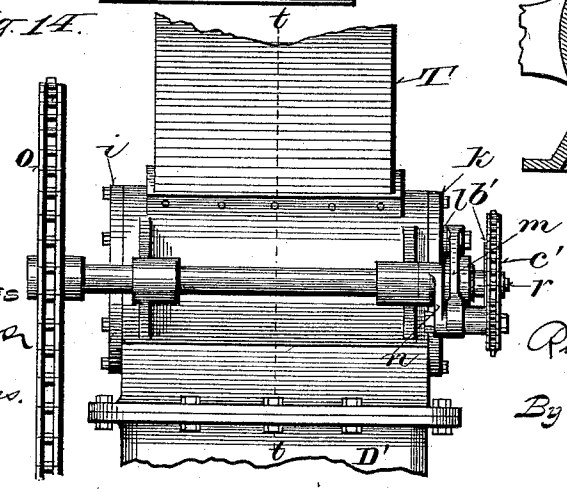


Fig. 14.



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UNITED STATES PATENT OFFICE.

RICHARD BIRKHOLZ, OF MILWAUKEE, WISCONSIN.

DESICCATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 449,359, dated March 31, 1891.

Application filed April 5, 1888. Serial No. 269,773. (No model.)

To all whom it may concern:

Be it known that I, RICHARD BIRKHOLZ, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Vacuum Drying Apparatus, of which the following is a full, clear, and exact description.

My invention relates to an apparatus which, although applicable for treating other materials, is more especially designed for treating the waste or spent grains from breweries and distilleries, and for subjecting these grains to the very peculiar and careful treatment which is required in order to completely deprive them of moisture without destroying their nutritious quality. These grains are delivered in a pasty or semi-fluid mass, of which about ninety per centum is water and the remainder a highly-nutritious material very valuable as food for domestic cattle, provided it is used immediately in its moist condition or thoroughly dried in such manner as to avoid on the one hand inducing fermentation or on the other hand heating it so highly as to chemically change the protides and render them unassimilable in the stomach.

Many attempts have been made to practically carry out this drying operation, and apparatus to this end has been constructed both in Europe and America in many forms; but up to the present time all such attempts have resulted in failure, and at the present day thousands of tons of these valuable grains are weekly dumped into the rivers and lakes, spread upon waste lands, and otherwise disposed of as waste material. To secure the successful drying of this particular material on a large scale and within reasonable limits as to cost, the apparatus must have the capacity of evaporating water rapidly and in enormous quantities, the operation must be continuous and mainly mechanical to reduce the cost of attendance to the minimum, and the temperature to which the material is subjected must be kept within narrow limits. The establishment and maintenance of the proper temperature and the subjection of all portions of the great mass of material constantly to this uniform temperature are the problems to the solution of which my invention is particularly directed. If the temperature is too low, the evaporation of the fluids will progress slowly, the capacity of the apparatus will be small, and fermentation in the mass will be frequently incited. On the other hand, any temperatures above 160° Fahrenheit so affects the material, particularly as regards the protides therein, as to render it indigestible and worthless as an article of food, its condition becoming akin to that in the so-called "glass malt," familiar to persons skilled in this art. To meet all the required conditions, it is necessary that the material shall be subjected from the beginning to the end of the operation to a high vacuum, equivalent to sixteen to twenty-six inches of mercury, to the end that the evaporating temperature may be kept sufficiently low, that while this high vacuum is maintained the material shall be thoroughly agitated and each granule or particle brought into direct contact with a heating-surface, that the great quantities of vapor and fluid developed shall be rapidly and steadily removed, and, above all, that the operations of feeding the wet material into and the dry product out of the apparatus shall be carried on steadily and continuously without material variation in the temperature and without destroying or impairing the vacuum in the retort and without admitting air to any part of the apparatus from which it must be again exhausted. It is to be particularly noted that my feed and discharge mechanisms, which for convenience of reference I term "feed" and "discharge" valves, are not mere stop-valves or closing devices, but mechanisms which communicate alternately with the interior and exterior of the retort without at any time opening direct communication between the retort and the external atmosphere. To meet these requirements, I employ a substantially horizontal closed retort, or a series of such retorts discharging one into another, in connection with an exhausting apparatus to maintain a vacuum, external heating-jackets, internal rotary hollow agitators, which serve, also, as heaters, and feed and discharge valves of such character that being operated continuously they gradually introduce and remove the material at opposite ends of the system without permitting the ingress of air.

I am aware that it is old to heat retorts by

steam-jackets, to provide retorts with hollow agitators and conveyers serving also as heaters, and to combine retorts with fans and other apparatus to produce an intermitting vacuum therein; but I believe myself to be the first to produce an apparatus in which granular or solid materials can be subjected to a low temperature and a high vacuum by an unceasing operation.

In the accompanying drawings I have represented my apparatus in its preferred form; but it will be manifest to the skilled artisan after reading this specification that the details may be modified in various respects without departing from the substance of the invention.

Figure 1 is a side elevation of my complete apparatus with portions of the upper two retorts and their connections shown in vertical section. Fig. 2 is a vertical axial section through two of the retorts and adjacent parts, the central portions of the retort being elided that the parts may be shown on a larger scale. Fig. 3 is a transverse vertical section through one of the retorts and its agitator on the line *v v* of Fig. 1. Fig. 4 is a cross-section of one of the agitator-arms on line *w w* of Fig. 3. Fig. 5 is a section on the line *x x* of Fig. 4, showing the form of the agitator. Fig. 6 is an inside face view of a cover or baffle-plate used to exclude air from the agitator-arms. Fig. 7 is a vertical central section of the float valve-chamber and valve to prevent the backsetting of water into the retorts. Fig. 8 is an end elevation of the apparatus shown in Fig. 1, looking from the left. Fig. 9 is a similar elevation looking from the right, the parts to the right of the line *u u* of Fig. 1 being omitted. Fig. 10 is a side elevation of the feed-valve or feed mechanism and the adjacent parts, portions being broken away to expose the construction more fully. Fig. 11 is an axial section through said valve on the line *s s* of Fig. 10. Fig. 12 is a longitudinal vertical section through the center of the discharge-valve on the line *z z* of Fig. 13. Fig. 13 is a top plan view of the same. Fig. 14 is an elevation of a portion of the feed-valve represented in Fig. 10 and attendant parts. Fig. 15 is a cross-section of the same on the line *t t* of Fig. 14.

Referring to the drawings, A A represent cylindrical horizontal retorts, each complete in itself. I may employ in my apparatus a single retort; but I prefer to employ a series arranged one above another, and connected so that the material to be dried shall pass through them all *seriatim*, and such is the construction shown in the drawings.

The retorts are encircled by heating-jackets and the series of jackets connected by intermediate tubes B, so that the steam or hot water entering the upper jacket through the throat C may finally escape from the discharge-pipe C′ at the base.

The retorts are connected at their alternate ends to upright chambers or flues D and D′, which communicate with each other through the interior of the retorts. The flue or chamber D connects through the passage D^2, valve-chamber D^3, and exhaust-pipe O with a condensing and exhausting apparatus P, Fig. 1, of ordinary construction, which acts to withdraw the air and vapors from the entire series of retorts and to maintain therein a vacuum of high degree. In the construction of the apparatus particular care is to be observed that the retorts and other parts are made of great strength to resist the severe external pressures to which they are subjected, and to see that all joints are strongly and closely fitted to prevent the ingress of air.

Owing to the great velocity with which air flows into the vacuum and to the fact that it expands many volumes after entering the same, the utmost precaution is to be observed in every particular to secure its exclusion.

Through the center of each retort there extends a longitudinal rotary stirrer pipe or shaft E, one end of which is closed and sustained in a suitable bearing F in the adjacent flue or chamber D′, while the opposite end sustained in a suitable bearing, as hereinafter described, is projected across the flue or chamber D and outward through a stuffing box or gland G. The agitator-shaft is provided within the retort with numerous radial tubular arms *e*, each of which is projected beyond the inner surface of the tube and provided with a baffle-plate connected thereto by arms, as shown in Fig. 3, for the purpose of preventing the water which accumulates in the pipe from being accidentally dashed into the arms. The agitator-arms *e* are screwed at their outer ends tightly into hollow shoes or casings, each of which has a heel portion or scraper *g* and a tubular rearwardly-extending portion *f*. The arms *f* lie at some distance from the surface of the retort and are intended to serve both as agitators and as radiators or heaters to distribute the heat uniformly through the mass of material. The heel portions or scrapers *g* are continued outward to a point close to the surface of the retort, in order to prevent the accumulation of the material thereon, and they are preferably set in a position oblique to the plane of rotation that they may act to some extent to urge the material endwise through the retort.

The agitator-shaft is provided at the outer end with a tubular extension fitted to revolve in a stationary gland or stuffing-box K on a steam-supply pipe H, connecting with a boiler or other generator, this arrangement serving to direct the steam through the tubular journal of the shaft into its arms and shoes.

A rapid condensation of the steam occurs within the agitating devices, and it is necessary to the successful operation of the apparatus that this be removed as rapidly as possible, so that it may not overflow into the agitator-arms or into the steam-pipe. For this purpose I employ a rotating pipe L, which is

passed centrally through the journal of the agitator-shaft E, and at its inner end carried outward in helical form to a point close to the inner surface of the agitator-shaft, as plainly shown in Figs. 2 and 3. As the pipe revolves with the shaft, its mouth reaching the lower side of the shaft receives or dips up the water which is caused by the continued rotation of the parts to flow outward through the pipe at the center. At its outer end the drainage-pipe L enters a stuffing-box L′ or waste-pipe M. The drainage-pipes from all the retorts are connected in like manner with pipe M. It will be observed that by passing the drainage-pipes through the steam-supplying journals of the retorts I am enabled to prevent loss of heat by radiation, and thus to return the water to the boiler at a high temperature. I am also enabled by this concentric arrangement of the pipes to employ retorts which are closed at one end, and thus to avoid the expense, the danger of leakage, and the other evils which would attend the employment of openings at both ends of the retorts.

In order that the tubular ends or journals of the agitator-shaft may be properly sustained without permitting the ingress of air to the retort, I find it necessary to employ peculiar bearings, such as represented in the drawings. An ordinary bearing requiring the use of oil or other liquid lubricant is inadmissible, first, because of the high temperature of the parts, and, second, because the atmospheric pressure would drive the lubricants through the bearings into the interior of the retort to the injury of its contents. I am therefore compelled to make use of a dry bearing to sustain the weight of the journal, and in connection with this bearing to employ a gland or stuffing-box to prevent leakage of air thereby.

Referring to Fig. 2, L′ represents a dry tubular bearing of compressed plumbago or equivalent anti-friction material encircling the journal of the shaft and seated within the stationary box or support G. This bearing is inserted endwise in its place. L^2 represents a packing material, such as cotton, asbestus, or the like, encircling the journal and seated against the outer end of the plumbago bearing L′. L^3 is a gland or follower and acting to compress the packing tightly between its inner end and the plumbago bearing L′ around and against the journal. It serves the double purpose of keeping the plumbago bearing L′ to its place and rendering the joint air-tight.

In order that the material introduced at the top of the apparatus may be directed to and fro through the successive retorts, I mount in the vertical passages D and D′ angular plates N, as clearly shown in Figs. 1 and 2, so arranged as to receive the material falling from the delivery end of one retort and direct it into the receiving end of the retort next below. These plates extend but partly across the vertical passages D D′, so that a free and direct course is afforded for the passage of the air and vapors from the ends of all the retorts to the exhauster.

In operating the apparatus it is desirable that the material shall be advanced steadily but slowly through the retorts. In order to prevent it from advancing too rapidly, the retorts are so constructed that the material must rise and escape from the delivery end at an elevated point. This elevated delivery-opening may be secured in any suitable manner; but I recommend, as shown in the drawings, the employment of end plates or weirs k', bolted to and across the delivery end of each retort, so that the escaping material is compelled to flow upward thereover before descending to the next retort. In order to maintain the proper level of the material within the retort and to assist in causing its overflow at the delivery end, I propose to provide each of the agitator-shafts E close to the receiving end of the retort with narrow spirally-disposed blades a^2, which act to force or crowd the material into the retort. The material is delivered into the foremost retort automatically and in small rapidly-succeeding charges, so that the feeding is practically continuous. This feeding of the material and the exclusion of the air are best effected by a feed mechanism, such as represented in Figs. 1, 10, 11, 14, and 15, although it may be replaced by an equivalent mechanism, which will in like manner introduce the charges while excluding the air.

As shown in the drawings, T represents a large hopper located on top of the apparatus with its delivery throat or mouth fitted tightly to the top of the upper receiving-chamber D′, which leads into the receiving end of the upper retort. In the bottom of the hopper is mounted a horizontally-revolving valve h. This valve is of cylindrical form, hollow, and with an opening t in one side. It is closed at the ends and fitted to revolve tightly within the lower part of the hopper, as shown in Fig. 15, the construction and arrangement being such that as the valve is revolved its opening will communicate alternately with the hopper above and with the discharge-opening below. It serves, however, at all times to prevent direct communication between the hopper and the interior of the apparatus. When the valve is turned to the position represented in Fig. 15, with its opening upward, the material descending from the hopper completely fills its interior, the fluid portion of the mass serving to completely expel the air. By the continued rotation of the valve its opening is first carried out of communication with the hopper and thereafter brought into communication with the opening below, whereupon the material passes out of its interior and downward toward the retort. After thus delivering its contents the valve, continuing its rotation, closes communication below and opens above. Thus it will be seen that the material is delivered in successive charges without permitting the ingress of air.

Owing to the very high tension of the air it is exceedingly difficult to prevent leakage into the apparatus; but owing to the extended outer surface of my valve, or, in other words, to its great bearing-surface within the inclosing surface of the hopper and to the constant presence of the semi-fluid mass, I find that I am enabled to effectually secure the desired end.

In order to insure the entrance of the material into and its discharge from the tubular valve, I propose to mount therein an independently-movable agitator or stirrer. As shown in Figs. 11 and 15, this agitator consists of a central shaft *r*, provided with arms carrying the blade *a'*. In order to secure the effective action of this agitator it is necessary that it shall move at a different speed from the valve. This may be effected by any suitable driving mechanism; but in the drawings I have shown the agitator-shaft provided with a sprocket-wheel *b'*, which is constantly driven by a chain or band from a pulley *c'* on a horizontal shaft provided with a driving-pulley *o*. The valve-shaft is provided with a ratchet-hub acted upon by a pawl *l*, carried by an arm which vibrates about the axis of the valve, being actuated by a pitman *m* from a crank on the last-mentioned shaft of wheel *o*. It will be perceived that by this arrangement the stirrer receives a continuous rotation while the valve is turned intermittingly. The parts are so arranged that the valve pauses while its mouth is in a receiving condition, and again while it is in a discharging position.

Referring now to the mechanism by which the discharge of the dry granular product is effected, attention is directed particularly to Figs. 1, 8, 12, and 13. The dry granular condition of the material to be delivered prevents it from flowing or being forced through small apertures or angular passages. Consequently the discharge valves or mechanisms must be so constructed as to admit of the material being discharged in a direct course. The bottom chamber D', into which the retorts discharge, is formed at the bottom with a descending throat or discharge-opening which leads into a horizontal stationary cylinder *d'*. This cylinder is normally closed at one end by a gravitating or self-closing valve *l'*, which is in the present instance hinged at its upper edge, so as to swing upward in the act of opening, its inner face being provided with suitable packing material. The cylinder contains a long tubular piston or plunger *f'*, which enters at the end opposite the valve through a stuffing-box *e'*, which is to be carefully constructed and tightly fitted. The piston is provided at its outer end with a cross-head and operated by pitmen extending thence to a crank *h'*, carried by a shaft *g'* in fixed bearings. The parts are so proportioned that the piston is first moved rearward from under the receiving-throat in order that the material may descend through the same into the cylinder, after which the piston is advanced beneath and beyond the throat and until its forward end stands flush with or is projected beyond the end of the cylinder at which the valve is located. In thus advancing the piston is passed beneath and closes the throat, so that the passage of air into the apparatus cannot occur, after which by its continued advance it compresses the material before it and against the valve *l'*. The valve being thus forced open the continued movement of the piston forces the charge of material before it out of the cylinder. As the piston retreats the valve closes immediately behind it, preventing the ingress of air. As a consequence a vacuum is maintained in the cylinder between the valve and the retreating piston, which latter again opens communication with the apparatus, so that the next charge may descend into the cylinder.

I believe myself to be the first to combine with a vacuum drier a discharge-valve mechanism by which the material is delivered and the ingress of air prevented, and the skilled mechanic will readily understand that the principles of operation involved in the valve herein shown may be embodied in other forms its mechanical equivalent.

The various moving parts hereinbefore described may receive motion through any suitable arrangement of driving devices; but I recommend the particular arrangement represented in the drawings, in which A' represents a driving-pulley belted to an upper pulley B'. The shaft of pulley B' is provided with a cone-pulley C', belted to a lower pulley E' on a horizontal shaft which is extended to the opposite end of the apparatus, and there connected by beveled gearing to a cross-shaft, as shown in Figs. 1 and 8, the cross-shaft being in turn connected by sprocket pulleys and chains to the upper pulley *o*, which drives the feed mechanism and the lower pulley *g'*, which drives the discharge mechanism. In this manner the feeding and delivering devices are operated continuously and automatically.

The agitator-shafts, with the exception of the one at the top, are provided each with a sprocket-wheel S^2, as shown in Fig. 9. The uppermost shaft is provided with a gear-wheel, S', which receives motion from a pinion on the shaft of pulley B'. This shaft also carries a sprocket-pulley, from which a single chain is passed to and fro around the driving-pulleys of the other agitator-shaft, as shown in Fig. 9, a single chain thus serving to communicate motion to the series of shafts. This chain is held outward from the pulleys on one side by an idle-pulley F, as shown in Figs. 1 and 9.

In order to prevent the water of injection or condensation from backing upward through the pipes into the retort, I provide in the valve-chamber D^3 at the top of the suction-pipe O an upwardly-closing valve *a*. As shown in Fig. 7, this valve is in the form of a flat float suspended by a link *d* from one end of

a weighted lever *c*. In its normal position the valve stands open and away from its seat or throat. When, however, the water rises up beyond the proper level it acts upon the valve, and, in connection with the weighted lever, causes the valve to rise against the close of the passage.

The operation of my apparatus is as follows: A suitable heating medium, preferably steam, is admitted into the jackets surrounding the retorts, and through the journals into the rotary agitator-shafts, filling the shaft, its radial arms, and the shoes at the ends of the arms. The hopper T is filled with the semi-fluid mass, care being taken to keep the same filled at all times, to the end that the gravitating fluid portion may assist in sealing the feed-valve and in completely displacing the air therefrom. The exhaust apparatus is operated to produce and maintain a high vacuum throughout the interior of the retorts and their connecting-chambers. As the feed-valve revolves, the material is delivered in successive charges practically free from air into the top of the apparatus. Being acted upon by the blades a^2 it is caused to flow slowly through the top of the retort, from which it overflows and descends into the next retort, through which it passes in turn, and so on repeatedly until it reaches the discharge-throat at the base. During its passage through each retort the material is constantly agitated and loosened by the revolving arms and shoes, which distribute the heat throughout all portions of the mass of material, subjecting each and every particle to the direct action of a heating-surface, and at the same time so loosening the mass that the vapors generated by the heat may readily escape toward the exhauster. The water which gravitates to the bottom of the retort is picked up and delivered through the pipe L, which is so proportioned and arranged as to prevent the accumulation of any great amount of water in the bottom of the retort. As the material arrives at the discharge-throat, it descends in front of the retreating piston, and is delivered by the latter in its advance past the valve into the atmosphere, the admission of air both during the advance and retreat of the piston being prevented in the manner before explained.

I am aware that an exhausted retort has been connected through ordinary stop-valves with a large feed-chamber from which it received the wet material, and with a large receiving-chamber into which it delivered the dry material. In the operation of this apparatus the feed-chamber is opened at intervals and filled, the inlet-opening closed, the air exhausted, and communication opened with the retort. In like manner the receiving-chamber requires, when filled, to be cut off from communication with the retort, opened to discharge the accumulated material, and then closed and the air exhausted therefrom before being again placed in communication with the retort. To such structure I lay no claim. My system comprehends a combination of parts by which the feed-chambers and their exhausting mechanism are dispensed with, the feed mechanism adapted to deliver the wet material from the atmosphere directly into the retort, and the discharge mechanism adapted to return the material when dry from the retort directly to the atmosphere.

Having thus described my invention, what I claim is—

1. An apparatus for carrying out unceasingly and under unchanging conditions the drying of granular material *in vacuo*, comprising, in combination, a closed retort with a heating-jacket, a constantly-acting exhauster to remove the air and vapors, a constantly-acting agitator to aid the flow of the material through the retort, the feed-hopper, the chambered power-driven valve communicating alternately with the hopper and retort to introduce the wet material and exclude the air, and the power-driven air-excluding discharge-valve, whereby the material is automatically and constantly passed through the apparatus subject to unchanging conditions as to speed, temperature, and vacuum.

2. In an apparatus for drying materials *in vacuo*, the combination of a closed retort, a jacket for heating the same, a constantly-acting exhaust apparatus for removing the air and vapors from the retort, a feed-valve, substantially as shown, for admitting the material and excluding the air, a discharge-valve, substantially as shown, for delivering the dry product and excluding the air, and a train of driving-gear, substantially as described, for continuously operating said valve mechanisms, whereby the delivery of the material into and through the apparatus is carried on automatically and unceasingly.

3. In combination with an exhausted retort and a feed-hopper, an intermediate rotary valve in the form of a cylinder having closed ends and a side opening, as described.

4. In an apparatus for carrying on a uniform and unceasing operation of drying *in vacuo*, the series of stationary horizontal retorts provided with heating-jackets, an exhaust mechanism to remove the air and vapors from the retorts, weirs at the delivery end of the retorts to maintain the level of the material therein, agitators within the retorts to facilitate the flow of the material therethrough, the chambered feed-valve opening alternately to the interior and the exterior of the retort, and the discharge-valve having the cylinder, piston, and end valve, substantially as shown, whereby the wet material may be introduced into and passed with constant progression through the retort and the dry product delivered therefrom without impairing the vacuum in any part of the apparatus.

5. In a drying apparatus, a retort, a cylinder communicating with the delivery end of said retort, an outwardly-opening valve closing the entire outer end of said cylinder, a

piston within said cylinder, and suitable mechanism for reciprocating said piston, whereby the dry product may be forcibly delivered from the apparatus against the external air-pressure and without permitting the inflow of air.

6. In combination with an exhausted retort, the cylinder d', opening at one side to the retort, an outwardly-opening valve l', covering the delivery end of the cylinder, and the piston adapted to pass over and close the opening to the retort and to drive the contents of the cylinder outward past the valve.

7. In a vacuum drier, a horizontal retort provided with the elevated discharge-opening, the short rotary feeder a^2 at the receiving end, and the central shaft provided with agitator-arms, whereby the material is kept in a loose condition, that it may flow under the influence of the feeder to the outlet, and that the heat may be more advantageously applied.

8. In combination with a retort, an internal rotating tubular shaft with tubular stirrer-arms and a steam-inlet, a pipe rotating with said shaft, one end projected horizontally to the outside and the other end fashioned into a scoop lying close to the inside of the shaft, whereby it is caused to dip into and lift the water of condensation to the exterior at each revolution.

9. In combination with a closed retort, a central tubular shaft with tubular stirrer-arms and a tubular steam-admission journal, and a rotary water-delivery pipe passed through said journal and carried at its inner end in helical form close to the inner surface of the shaft, whereby the steam and water are passed through one and the same end of the shaft and its opposite end left intact.

10. In a vacuum drier, a retort connected with an exhausting apparatus and closed against the entrance of air, a central rotary stirrer-shaft located within the retort and provided at one end with a projected journal and an inclosing bearing, through which the journal passes, said bearing comprising a wearing-surface of dry lubricating material, and a gland or stuffing-box to prevent leakage, whereby the admission of air is prevented and the employment of fluid lubricants and consequent injury to the material under treatment are avoided.

11. In combination with the rotary tubular valve with side opening, the internal independently-movable agitator, substantially as shown, to facilitate the inflow and outflow of the material.

12. In combination with an exhausted retort, the rotary tubular valve, the concentric independently-rotative agitator or scraper, the pulley and belt to give a continuous rotation to the agitator, and the pawl-and-ratchet mechanism to rotate the valve intermittingly.

13. In combination with the cylinder-having the lateral inlet-throat, the self-closing valve at its end, and the reciprocating piston, whereby the piston is enabled to discharge the contents of the cylinder automatically and the cylinder automatically closed on the retreat of the piston to prevent the admission of air.

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,
GEORGE M. GOLL.