(No Model.)

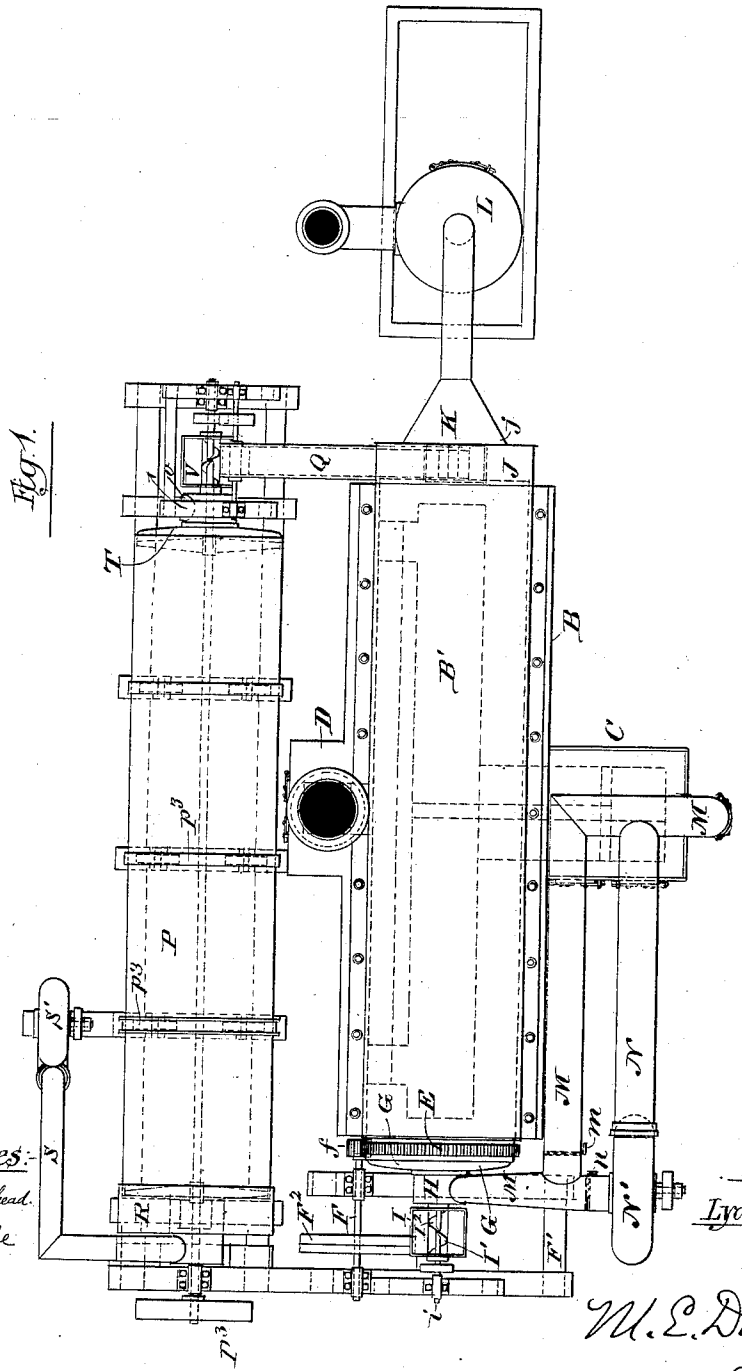
5 Sheets—Sheet 1.

L. J. CADWELL.

DRIER.

No. 333,825. Patented Jan. 5, 1886.

Fig. 1.



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(No Model.)

5 Sheets—Sheet 2.

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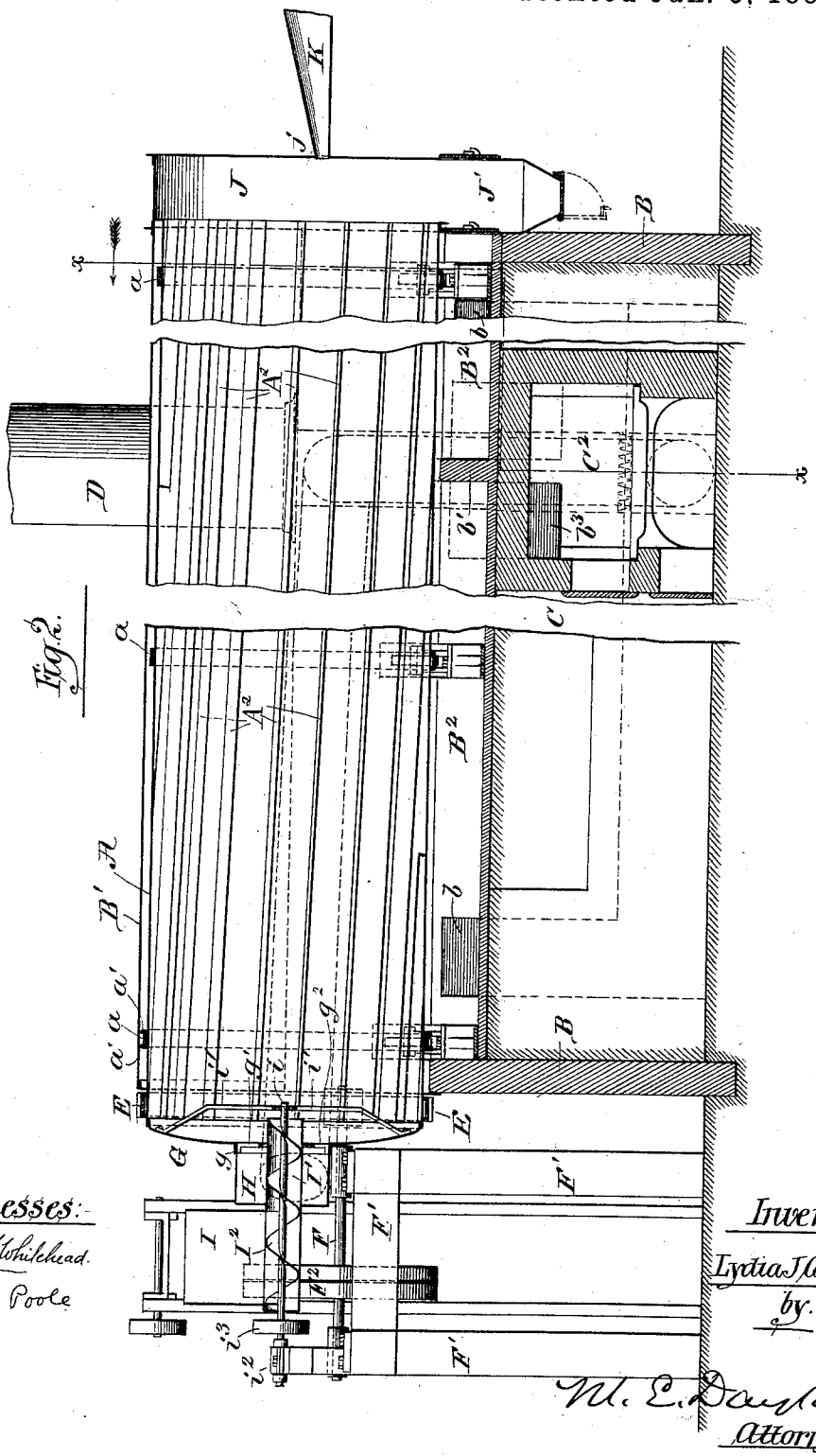
DRIER.

No. 333,825. Patented Jan. 5, 1886.



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(No Model.)

5 Sheets—Sheet 3.

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DRIER.

No. 333,825. Patented Jan. 5, 1886.

Fig. 6.

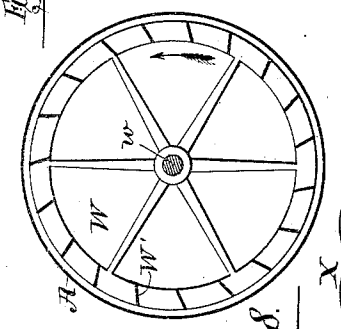

Fig. 7.

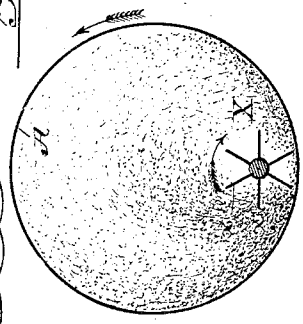

Fig. 8.

Fig. 3.

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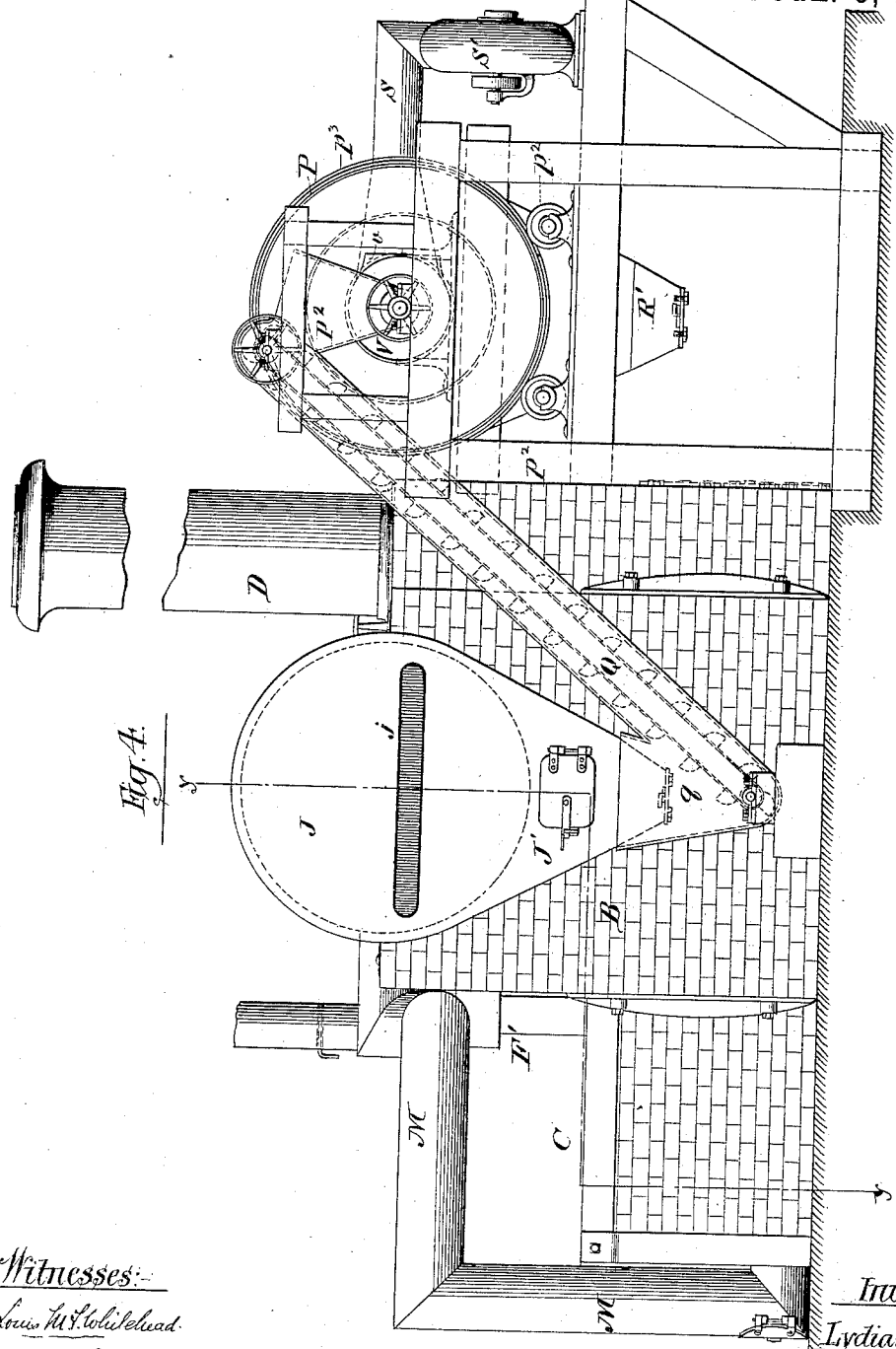
(No Model.)

5 Sheets—Sheet 4.

L. J. CADWELL.

DRIER.

No. 333,825. Patented Jan. 5, 1886.



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(No Model.)

5 Sheets—Sheet 5.

L. J. CADWELL.

DRIER.

No. 333,825. Patented Jan. 5, 1886.

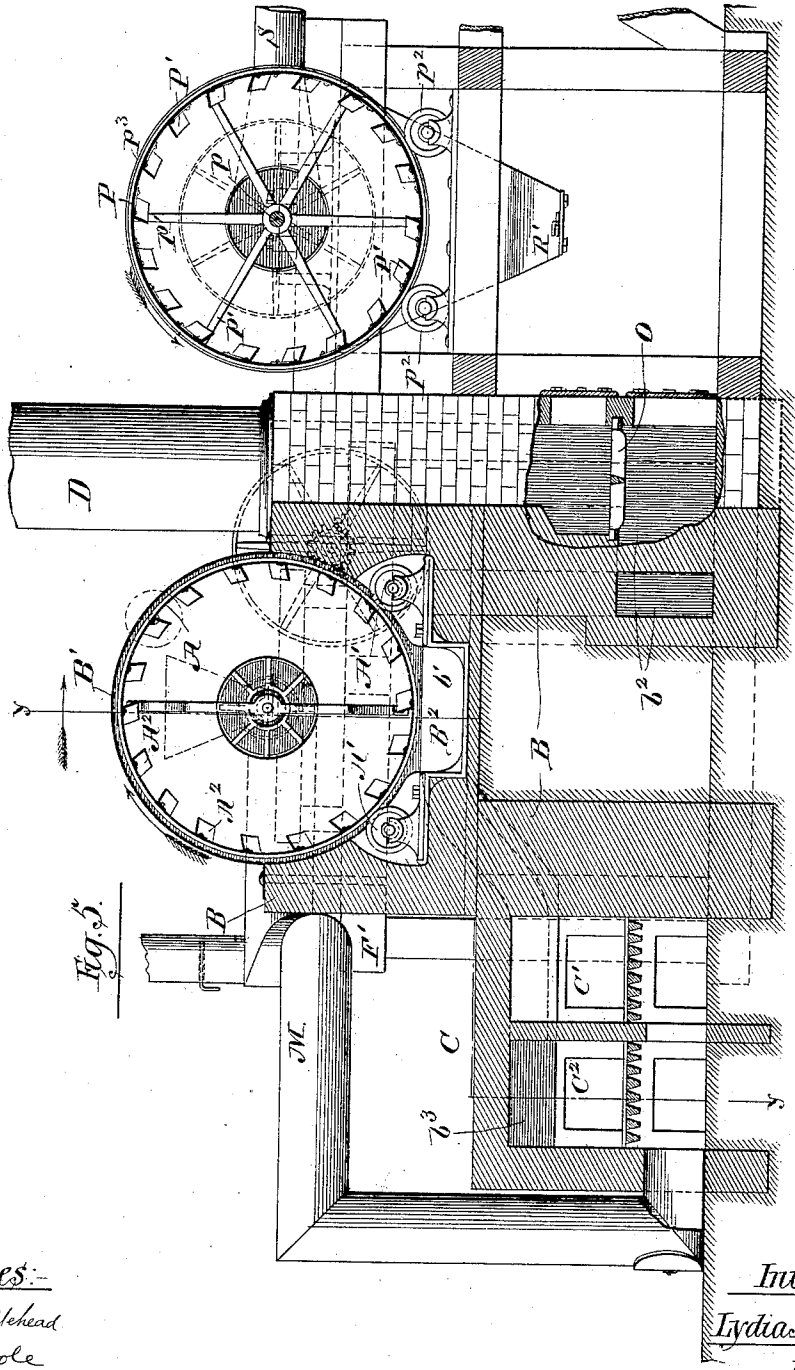

Fig. 5.

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UNITED STATES PATENT OFFICE.

LYDIA J. CADWELL, OF CHICAGO, ILLINOIS.

DRIER.

SPECIFICATION forming part of Letters Patent No. 333,825, dated January 5, 1886.

Application filed September 10, 1885. Serial No. 176,650. (No model.)

To all whom it may concern:

Be it known that I, LYDIA J. CADWELL, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Apparatus for Drying Fertilizers; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

My invention relates to rotary driers, more especially adapted or intended for the treatment of pulverulent or ground fertilizers, brewers' grains, and similar substances.

It has for its primary object to provide an apparatus of superior efficiency and economy in operation; and it consists in the several matters hereinafter set forth, and pointed out in the appended claims.

In the accompanying drawings, which illustrate one form in which my invention may be embodied, Figure 1 is a plan of an apparatus containing my improvement, including a cooling-reel, which may sometimes be employed with advantage in connection with the drier proper, and which is referred to in certain of the appended claims. Fig. 2 is a longitudinal vertical section in the parallel planes indicated by lines *y y* in Figs. 4 and 5. Fig. 3 is a repetition of part of Fig. 2, but shows in addition and in side elevation an air-heating furnace by which heated air is supplied to the rotating driving-chamber. Fig. 4 is an end elevation of the entire apparatus, as shown in Fig. 1, excepting the air-heating furnace, from the position of which the view is taken. Fig. 5 is a transverse vertical section taken in the parallel planes indicated by the indirect line *x x* of Fig. 2, and looking in the direction of the arrow on that line. Figs. 6, 7, and 8 illustrate modifications which are embraced within my invention as equivalents of other devices shown and described.

A, Figs. 2 and 5, represents a hollow metal cylinder, which will be commonly of considerable size—say, twenty to forty feet long, and, say, five to six feet in diameter.

A′ A′ are a series of suitably-supported stationary rollers arranged in position to sustain the cylinder A, and to allow the latter to be rotated on its axis. The cylinder is provided with annular circumferential tracks *a*, which ride on the rollers A′, and one of which at least is desirably provided with flanges, as seen at *a′*, to retain the cylinder longitudinally in place by engagement with the rollers A′.

B B is a structure, in this instance of masonry, which rises about the sides of the cylinder A, and is supplemented by a semi-cylindric cap-plate, B′, to form an inclosure, which laterally surrounds the cylinder A at a distance of a few inches therefrom. The structure B in this case supports the rollers A′, and is provided with a horizontal flue or passage, B^2, beneath the cylinder, which is in communication at one or more points, as *b*, with passages, b^2, leading into the chimney D.

In the case of an apparatus embracing a cylinder of the length suggested, the passage B^2 is preferably divided about centrally by a transverse partition, *b′*, Figs. 2 and 5, each of which connects with a furnace-fire.

C is a furnace, which delivers its products of combustion into the passage B^2. This furnace is here shown as located opposite the partition *b′* of the flue B^2, and as being double, or as having two fire-boxes, C′ and C^2, one connecting with one and the other with the other compartment of the said flue B^2 by passages b^3, indicated partially by dotted lines in Figs. 2 and 5. The chimney D is also shown located opposite the partition *b′* of the longitudinal flue B^2, where it is preferably placed when the drying-cylinder is of considerable length.

At the head or receiving end of the cylinder A (seen at the left in Figs. 1 and 2) a driving-gear and feed mechanism are shown.

E is an annular rack fixed to the outer circumference of the cylinder A.

F is a drive-shaft mounted on a suitable support, F′, and provided with a pinion, *f*, which meshes with the rack E, as shown in Fig. 1 and in dotted lines of Figs. 2 and 5.

F^2 is a pulley on the shaft F, to receive a driving-belt from any suitable motor or counter-shaft.

G is a stationary or non-rotating plate, constructed to practically close the adjacent end of the cylinder A, and supported in any suitable manner, preferably independently of said cylinder.

H is a shell or drum attached to the plate

G by the flange g, and communicating with the interior of the cylinder A through openings g'.

I is a hopper or the terminal of a feed-pipe intended to deliver the material to be operated upon to the rotating cylinder A.

I' is a horizontal tube leading from the hopper or pipe I through the shell H, and the plate G, and I^2 is a spiral conveyer extending across the bottom of the hopper I and through the tube I'. The inner end of the shaft i of said conveyer is supported in a bearing, which is upheld by any desired number of arms, i', attached to the plate G, and the outer end of said shaft rotates in a suitable bearing, i^2. The shaft i is rotated by a belt trained over the pulley i^3 or otherwise in any suitable manner.

The opposite end or tail of the cylinder A is closed by a stationary sheet-metal hood, J, which is provided at the bottom with a hopper, J', into which the contents of the cylinder are discharged in the operation of the machine. This hood is represented as being upheld in place by attachment with the structure B B'.

K is a pipe leading from the air-heating chamber of a suitable furnace or other air-heating device, L, through the hood J, so as to deliver hot air into the tail of the cylinder A. Preferably said air-pipe is broadened out horizontally at its connection with the hood-plate, as represented at j, Figs. 1 and 4, so that the air enters the cylinder in a correspondingly broad sheet or current.

The cylinder A is provided on its inner surface with a series of longitudinal flanges or wings, A^2, Figs. 2 and 5, preferably pitched or inclined forwardly or in the direction of their motion toward their free edges, as shown, whereby, in the rotation of the cylinder, they act as buckets and lift the material toward the top of the cylinder, and thence discharge or drop it. Any desired form besides that of the inclined flat blades shown may be given to those wings or buckets that will best serve the purpose of thus raising and then dropping the material across the interior of the cylinder. The wings A^2 are also shown as being inclined longitudinally, so as to operate in a familiar manner to carry the material slowly lengthwise of the cylinder from the head to the tail thereof when the latter is rotated. The equivalent and familiar expedient of setting the reel with its tail end lower than the head may of course be employed for this purpose, through I prefer to set the cylinder in a horizontal position and to rely on the direction of the said wings A^2 to effect the desired progress of the material through the cylinder in the operation of drying.

M is an air-flue connected with the shell H, and leading into the ash pit or space beneath the grate of the furnace C.

N is a branch or by-pass connected with the pipe M, and provided with a suction-fan or air-mover, N'.

Valves m and n, located in the flues M and N, respectively, enable the fan and by-pass to be used or excluded from use at pleasure.

O is a grate located at the foot of the chimney D above the point at which the products of combustion enter the same.

The operation of the mechanisms so far described is as follows: The cylinder A has a rather slow rotative movement, in which the material fed into it by the spiral conveyer I^2 is gradually carried from the head toward the tail thereof. The cylinder itself is directly heated by the products of combustion from the furnace C, and correspondingly heats the material contained therein and brought into contact with it, with the effect of vaporizing the moisture contained in such material. During the progress of the material through the cylinder said material is also disintegrated or opened out as a mass by the blades A^2, which lift it in parts and pour it in particles across the interior of the cylinder, so that all parts of the mass are subjected to the heat of the cylinder, and are then so exposed as to permit the vapor to pass freely away. While the material is falling the heated air which is admitted at the tail of the cylinder, and has its exit through the openings g' at the head of the cylinder, encounters the thus separated particles of the mass, and both further heats them and takes up the moisture evaporated therefrom. The direction of the hot-air current relative to that of the material through the cylinder is significant in this respect, to wit: that the moisture taken up by the air at any given point in the cylinder is carried toward a point therein where the material has greater moisture, and not toward a point where it has less, as would be the case if the direction of the material and air were the same. The advantage gained at any point in the cylinder is therefore retained, and the air is continually effective in taking up moisture during its entire progress through the cylinder. Another advantage of giving the hot air a direction opposite that of the material being treated relates to the obvious fact that the finer particles of the material become dry first. In this relative movement of the hot-air current these dry or drier particles are borne into contact with the more moist and larger particles nearer the head of the cylinder and adhere to them, so that the former are arrested and also reabsorb moisture from the particles to which they adhere. They are thus made to aid in equalizing the hydrous condition of the mass, besides being prevented from escape and loss by the action of the air-current. Still another advantage of this relative direction of movement on the part of the hot or heated air accompanies the expansion of the vapors, which are more highly heated thereby, and by such expansion impel themselves forward toward the outlet at the head of the cylinder, where alone they find free escape.

The pipe M is intended to conduct the vapors and gases from the drying-cylinder to the

fire of furnace C, where they are consumed. Advantages of this disposition of them are a lessening of the quantity of other fuel required to maintain the fire and a prevention of the escape of unpleasant or noxious odors into the outer air through the chimney. In the case of fertilizers made from the residue of rendering-tanks the latter consideration is of great importance, and, to fully insure the desired result, the grate O is located in the chimney D above the entrance of the passage b^2, so that when necessary a secondary fire may be there built, through which the products of combustion from the furnace C may pass, with the effect of consuming such of the gases as shall have escaped consumption in said furnace C. Of course it is not necessary that these identical fires shall be relied on for the whole or any part of this work, as the same result will be attained by conducting the vapors and gases to another fire, or succession of fires, maintained in available distance from the drier.

When the destruction of odors is a desideratum, or it is only desired to utilize the gases as fuel, it will commonly be practicable to increase the efficiency both of the drying-air current and of the fire by putting the fan N′ into operation, and thus applying a suction to the drying-cylinder and a blast to the fire. For this purpose, when two pipes, as M and N, are present, the valve *m* will be closed and the valve *n* opened. If it be found at times desirable to maintain a given draft or force of air-current through the cylinder A, and to supply less than the entire volume of moisture-laden air to the fire, a part of the latter may be given escape elsewhere than beneath the furnace-grate, as provided for in an ordinary escape-flue, as M′, Fig. 4.

In treating some materials it is desirable to cool them after drying, and for this purpose the cylinder F is shown. This cylinder is represented as being provided with an axial shaft (seen at *p* in Fig. 4, and in dotted lines in Fig. 1) and radial arms supporting the cylinder from said shaft. When of considerable length, it is further supported by stationary rollers p^2, on which run the circumferential tracks or ribs p^3, corresponding with the rollers A′ and ribs *a* of the drier proper. The cylinder P is provided with interior longitudinal wings P′, doubly inclined for the purpose of simultaneously advancing and agitating the material therein, also as in the drying-cylinder. The cooling-cylinder, if on the same floor with the drier, will commonly be arranged parallel with the drying-cylinder, and with its head adjacent to the tail of said drying-cylinder. This is the arrangement shown in the drawings.

Q is a belt-conveyer and its box, which, with a suitable hopper, *q*, is arranged to receive the material discharged from the drying-cylinder and to carry it to the feed-hopper P^2 of the cooler, whence it is taken into the cylinder P by a spiral conveyer on the shaft *p*. The cooling-cylinder is constructed at its tail or delivery end with a non-rotating hood, R, having a discharge hopper or spout, R′, and through this hood a pipe, S, supplies a blast of air to the interior of the cylinder. The opposite end of the cylinder is closed by a non-rotating head, T, corresponding with the head G of the drier, and which therefore need not be described in detail.

V is a section of a flue or an open shell, through which the air escapes. A gentle current of cool or cold air may be impelled through the cooling-cylinder by a fan, S′, attached to the pipe S, as seen in Figs. 1 and 4.

Appropriate motion may be imparted to the cylinder P through the pulley P^3 on the shaft *p*.

The cooling of brewers' malt and grains and of fertilizers, as heretofore commonly practiced, is effected by spreading the same on extensive floors and turning them over with shovels. The rotating cylinder P, with its buckets P′, does this work far more rapidly and effectively and at much less expense. The cool air admitted through the pipe S may advantageously be first dried and then cooled by any of the familiar devices known for such purposes, in order to further dry as well as cool the material, if desired, or to prevent moistening it again to any degree by contact with air not thoroughly dry.

It will obviously be practicable to dispense with a conveyer, and to employ only a spout or box when the cooler is located on the floor below or elsewhere beneath the drier.

In Figs. 6, 7, and 8 are shown in transverse vertical section modifications of the drying or cooling chamber above described, and intended to be embraced in my invention, as herein claimed.

The cylinder A, in Fig. 6, does not necessarily rotate; but within said cylinder is mounted a rotating skeleton reel, W, having appropriately-inclined longitudinal blades or buckets W′, supported from a central shaft, *w*. These buckets W′ sweep near or in contact with the cylinder, and lift and drop the material therein, and also advance it through the cylinder in precisely the same way as it is carried in the drier, as first described.

In Fig. 7 is shown a cylinder, A, which may be substituted for either the drying or cooling cylinder of Figs. 1 to 5, inclusive, and which may either rotate or not, as preferred. It has no interior buckets or wings, and to give the desired disintegrations of the material, a flier, X, having wings *x x*, is placed above the bottom, running through the entire length of the cylinder. Said flier being rapidly rotated on its axis, the material being treated will be thrown up and dissipated, as shown, with the same result in kind as produced by pouring the same off the buckets of the cylinder of the drier or cooler, as at length shown and described. If the flier has its wings arranged spirally about its shaft, as suggested in Fig. 8, the desired advance of the material through the cylinder will be thereby effected.

By the employment of a jacketed drying-cylinder in the combination with an internal drying-current and an external heater, instead of the single shell cylinder heretofore, I am enabled to distribute the heat uniformly over all parts of the drier proper and avoid burning the material under treatment, while in connection with the drying-current I get a uniform result.

I claim as my invention—

1. The combination, with a rotary drying-cylinder, a furnace for supplying the same with dry or heated air internally, and a furnace for heating the drying-cylinder externally, of a sheath or shell constituting a chamber about the drying-cylinder for the purpose of retaining and evenly distributing all the heat evolved from the external furnace, and thus preventing loss of heat from the motion of the drying-cylinder or otherwise.

2. The combination, with a drier for pulverulent fertilizers and similar substances, provided with means for dissipating the mass within the drier, of means for producing a current of air through the drier, a furnace separate from the means for producing the current of air, and a flue arranged to conduct vapor and gases from the drier to this furnace.

3. In combination with a drier constructed to dissipate within its drying-chamber the mass being treated, a furnace constructed to supply heated air to the drying-chamber, a separate furnace arranged to heat the wall of the drying-chamber, and a flue arranged to conduct the vaporous air and gases from the drying-chamber to one of the furnace-fires.

4. The combination, with a drier constructed to dissipate within the drying-chamber the material being dried, of a furnace constructed to supply heated air to the drying-chamber, a furnace arranged to heat the wall of the drying-chamber, a flue arranged to conduct the vapor and gases from the drying-chamber to the fire of one of said furnaces, and a fire-box for a secondary fire, located in position to receive the products of combustion from the furnace to which said vapor and gases are first conducted.

5. The combination, with a metal drying-cylinder, A, and a housing therefor, of a transversely-divided passage, B^2, in the housing, a furnace, a chimney, passages leading from the furnace to the several compartments of the passage B^2, and passages leading from the said several compartments to the chimney, substantially as described.

6. The combination of a metal-walled drying-chamber, a furnace arranged to heat the drying-chamber by contact of its products of combustion with the chamber-wall, a flue leading from the drying-chamber to the furnace, a chimney having a receiving-flue, b^2, leading from the furnace, and a fire-grate, O, located in the chimney above the grate, substantially as and for the purpose set forth.

7. The combination of a drying-chamber, means for supplying said chamber with air, a furnace, and a flue leading from the drying-chamber to the fire-box of the furnace, and provided with a branch passage, whereby a part only or the whole of the vapor-laden air from the drier may be delivered to the fire.

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

LYDIA J. CADWELL.

Witnesses:

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WILLIAM M. STANLEY.