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APPARATUS FOR DRYING GRANULAR MATERIALS.

No. 538,237. Patented Apr. 30, 1895.

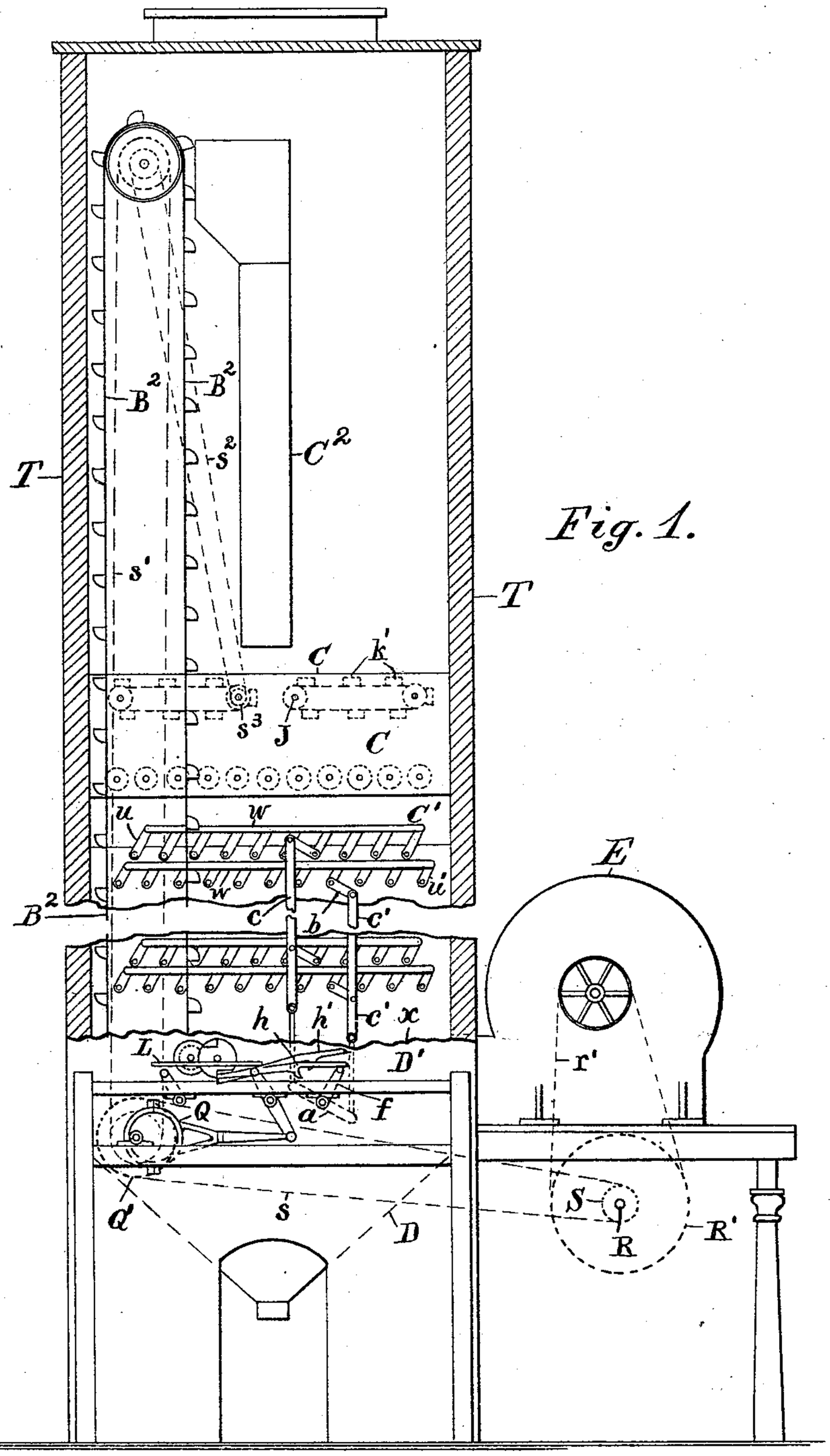

Fig. 1.

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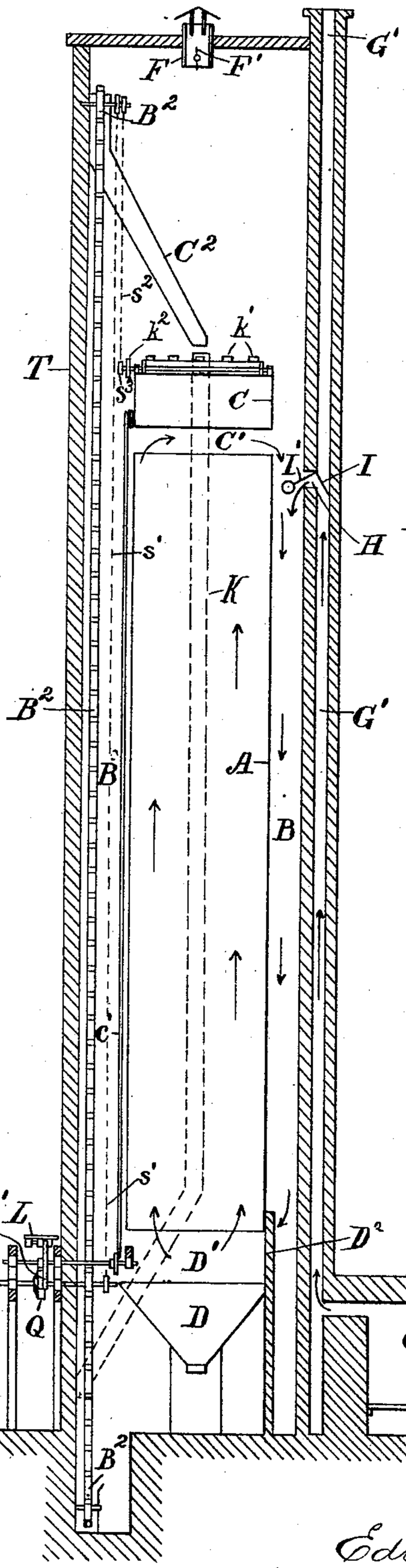

Fig. 2.

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Fig. 3.

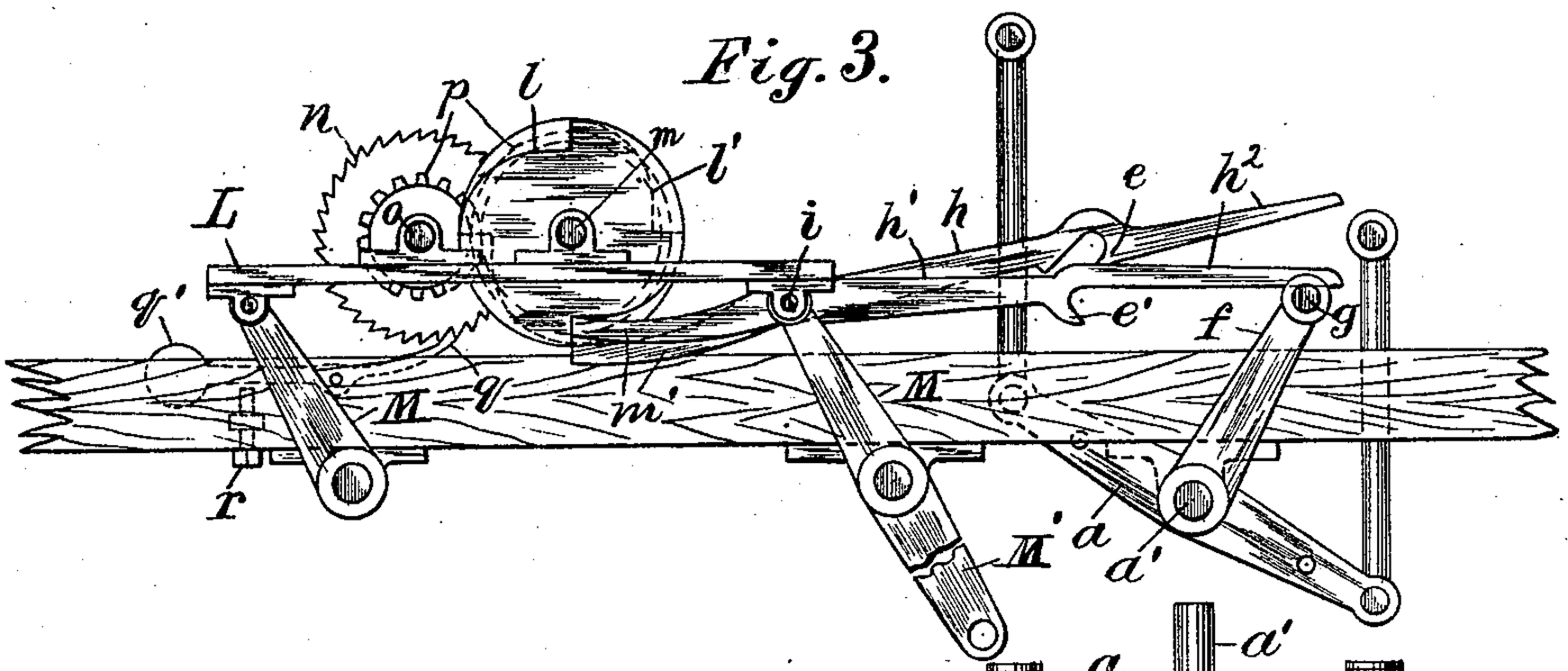

Fig. 4.

Fig. 5.

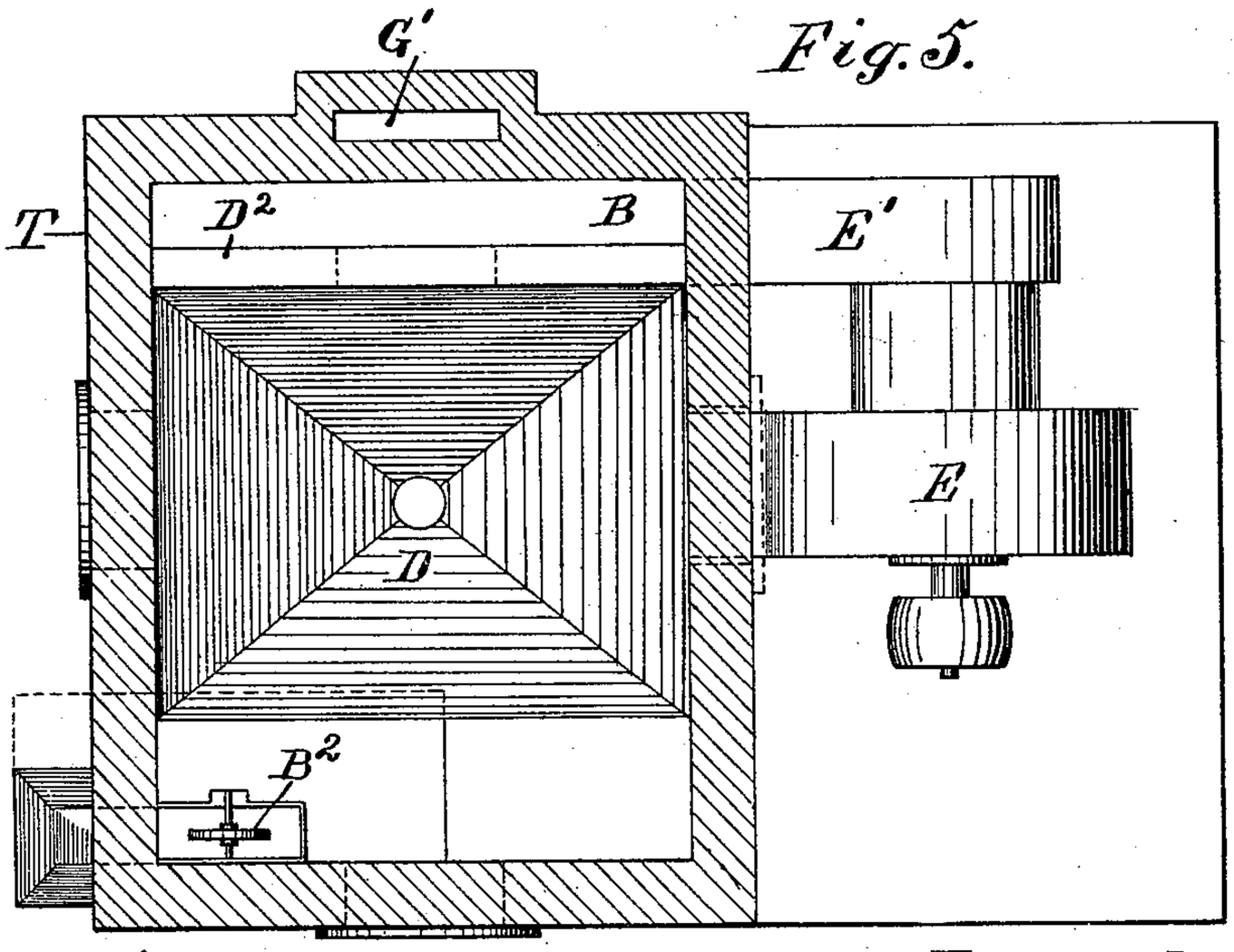

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Fig. 6.

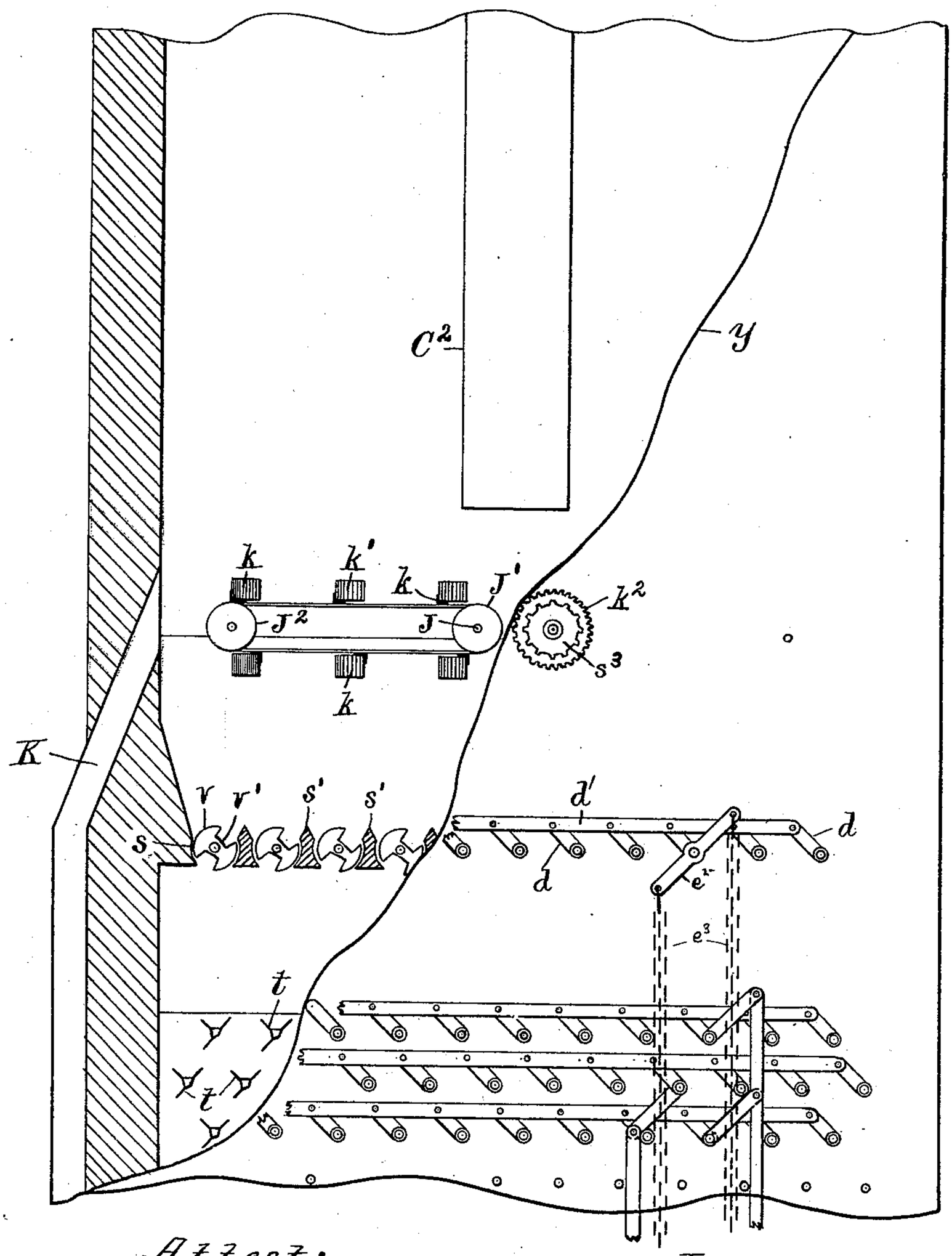

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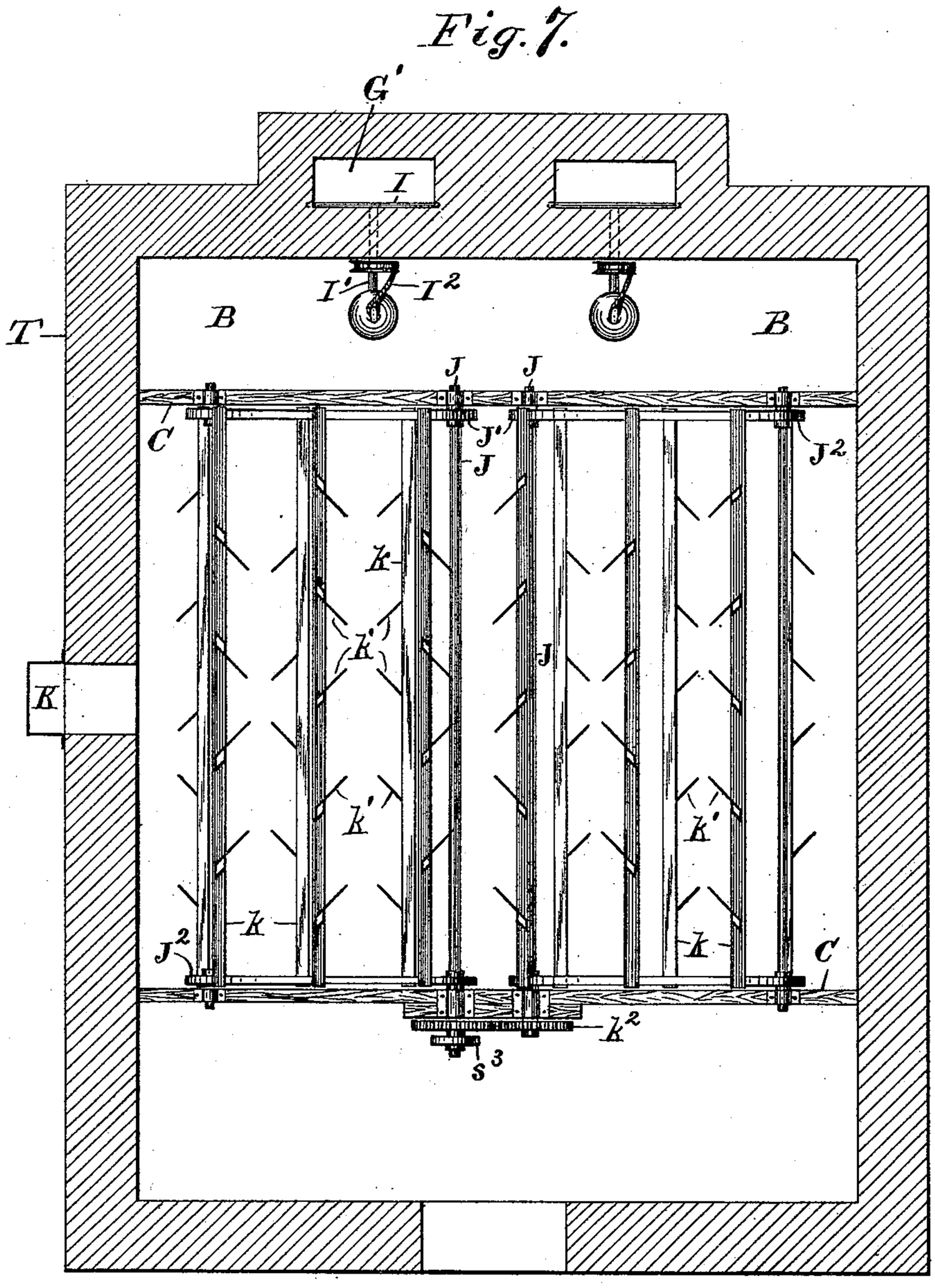
Fig. 7.



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APPARATUS FOR DRYING GRANULAR MATERIALS.

No. 538,237. Patented Apr. 30, 1895.

Fig. 8.

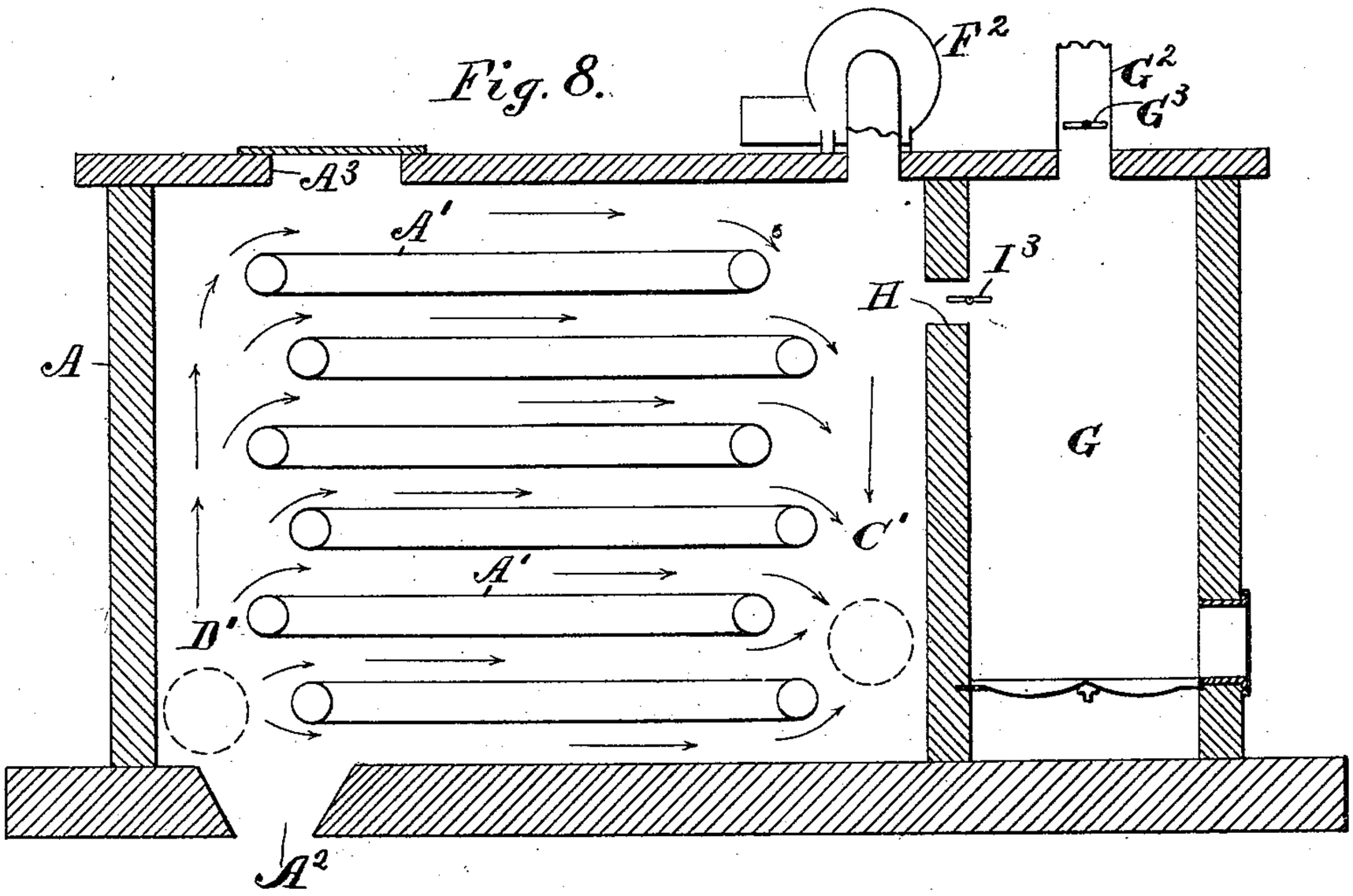
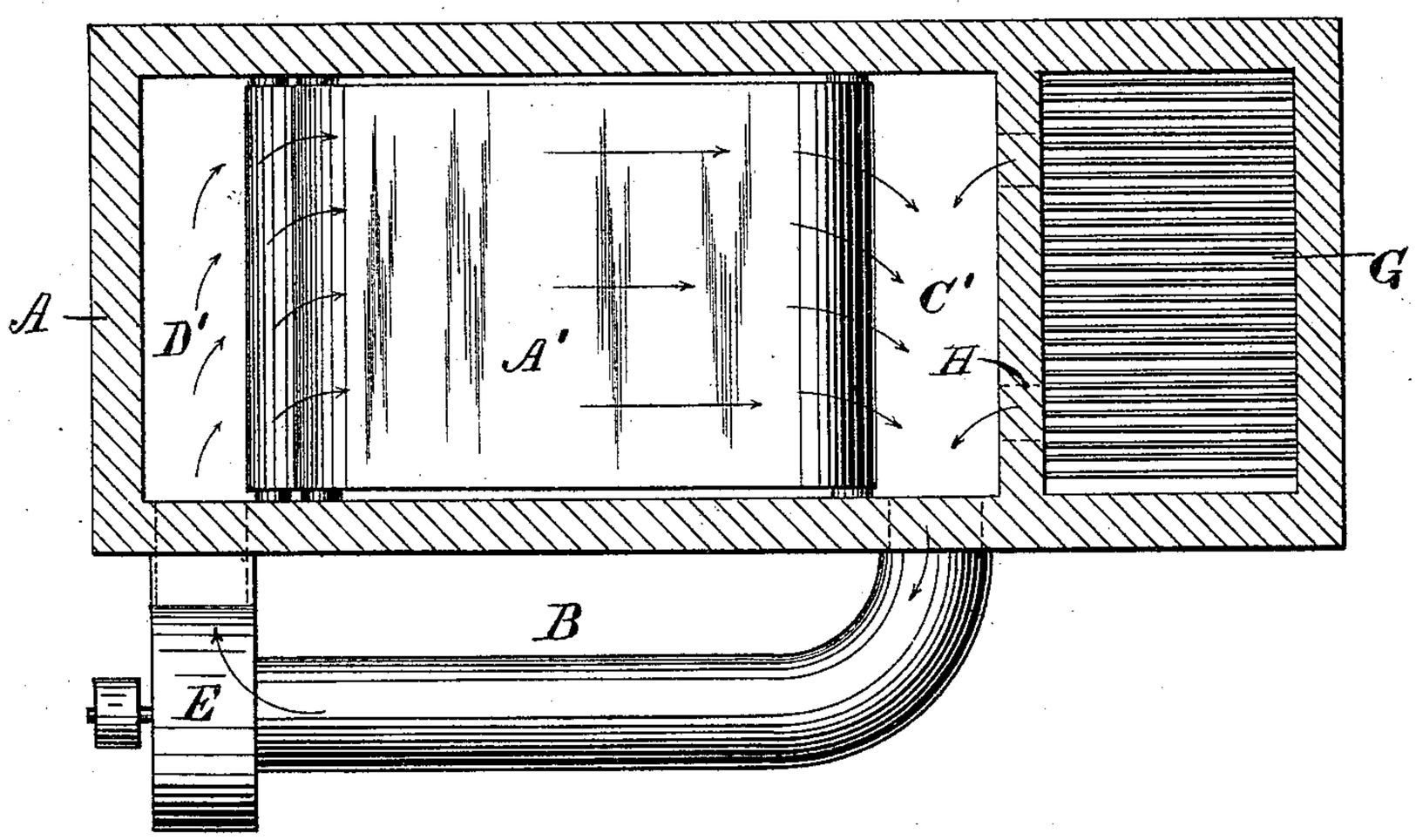


Fig. 9.



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UNITED STATES PATENT OFFICE.

EDWARD M. COOK, OF NEW YORK, N. Y.

APPARATUS FOR DRYING GRANULAR MATERIALS.

SPECIFICATION forming part of Letters Patent No. 538,237, dated April 30, 1895.

Application filed January 2, 1895. Serial No. 533,529. (No model.)

To all whom it may concern:

Be it known that I, EDWARD M. COOK, a citizen of the United States, residing at New York, county of New York, and State of New York, have invented certain new and useful Improvements in Methods of and Apparatus for Drying Granular Materials, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to that class of apparatus in which the material under treatment is subjected to the direct action of a current of heated air, which is recirculated through the apparatus and brought into repeated contact with the material.

In the present construction the moisture laden air which is discharged from the apparatus is not replaced with cold air, but by an equivalent of highly heated air, which before it is permitted to come in contact with the material is thoroughly mixed with a large volume of partially saturated air. The direct products of combustion are preferably used for this purpose, and their temperature is suitably reduced by said admixture before they come in contact with the material. The direct products of combustion, which have normally a very high temperature, may thus be used for treating tender materials, which are greatly injured by exposure to a high temperature.

The method described may be practiced with an apparatus in which the material is moved either vertically or horizontally. In apparatus in which the material is moved vertically, I prefer the form of drier employing numerous series or tiers of oscillating duplex troughs, and in apparatus moving the material horizontally, I prefer a series of endless aprons placed one over the other, and moved in opposite directions.

I will first describe the invention with reference to the vertical form of apparatus, in which I employ a tower of suitable height and suitable dimensions to inclose the vertical drying chamber, with a vertical air mixing chamber at one side thereof, and a space for containing an elevator chain with lifting buckets at the opposite side, all of the parts of the apparatus being thus supported most conveniently in their proper relations.

The drying chamber is provided at the top with a feed bin, and the elevator is arranged to receive the material at the base of the tower, and to discharge it through a chute into the feed bin. The bottom of the feed bin is formed with a series of slots having concave walls, between which a series of oscillating valves is fitted, and arranged to receive the material when turned in one position; and when turned in the reverse position, to carry a definite charge of the material downward, adjacent to the concave wall, and discharge it at the bottom of the slot. This apparatus is adapted for use upon a large scale, in which the tower would be from forty to eighty feet in height; and an operator at the base of the tower may be advised when the bin is filled to a certain level, by providing an overflow channel at a suitable level upon the side of the bin, and conducting the same to a point where the operator below can control the supply of material to the bin.

The following description relates to the preferred construction, but other forms of apparatus may be used to practice the same method.

In the annexed drawings, Figure 1 is a side elevation of the apparatus with the front wall removed above the line *x*, and the figure broken for want of room upon the drawing. Fig. 2 is an elevation of the apparatus with the nearer wall of the tower removed, and the right hand wall of the tower broken away to the flue G′, and interior of the furnace G. Fig. 3 is an elevation of the trough oscillating mechanism, with the nearer supporting beam removed. Fig. 4 is a plan of the same, with the shaft of the oscillating lever broken for want of room. Fig. 5 is a plan of the apparatus, just above the furnace G, with the oscillating mechanism and the furnace omitted for want of room upon the drawing. Fig. 6 is an elevation of the feed bin and adjacent parts, in section through the overflow channel at the left of the broken line *y*. Fig. 7 is a plan of the feed bin. Figs. 8 and 9 are diagrams showing, respectively, a sectional elevation and plan of a horizontal drier.

T designates a tower of suitable dimensions to inclose the vertical drying chamber A with vertical air mixing chamber B at one side thereof, and a space B′ at the opposite side

to accommodate the elevator B^2, and give access to the cranks which oscillate the troughs. A feed bin C is sustained in the tower above the drying chamber A, and a spout C^2 discharges the material from the elevator into the center of the bin. A discharge hopper D is sustained below the drying chamber and receives the material therefrom. Spaces C′ and D′ are provided at opposite ends of the drying chamber.

The air mixing chamber communicates with the top of the drying chamber through the space C′ beneath the feed bin, but is cut off from the space D′ by a partition D^2. A fan E is provided, as shown in Fig. 5, to draw the air from the lower part of the mixing chamber through trunk E′, and deliver it into the space D′ at the bottom of the drying chamber.

An outlet pipe F in the top of the tower provides for a continuous discharge of the required portion of the partially saturated air, and may be provided with damper F′ as shown in Fig. 2, to regulate the discharge, or may be furnished with a suction blower, the speed of which may be regulated for the same purpose. A furnace G is shown adjacent to the mixing chamber with its flue G′ extended upward by the side of the same and connected therewith near the top of the mixing chamber by inlet H. A gate I is hinged upon the inlet and provided with weighted lever I′ and cord I^2 to open the gate at pleasure. When closed the hot air escapes at the top of the flue. The cord is shown in Fig. 7 extended to a pulley upon the wall of the tower, from which pulley it may be carried to any convenient point for actuation by the operator. The cord is not shown in Fig. 2 on account of the smallness of the scale upon which such figure is drawn. The bottom of the feed bin is formed with a series of slots having concave walls *s*, between which a series of oscillating valves *v* is fitted, each having two grooves or chambers *v′* which alternately receive and discharge the material from the bottom of the slot when the valve is oscillated. The partitions between the slots are formed at the top with acute edges *s′*. Two rotary shafts J are mounted transversely across the bin near the middle line, and provided with chain wheels J′. Shafts provided with similar wheels J^2 are mounted near the outer edges of the bin, and endless chains connect the wheels upon the middle shaft to those at the edges, and carry transverse bars *k* with blades *k′*. The chute C^2 discharges the material between the shafts J, and the chains are so propelled as to carry the blades upon the under sides of the wheels from the center of the bin toward the sides, thus distributing and leveling the material. The blades, as shown in Fig. 7, are inclined from the middle line of the bin toward the ends, so that the motion of the blades spreads the material in every direction.

An overflow channel K is provided at a suitable level at the side of the bin, and conducted to a point where the operator can observe the same and control the supply of material to the bin by stopping the elevator or its supply. The drying chamber is provided with numerous series of oscillating duplex troughs *t* arranged in horizontal tiers, the pivots of the alternate tiers being provided with cranks *u*, and of the intermediate tiers with cranks *u′*, outside the wall of the chamber. The cranks of each tier are coupled by a common link *w*. An oscillating lever *a* is mounted upon the shaft *a′* in the bottom of the space B′, and connecting-rods *c* and *c′* are coupled to the ends of the same, and to arms *b* which operate one duplex trough in each tier, and thus moves the remainder simultaneously by means of the links *w*. Cranks *d* coupled by link *d′* are attached to the pivots of the valves *v*, and chains e^3 are extended from a double arm e^2 upon one of the pivots to the oscillating lever *a;* thus securings the oscillation of the feed valves when the duplex troughs are actuated. The upper ends of the chains e^3 are shown in the drawings upon Fig. 6, and their lower ends would be extended to the holes which are shown within its ends upon the arm *a* in Fig. 3. The movement of the arm thus actuates the valves and troughs simultaneously. An arm *f* is attached to the shaft of the lever *a* and provided with a crank pin *g* to which reverse pawls *h*, *h′*, are fitted. The pawls are mounted by a pivot *i* upon a reciprocating frame L, which is hinged upon pivoted arms M, one of which is provided with an arm M′ actuated by an eccentric Q. The eccentric is shown in Fig. 1 mounted upon a shaft having a driving pulley Q′ which, like the spindle of the fan E, would be rotated by any suitable means. Cams *l*, *l′*, are mounted by a shaft *m* upon the frame, and provided with notches adapted to admit tail-pieces *m′* projected from the rear ends of the pawls. A ratchet wheel *n* is fixed by a shaft *o* upon the same frame and connected with the cams and their shaft *m* by gear wheels *p*, and a pawl or tooth *q* is fixed adjustably by the side of the reciprocating frame to engage the teeth of the ratchet wheel at each reciprocation of the frame. The tooth is shown pressed normally toward the periphery of the ratchet wheel by weight *q′*. The oscillation of the frame moves the edge of the ratchet wheel over the end of the tooth, and causes the latter to engage the ratchet teeth and push the wheel around as desired. A set screw *r* is provided to regulate the proximity of the tooth *q* to the ratchet wheel, and as the frame L moves in an arc by its connection with the arms M, the tooth may be thus made to engage the ratchet wheel sooner or later, and thus vary the feed, as may be desired. The pawls are provided with hooks *e*, *e′*, which point in opposite directions, and with fingers h^2 which guide the hooks into contact with the crank pin *g*, and the cams *l*, *l′*, have their notches arranged opposite one another, so that the pawls are permitted to fall alternately into engagement

with the crank pin. The first reciprocation of the pawl, after the tail-piece m' has fallen into the notch of the cam, serves to shift the arm f (as shown of the pawl h' in Fig. 3), and thus to actuate the oscillating lever a, the duplex troughs, and the valves v. The subsequent reciprocations of such pawl produce no further effect, and the succeeding rotation of the cams operates to raise such pawl and to drop the opposite pawl after a suitable interval of time. The feed bin being filled and the material suitably leveled, the valves v serve to discharge an equal supply of the material upon all of the duplex troughs in the upper part of the drying chamber.

The acute edges s' upon the partitions between the valves serve to prevent the clogging of the material and to lead it freely into the valve chambers v'. The material drops through the space C′ upon the upper tier of troughs, and is discharged downwardly from one tier to another until it drops through the space D′ into the hopper D; from whence it would be discharged and removed in any suitable manner.

The operation of the recirculating current, as indicated by arrows z, is as follows: The fan E continuously circulates the air through the mixing chamber and drying chamber, by drawing it from the mixing chamber and discharging it into the lower part of the drying chamber, or space D′, from whence it passes upward between the troughs and falling material, and enters the upper end of the mixing chamber through the space C′. At this point, the recirculating current receives the desired proportion of highly heated air from the flue inlet H, such portion of air being determined by the discharge of saturated air from the outlet pipe F in the top of the apparatus. Before such highly heated air enters the drying chamber, it mingles with the recirculated current in its progress through the entire length of the mixing chamber, and through the fan E, and is thus reduced to the desired temperature before it enters the drying chamber.

A drier with horizontal movement of the material is shown in Figs. 8 and 9, where the drying chamber A contains a series of endless aprons A′, which extends nearly to the ends of the chamber, leaving the spaces C′ and D′ at the opposite ends. An aperture A^3 is shown at the top of the drying chamber and another A^2 at the bottom, to represent the inlet and outlet for the material. The furnace G is shown with passage H extending directly into the space C′, and provided with dampers or valves I^3. The fan E is placed adjacent to the space D′ outside of the drying chamber and connected therewith with a suitable inlet pipe, and the air mixing chamber is formed of a pipe B connecting the suction inlet of the fan with the space C′. The outlet F in the top of the mixing chamber is shown provided with a blower F′ to regulate the discharge, and thus determine the influx of heated air through the inlet H. The furnace is shown supplied with a separate chimney flue G^2 and with damper G^3. The operation of the air current is precisely the same in this construction, the recirculating current moving from the space D′ to the space C′, where its temperature is renewed with the desired proportion of heated air; which is mixed therewith in the pipe or chamber B and then discharged by the blower into the space D′.

It is immaterial how the rotary motion be imparted to the pulleys K^2 (which actuate the leveling blades), to the elevator, to the fan E, and the eccentric Q, which operates the feed devices; but I have shown in Figs. 1 and 2 suitable connections for conveying the motion to these parts from a single shaft R. Pulleys and belts, to furnish such connections, are shown in dotted lines to avoid obscuring the other parts of the drawing, a pulley R′ being furnised to drive the blower by a suitable belt r', a pulley or sprocket wheel S to drive the shaft of the eccentric Q by belt s; and belts s' and s^2 being applied to suitable pulleys or sprocket wheels for driving the elevator and one of the shafts J. Fig. 7 shows spur wheels k^2 connecting the shafts J, and the wheel s^3 for receiving the belt s^2. Link belts would be used if sprocket wheels are employed. Any other suitable connections may be employed.

Having thus set forth the nature of my invention, what I claim herein is—

1. A drying apparatus comprising a drying chamber with an outlet for discharging a regulated portion of the saturated air, an air mixing chamber for mixing the partly saturated air with a fresh portion of highly heated air, the mixing chamber having connections at opposite ends to the drying chamber with a circulating fan interposed in one of the said connections, and the said mixing chamber having an inlet for heated air, the whole arranged and operated as herein set forth.

2. A drying apparatus comprising a drying chamber having an inlet for the material, with means for advancing the material progressively through the chamber, and means for discharging a regulated proportion of the saturated air, a separate air mixing chamber having connections to the drying chamber at opposite ends with a circulating fan interposed in one of said connections, and the said mixing chamber having an inlet for heated air, the whole arranged and operated substantially as herein set forth.

3. In a drying apparatus, the combination, with a vertical drying chamber, of a feed bin at the top of the chamber with valves in the bottom, a chute for delivering the material into the bin, leveling blades arranged to move across the upper part of the bin, and an overflow channel adjacent to the level of the blades to serve as a tell-tale indicator.

4. In a drying apparatus, the combination, with a vertical drying chamber, of a feed bin at the top of the chamber, the feed bin hav-

ing a series of concave-walled slots in the bottom, acute edged partitions between the slots, and a series of oscillating carriers fitted to the concave walls of the slots, with means for actuating them intermittingly.

5. In a drying apparatus, the combination, with a tower containing a vertical drying chamber, with a vertical air mixing chamber at one side of the same, and an elevator chain with lifting buckets at the opposite side of the same, of a furnace with outlet for the heated gases into such mixing chamber, a feed bin at the top of the drying chamber with chute leading from the elevator, and sundry series of oscillating duplex troughs pivoted in tiers within the drying chamber, and means for oscillating the troughs, substantially as herein set forth.

6. In a drying apparatus, the combination, with a drying chamber, having sundry series of oscillating duplex troughs pivoted, in tiers within the drying chamber, of cranks attached to the pivots outside the wall of the chamber, a lever with connections to the said cranks to oscillate the same, an arm for vibrating said lever, with a crank pin having reverse pawls fitted thereto and a reciprocating carriage having the pawls pivoted thereon and provided with rotating cams adapted to drop the pawls alternately upon the crank pin, as set forth.

7. In a drying apparatus, the combination, with a vertical chamber, of a feed bin above the same, a discharge hopper below the same, and means for drawing the air from the chamber below the feed bin and delivering it to the chamber above the discharge hopper, as and for the purpose set forth.

8. In a drying apparatus, the combination, with a vertical drying chamber, of a feed bin sustained above the top of the drying chamber, a discharge hopper sustained below the bottom of the same, an air mixing chamber connected with the drying chamber near the top, and a fan drawing the air from the mixing chamber and delivering it to the drying chamber above the discharge hopper.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

EDWARD M. COOK.

Witnesses:
EDW. F. KINSEY,
THOMAS S. CRANE.