No. 767,727. PATENTED AUG. 16, 1904.

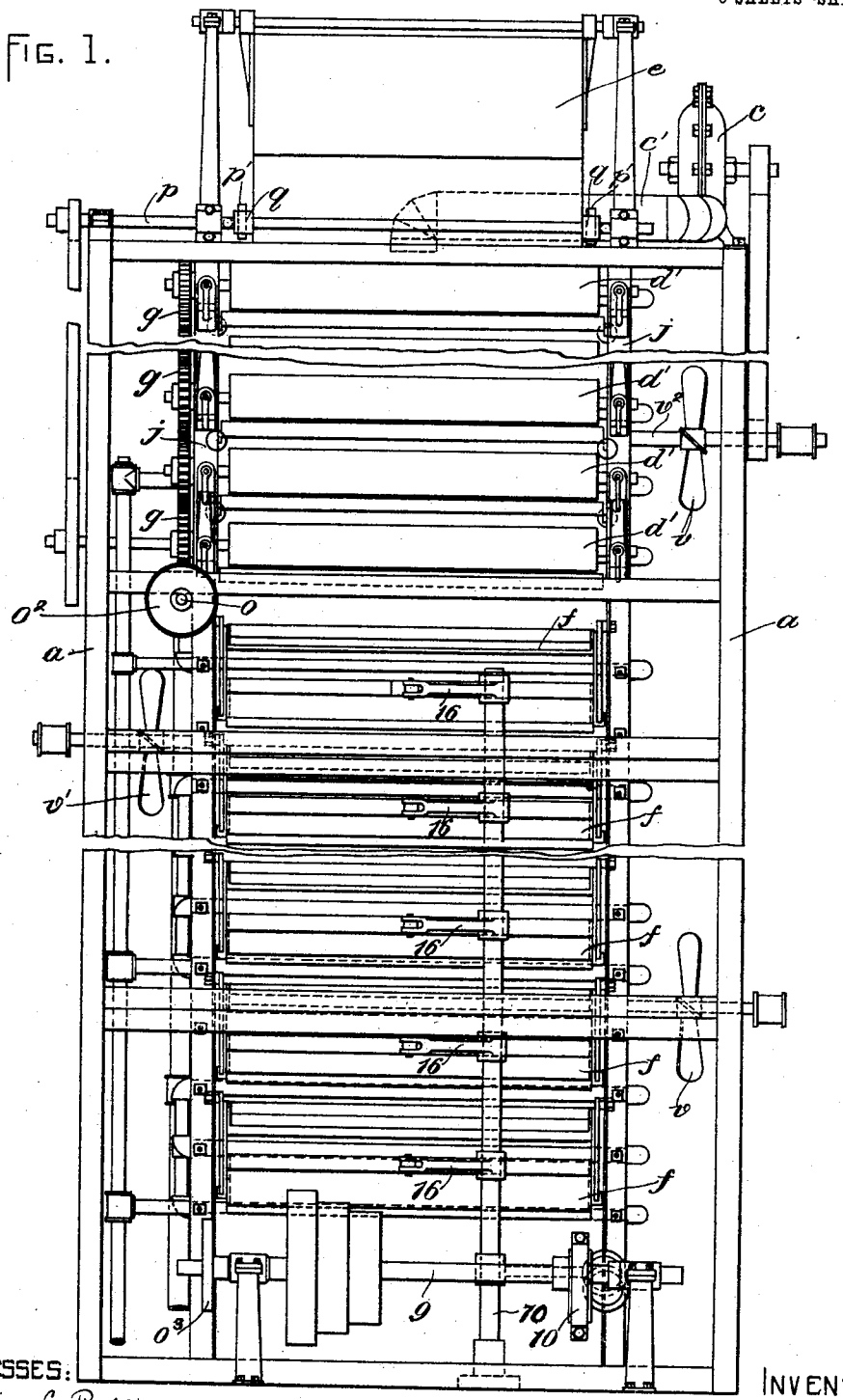
F. E. ALLEN.

DRYING APPARATUS.

APPLICATION FILED MAY 27, 1902.

NO MODEL. 5 SHEETS—SHEET 1.

FIG. 1.



WITNESSES:
Adeline C. Ratigan
E. Batchelder

INVENTOR:
F. E. Allen
by Wright Brown Quinby & Atty's.

No. 767,727. PATENTED AUG. 16, 1904.

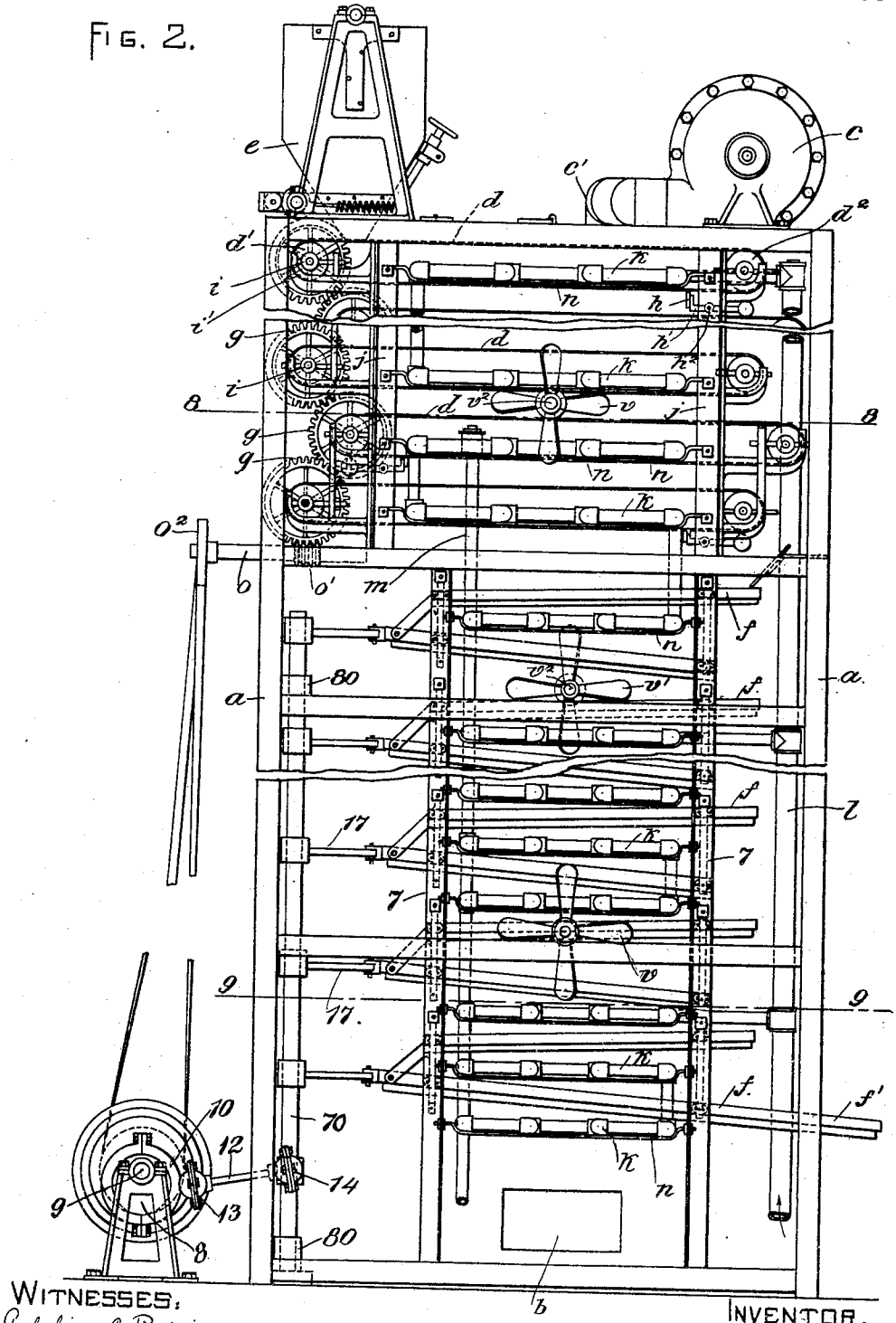
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NO MODEL. 5 SHEETS—SHEET 2.

FIG. 2.



WITNESSES:

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NO MODEL. 5 SHEETS—SHEET 3.

FIG 3.

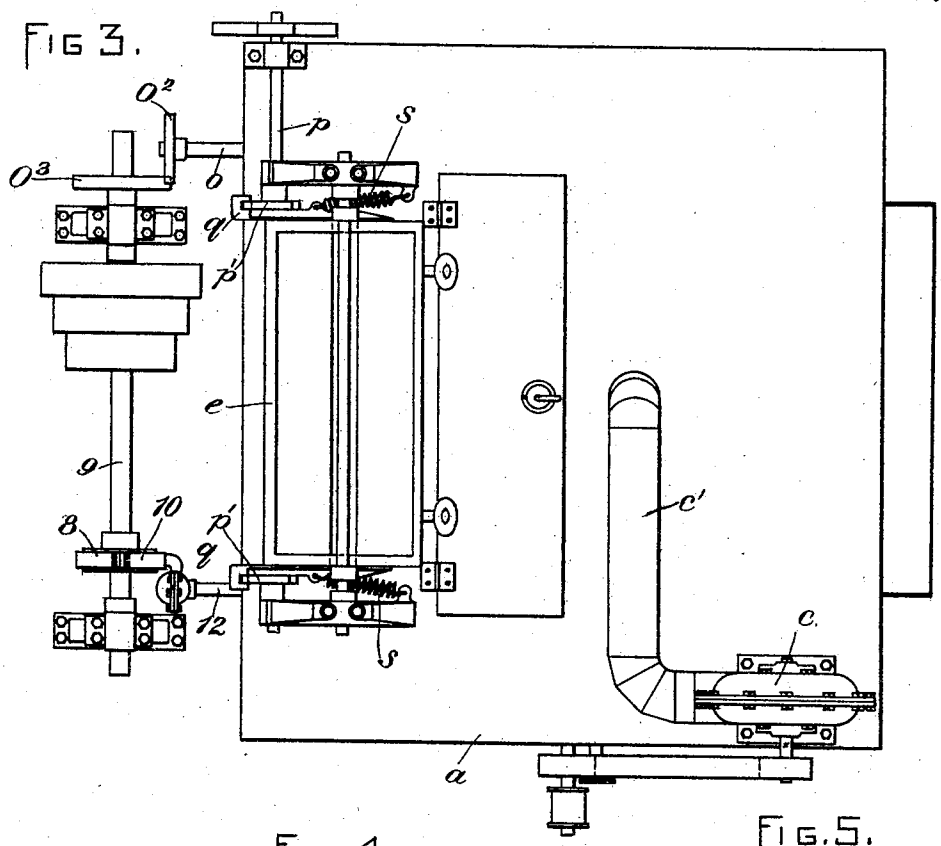


FIG. 4.

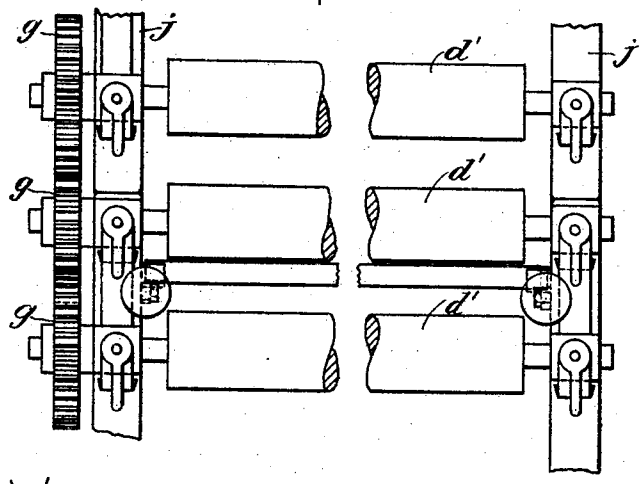
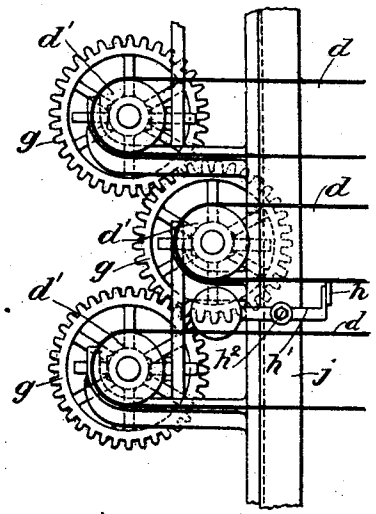


FIG. 5.



WITNESSES:

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NO MODEL. 5 SHEETS—SHEET 4.

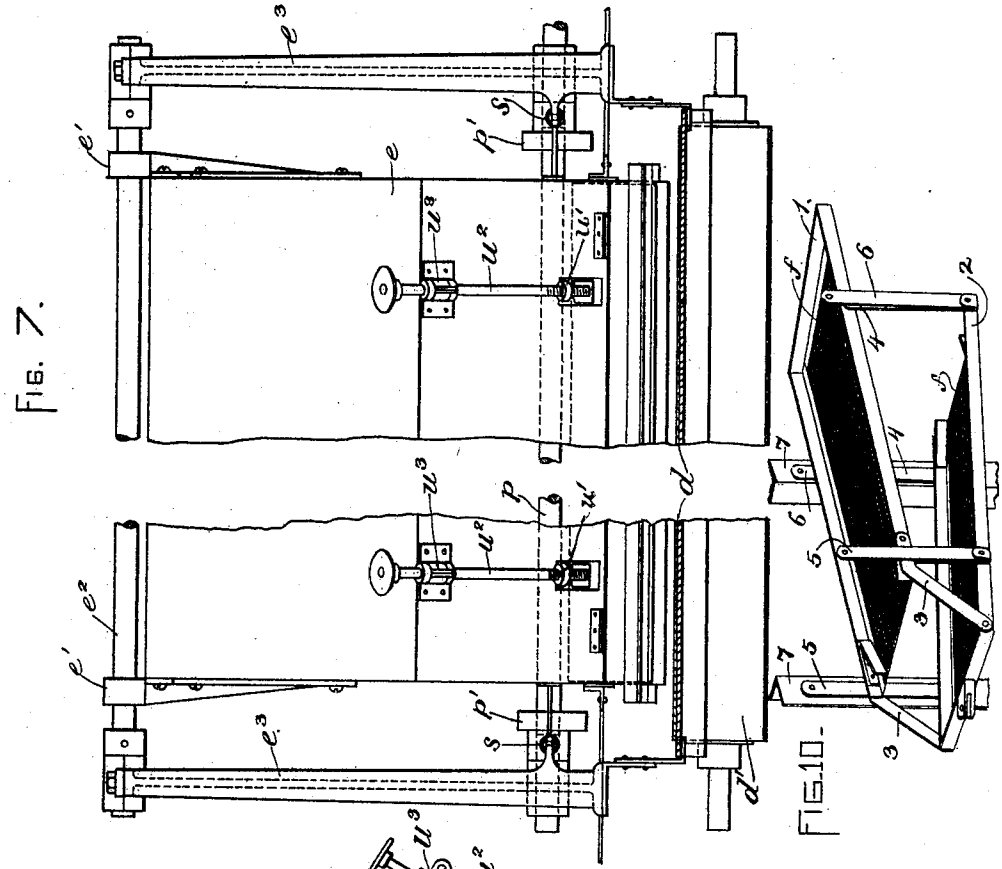


FIG. 7.

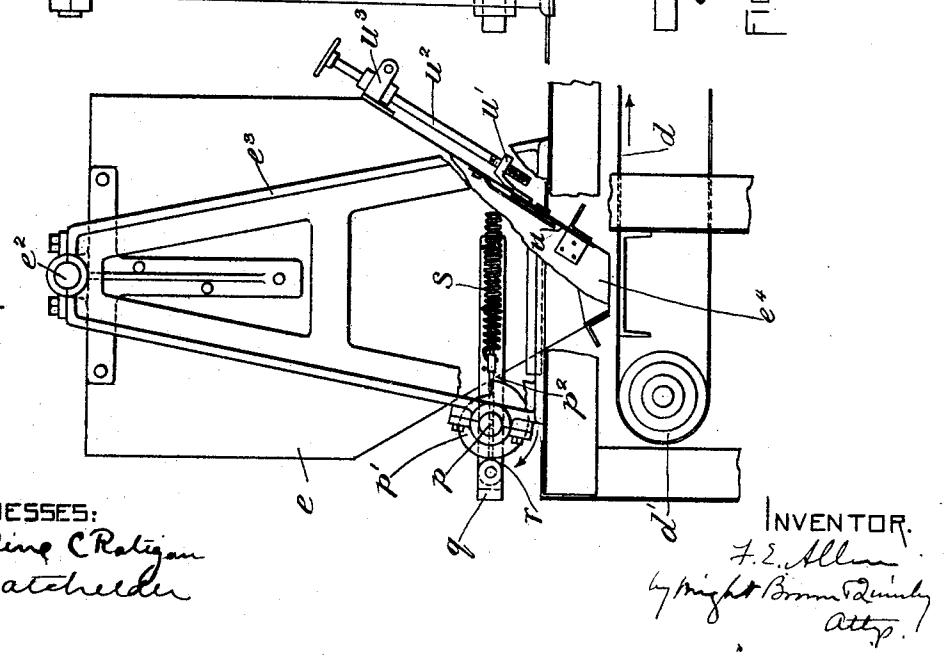


FIG. 10.

FIG. 6.

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No. 767,727. PATENTED AUG. 16, 1904.

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DRYING APPARATUS.

APPLICATION FILED MAY 27, 1902.

NO MODEL. 5 SHEETS—SHEET 5.

FIG. 8

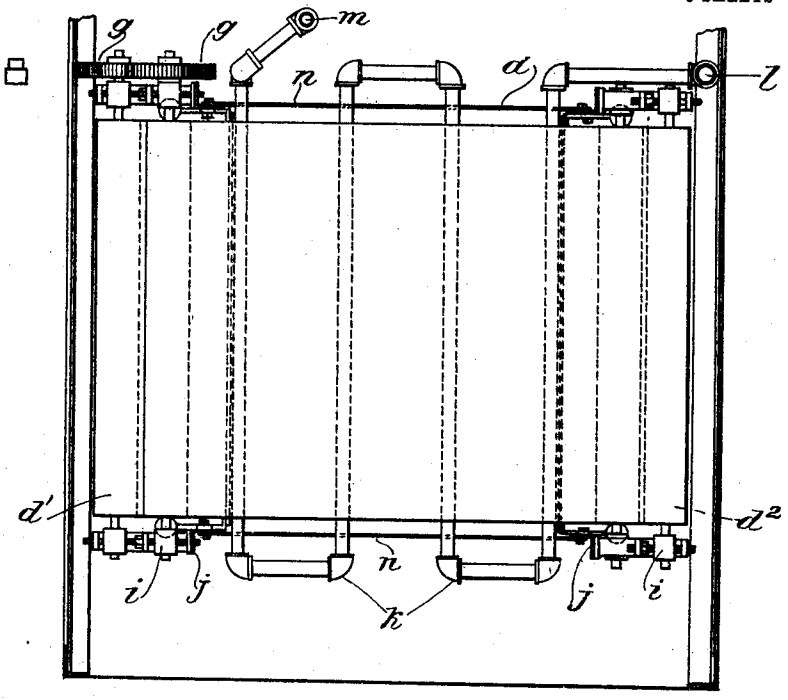
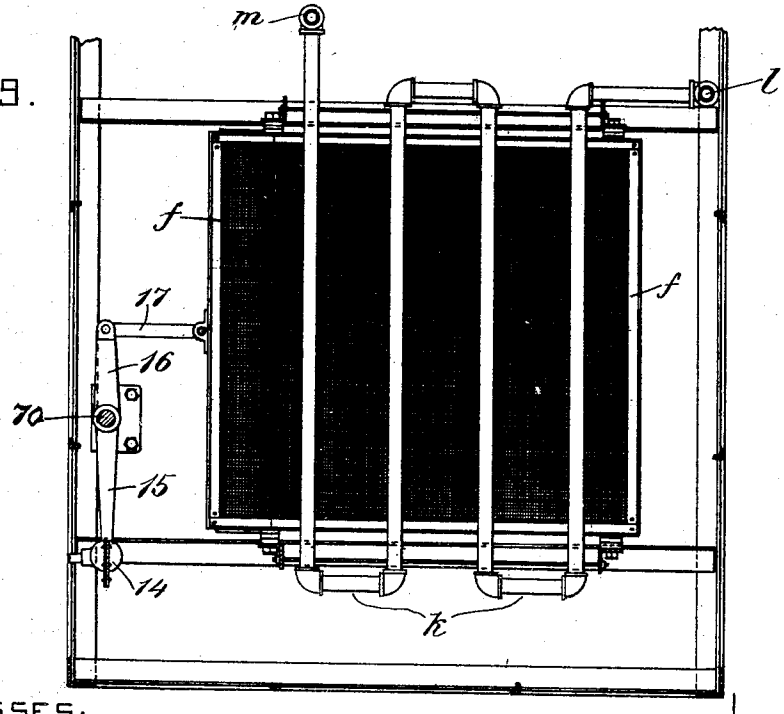


FIG. 9.



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No. 767,727. Patented August 16, 1904.

UNITED STATES PATENT OFFICE.

FREDERICK E. ALLEN, OF BOSTON, MASSACHUSETTS.

DRYING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 767,727, dated August 16, 1904.

Application filed May 27, 1902. Serial No. 109,208. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK E. ALLEN, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Drying Apparatus, of which the following is a specification.

This invention has for its object to provide a compact and efficient apparatus for drying various articles or commodities—such as coffee-berries, cereals, sugar, fruit, vegetables, &c.—the particular object of the invention being to enable materials which before drying are of a somewhat sticky nature to be readily circulated and passed in a sinuous downward course while in contact with heated air until they are thoroughly dried.

The invention consists in the improvements which I will now proceed to describe and claim.

Of the accompanying drawings, forming a part of this specification, Figures 1 and 2 represent elevations of the apparatus from different sides, the walls of the casing being removed to show the internal parts. Fig. 3 represents a top plan view of the apparatus. Fig. 4 represents a side elevation showing some of the rolls or pulleys which support the endless carriers or belts hereinafter referred to. Fig. 5 represents an end elevation of the parts shown in Fig. 4 and in addition thereto parts of three of the endless carriers. Fig. 6 represents an end elevation of the oscillating hopper and one of its supports and a sectional view of a portion of the casing. Fig. 7 represents a side elevation of the hopper and a sectional view of a portion of the casing. Fig. 8 represents a section on line 8 8 of Fig. 2 and a plan view of the parts below said line. Fig. 9 represents a section on line 9 9 of Fig. 2 and a plan view of the parts below said line. Fig. 10 represents a perspective view showing two of the inclined carriers hereinafter referred to.

The same characters of reference indicate the same parts in all the figures.

My improved drying apparatus comprises a vertically-elongated casing composed of suitable uprights *a a* and connecting bars or members, the whole forming a rectangular frame of the desired height, and suitable side pieces forming the walls of the casing and filling the spaces between the frame parts or members. I do not deem it necessary to describe the construction of the casing in detail, it being sufficient to say that it provides an inclosure for the carriers, the heating apparatus, and the air-circulating apparatus hereinafter described, the lower portion of the casing being preferably provided with an air-inlet *b* and the upper portion with an exhaust apparatus *c*, which is preferably an exhaust-fan, the casing of which is connected by a flue *c'* with the upper portion of the casing, so that the exhaust apparatus removes from the upper portion of the casing the moisture-laden air therein. In the upper portion of the casing are located a series of endless carriers or belts *d*, each supported by two pulleys d' d^2, the belts being of suitable width so that they are adapted to receive layers of material to be dried from the hopper *e*, hereinafter described. The stretches of the belts between the pulleys d' d^2 are substantially horizontal, and the belts are arranged so that the upper belt discharges its load upon the next belt below it, each belt in turn discharging upon the next lower belt until the lowest belt of the series is reached, this belt discharging its load upon the upper one of a series of reciprocating inclined conveyers *f*. The arrangement of the belts whereby the load of one belt is discharged upon the next lower belt is clearly shown in Figs. 2 and 5, the pulleys supporting one belt being offset from or out of alinement with the pulleys supporting the next lower belt. The belts are driven progressively by means of a train of gears *g*, affixed to the belt-supporting pulleys d', and suitable driving mechanism hereinafter described which imparts motion to the said train of gears, the arrangement being such that the upper stretch of each belt moves in an opposite direction from the direction of movement of the upper stretch of the next belt, so that material deposited upon the highest belt by the hopper *e* is carried horizontally nearly across the casing, is then discharged upon the next belt and carried in the opposite direction nearly across the casing, and so on.

h h represent scrapers which bear upon the lower stretches of the belts and dislodge there-

from any of the material which may fail to drop from the belt by gravitation. Each scraper is attached to weighted arms h', which are pivoted at h^2 to suitable supports within the casing, the weights on said arms acting as counterbalances.

The belt-supporting pulleys d' d^2 are journaled in bearings i, which are preferably mounted on arms i', affixed to uprights j within the casing, said bearings i being horizontally adjustable in the directions required to cause the pulleys supported by them to tighten or loosen the belts d.

The belts d may be made of any suitable flexible material—such as canvas, leather, &c.—and, if desired, they may be made of woven-wire fabrics of suitable fine mesh.

The inclined carriers f, which may be composed of rectangular frames with a suitable filling or bottom of woven-wire or other suitable fabric, are preferably connected in pairs, as shown in Fig. 10. I have designated the two conveyers f of each pair by the numerals 1 and 2. Said members are inclined in opposite directions, the member 1 being arranged with its delivering or lower end over the receiving or higher end of the member 2, so that the material which is caused to fall from the member 1 by the inclination and by the reciprocating movements of the members hereinafter described drops onto the higher or receiving end of the member 2, the latter being arranged with its delivering end over the higher or receiving end of the member 1 of the next pair below. The members 1 and 2 are rigidly connected by any suitable means, such as rods 3 3 and 4 4, rigidly attached to the frames of said members. The pair of members 1 and 2 are supported in such manner that they are adapted to oscillate in unison by links 5 5 and 6 6, pivoted at their upper ends to frame-uprights 7 7, rigidly secured within the casing, and at their lower ends to the member 2. There may be as many pairs of members 1 and 2 as the height of the casing will admit, and these members are reciprocated longitudinally by the following mechanism:

70 represents a vertical rock-shaft journaled in fixed bearings 80 80, affixed to the casing-frame. Said rock-shaft is oscillated in its bearings by means of an eccentric 8 on the driving-shaft 9, which is journaled in fixed bearings outside the casing, a strap 10 embracing said eccentric, and a rod 12, connected by a ball-and-socket joint 13 with the strap 10 and by a ball-and-socket joint 14 with one end of an arm 15, affixed to the rock-shaft 70. To the rock-shaft are affixed a series of arms 16, projecting from the opposite side of the rock-shaft from the arm 15, there being as many arms 16 as there are pairs of inclined conveyers, each arm 16 being connected by a link 17 with the lower member 2 of each pair of conveyers. It will be seen that the rotation of the driving-shaft 9 imparts an oscillatory or rocking motion to the rock-shaft 70, this motion being imparted through the arms 16 and links 17 to the inclined conveyers, so that all the inclined conveyers of the series are simultaneously reciprocated. This reciprocating movement in connection with the inclination of the inclined conveyers causes the material which falls upon the higher ends of the conveyers to move to the lower ends and drop therefrom, so that the material delivered by the lowest belt d of the series after being carried by the series of belts in a sinuous course through the upper portion of the casing is carried in a sinuous course through the lower portion of the casing by the conveyers f. The lowest conveyer f of the series has an extension f', which projects through an opening in one side of the casing and serves as a delivery-spout through which the dried material passes to a suitable external receptacle. In case the body portions of the inclined conveyers f are made of woven wire I consider it preferable to provide the lowest conveyer f with a closed or imperforate body to prevent any particles of the dried material from being sifted through it and falling to the bottom of the casing.

As above stated, air is admitted to the casing through an opening b in the lower portion thereof, said opening being preferably provided with a sliding cover whereby it may be opened and closed. The air thus admitted is heated by a series of horizontal radiators or manifolds k k, which are arranged in suitable proximity to the inclined conveyers f and to the endless conveyers d. The preferred form of said radiators or manifolds in plan view is shown in Figs. 8 and 9. The receiving end of each radiator is connected with a vertical supply-pipe l, which is connected with a supply of live steam, the delivering ends of the radiators being connected with a vertical exhaust-pipe m, by which the exhaust-steam and the water of condensation may be carried to a steam-trap or to any suitable outlet. I prefer to alternate the radiators with the conveyers in the manner shown in Fig. 2, where I show radiators k located under nearly all of the inclined conveyers f and interposed between the upper and lower stretches of each of the belts d. Said radiators are preferably supported by horizontal rods or bars n, affixed at their ends to the uprights 7 7 and j j, as clearly shown in Fig. 2.

The driving-shaft 9 imparts motion not only to the inclined conveyers f through the mechanism above described, but also to the train of gears g, whereby the belts d d are progressively impelled. The means for communicating motion from the driving-shaft to the gears g, as here shown, comprise a shaft o, journaled in fixed bearings in the casing and provided with a worm o', which is formed to mesh with the teeth of the lower gear g and

with a wheel or pulley o^2, which may be connected by a belt or by a sprocket-chain with a corresponding wheel or pulley o^3 on the driving-shaft. It follows, therefore, that the rotation of the driving-shaft imparts motion simultaneously to the endless conveyers d and to the inclined conveyers f.

The hopper e is provided with ears e' e', Fig. 7, which are mounted to oscillate upon a rod e^2, affixed to vertical brackets e^3 e^3, mounted upon the top of the casing. The lower portions of the sides of the hopper are inclined inwardly to form a contracted outlet e^4, which extends through an opening in the top casing and is arranged in close proximity to the upper stretch of the highest belt d. Means are provided for oscillating the hopper, the oscillating movement in one direction being abrupt, so as to jar or agitate the contents of the hopper and cause them to descend freely, the movement in the opposite direction being gradual and opposite to the direction of movement of the upper stretch of the receiving-belt d, so that after the agitation of the contents of the hopper the said contents are spread or distributed to a certain extent over the upper surface of the belt by the gradual movement of the hopper in a direction opposite to the direction of movement of the belt. The means here shown for oscillating the hopper in the manner described comprise a shaft p, journaled in bearings on the brackets e^3 and continuously rotated by power suitably applied, cams p' p', affixed to said shaft, each cam having a shoulder p^2, Fig. 6, arms q q, affixed to the ends of the hopper, each arm having a roller r, which bears against the perimeter of the cam, and springs s s, which are affixed to the arms q and to the brackets e^3 and act to hold the rollers r yieldingly against the perimeters of the cams. The rotation of the cams being in the direction indicated by the arrow in Fig. 6, it will be seen that when the shoulders p^2 of the cams reach the rollers r they will suddenly release the arms q and permit the springs s to abruptly swing the hopper to the right as viewed in Fig. 6 until the rollers reach the shorter radius of the cam. This abrupt movement jars or agitates the contents of the hopper. Thereafter the perimeters of the cams move the hopper gradually toward the left as viewed in Fig. 6, causing the hopper to distribute the material upon the upper stretch of the belt, which is moving toward the right. The hopper is provided with an adjustable gate u, having ears u', provided with screw-threaded orifices which are engaged by the screw-threaded portions of rods u^2, journaled in bearings u^3 on the hopper. The rotation of said rods adjusts the gate vertically, and thus varies the outlet capacity of the hopper.

To facilitate the circulation of the heated air within the casing and over the material spread upon the carriers, I provide two series of air-circulating fans v and v'. The fans v are located near one side of the casing, and the fans v' are located near the opposite side of the casing and alternate with the fans v. Said fans are affixed to shafts v^2, which may be rotated by any suitable means, each fan being arranged to force the current of air in a substantially horizontal direction across the casing and across the layers of material spread upon the carriers. It will be seen that the described relative arrangement of the fans v and v' enables currents of air to be driven back and forth across the casing through practically all parts of the casing, so that there is an efficient circulation of air in contact with all parts of the material passing through the casing. It will also be seen that the fans v v' act independently of the exhaust apparatus e and that said fans v v' will therefore circulate the air within the casing and force air-currents crosswise of the casing without drawing air into or forcing it from said casing. In other words, the internal fans v v' agitate the air that is within the casing, while the independent exhaust apparatus operates to remove from the casing a lesser volume of air than that acted on by the circulators v v'. Consequently only sufficient air need be withdrawn from the casing to remove the excess of moisture, while the fans v v' circulate the air that is within the casing to effect the drying in an economical manner.

It will be seen that the endless conveyers located at the upper portion of the casing provide for a circulation of the fresh material while it may be in a damp and sticky condition and the subjection of the same to the heated air in the upper portion of the casing until the material has become sufficiently dried to so far lose its sticky quality as to be able to pass along the inclined conveyers f.

The inclined conveyers and their supporting and driving means are less expensive and complicated in construction than the endless conveyers and are therefore preferable so far as economy and rapidity of operation are concerned; but there are many materials which in their original condition before being partially dried are too sticky to pass over the inclined conveyers. Hence the utility of the endless conveyers for the preliminary drying of the material will be apparent. The material delivered by each endless conveyer or belt to the next is practically turned over, and its parts occupy different positions on each belt from those occupied on the preceding belt.

The scrapers h are of especial importance when sticky materials are being dried, each scraper dislodging any material that may be carried onto the under stretch of the belt and causing it to drop on the next belt below.

I claim—

1. A drying apparatus comprising a casing, a vertical series of substantially horizontal carriers therein adapted by the aid of gravita-

tion to conduct a stream of material in a sinuous course downwardly through the casing, heating means comprising a vertical series of substantially horizontal radiators or manifolds arranged in operative proximity to said carriers, and air-circulating means within the casing adapted to force air-currents crosswise of the casing without drawing air into or forcing it from said casing, means being provided for agitating the material while subjecting it to the air-currents.

2. A drying apparatus comprising a casing, a vertical series of substantially horizontal carriers therein adapted by the aid of gravitation to conduct a stream of material in a sinuous course downwardly through the casing, heating means comprising a vertical series of substantially horizontal radiators or manifolds arranged in operative proximity to said carriers, and air-circulating fans within the casing arranged to force air-currents back and forth across the casing without drawing air into or forcing it from said casing, means being provided for agitating the material while subjecting it to the air-currents.

3. A drying apparatus comprising a casing, a vertical series of substantially horizontal carriers therein adapted by the aid of gravitation to conduct a stream of material in a sinuous course downwardly through the casing, heating means and air-circulators within the casing, means for agitating the material while subjecting it to the air-currents, and an exhaust apparatus adapted to draw the moisture-laden air from the upper portion of the casing, the air-circulators being adapted solely to agitate the air within the casing, and the exhaust apparatus being independent of the circulators to remove a lesser volume of air than that acted on by the circulators.

4. A drying apparatus comprising a casing, a vertical series of substantially horizontal carriers therein adapted by the aid of gravitation to conduct a stream of material in a sinuous course downwardly through the casing, an oscillatory hopper located mainly above the casing and having its delivering end within the casing over the highest carrier of the series, and means for oscillating and jarring the said hopper in the direction of the feed of the material.

5. A drying apparatus comprising a casing, a series of endless carriers or belts and supporting-pulleys therefor located in the upper portion of the casing, each belt having substantially horizontal stretches, a series of inclined longitudinally-movable carriers located in the casing below the belts, and carrier-operating mechanism having provisions for moving the endless carriers progressively and for reciprocating the inclined carriers, the lowest inclined carrier being extended and projecting as a discharge-spout through an opening in the casing.

6. A drying apparatus comprising a casing, a carrier therein adapted to move a layer of material, an oscillatory hopper arranged to deliver material to said carrier, and means for oscillating and jarring said hopper, said hopper being pivoted to swing on a horizontal axis.

7. A drying apparatus comprising a casing, a carrier therein adapted to move a layer of material, an oscillatory hopper arranged to deliver material to said carrier, said means having provisions for giving the hopper an abrupt movement in one direction and a gradual movement in the opposite direction, said hopper being mounted to oscillate on a horizontal axis.

8. A drying apparatus comprising a casing, a carrier therein adapted to move a layer of material, an oscillatory hopper mounted to swing on a horizontal axis and arranged to deliver material to said carrier, a shaft adjacent to the hopper and provided with cams, arms affixed to the hopper and having rollers bearing on said cams, and springs arranged to press said rollers yieldingly against the cams, whereby a slow movement is imparted to the hopper in one direction and an abrupt jarring movement in the other direction.

In testimony whereof I have affixed my signature in presence of two witnesses.

FREDERICK E. ALLEN.

Witnesses:
C. F. BROWN,
E. BATCHELDER.