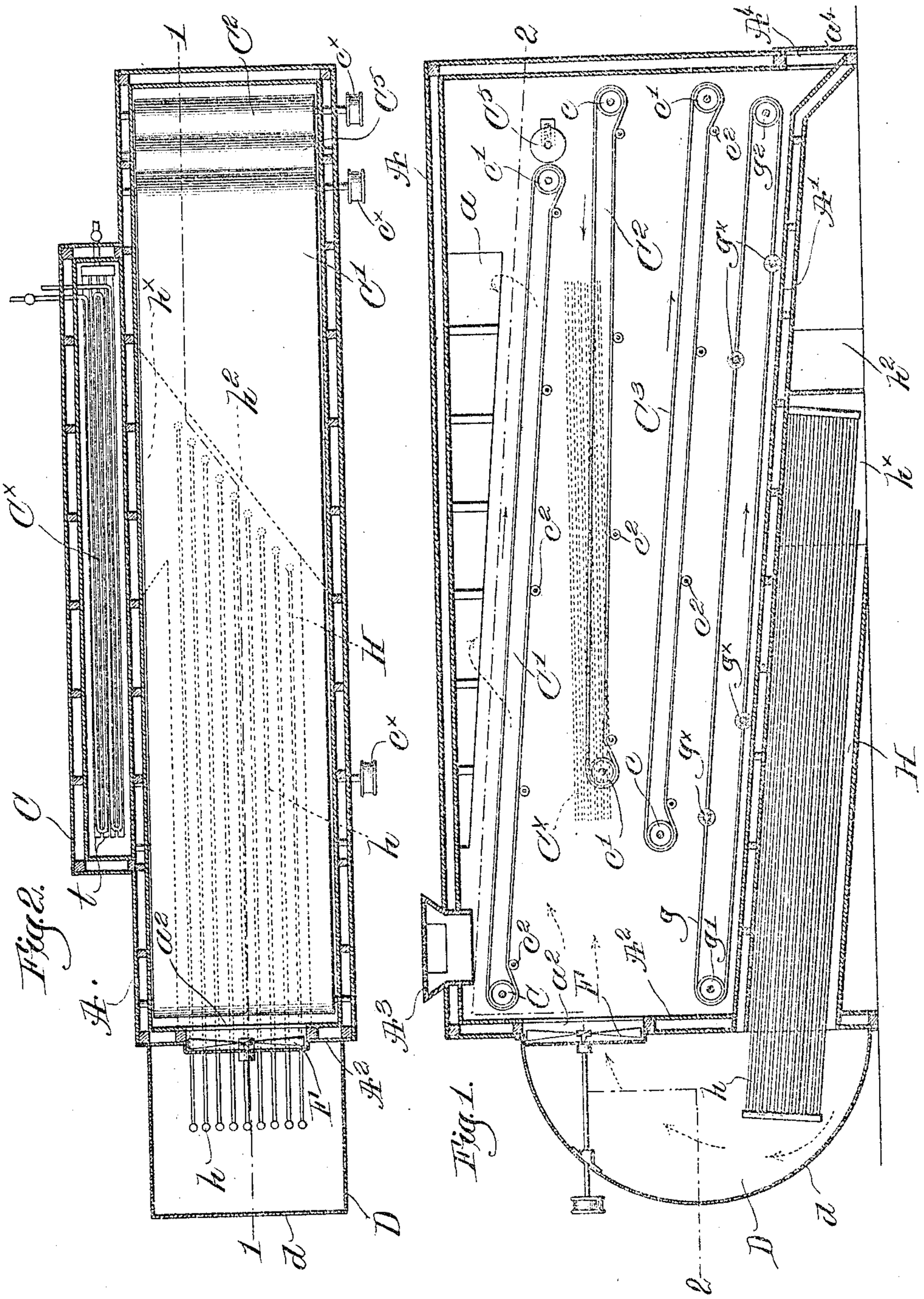
No. 815,373. PATENTED MAR. 20, 1906.

E. E. PERKINS.

APPARATUS FOR DRYING STARCH, &c.

APPLICATION FILED DEC. 9, 1904



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR DRYING STARCH, &c.

No. 815,373. Specification of Letters Patent. Patented March 20, 1906.

Application filed December 9, 1904. Serial No. 236,133.

To all whom it may concern:

Be it known that I, ELMER E. PERKINS, a citizen of the United States, and a resident of Melrose, in the county of Middlesex and State of Massachusetts, have invented an Improvement in Apparatus for Drying Starch, &c., of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention has for its object the production of novel drying apparatus for the economical, rapid, and efficient removal of contained moisture from organic material, so that the same is dried to the desired extent in much less time than is now requisite.

My invention is particularly adapted for use in the manufacture of starch, (to mention one instance of its particular utility,) wherein it is desirable that the material may be rapidly dried to the desired extent, but without burning or discoloration and without improper agitation when the drying operation has rendered the material light in weight. It is also equally well adapted for drying brewers' grain, fertilizer, or similar material.

In accordance with my invention the material to be treated is made to traverse by suitable conveying means a long closed drying-chamber, in which it is subjected to the action of a current of hot dry air, whereby moisture is extracted from the material, the moisture-laden air passing out of the chamber to be cooled. Such cooling condenses its contained moisture, and the cooled air so dried is returned to a heater, from which it is forced in a strong blast or current into the drying-chamber, the heater being so separated therefrom and the blast being so directed that the material cannot be overdried or burned by too rapid action of the heat nor blown about when it becomes drier or lighter in weight. The material is fed into the chamber at one end, and at that end the air is forced in, acting on the heavy raw or "green" material, meaning thereby in the condition in which it is introduced to the chamber. As the material becomes lighter by loss of moisture it is subjected less and less to the direct action of the air blast or current and is finally discharged at the opposite end of the chamber.

I prefer to cause the material to traverse the chamber a plurality of times in order that it may be properly acted upon while therein, and by making the conveying means in several parts or sections the material is turned over and agitated as it passes from the upper run of one section to the upper run of the section next below it.

While my novel drying apparatus is particularly adapted for drying starch, brewers' grain, and fertilizer, it is not in any sense restricted thereto, as it may be used to great advantage in drying various other materials.

The various novel features of my invention will be fully described in the subjoined specification and particularly pointed out in the following claims.

Figure 1 is a longitudinal sectional view of a drying apparatus embodying one form of my invention, taken on the line 1 1, Fig. 2. Fig. 2 is a horizontal longitudinal section thereof below the line 2 2, Fig. 1.

I have herein shown the drying apparatus as comprising an elongated relatively narrow closed chamber A, constructed of suitable material and preferably made to conduct heat poorly—as, for instance, by making its walls double with an inclosed air-space, so that as little heat as possible may be lost by radiation, the chamber having a long outlet *a* in one side wall near the top of the chamber. (See Fig. 2.) The tight floor A′ of the chamber is inclined in the direction of its length, sloping toward the discharge end, and beneath the floor is a heater, shown as a box-like compartment H, Fig. 1, and having therein a heating device, shown as steam-coils *h*, the coils projecting from the front end of the heater into a drum D. This drum is conveniently made of sheet-iron, and its side walls are alined with the sides of the chamber or housing A, the end wall *d* of the drum being curved upward from the bottom of the compartment H to the end wall A^2 of the chamber. A circular opening a^2 is made in the wall A^2 at the upper part of the drum, and in this opening is mounted a suitable fan F, Figs. 1 and 2, the drum acting as a curved flue or conduit connecting the front end of the heater with the adjacent end of the chamber A. I prefer to make the area of the opening a^2 substantially equal to the cross-sectional area of the heater H to get a full steady current of air. The fan is rotated at speed in any convenient manner, electrically or mechanically, and is arranged to draw air from the heater and force it in a blast or strong current in a substantially horizontal direction into the chamber from the front end thereof.

Outside of the chamber and adjacent its side wall, having the outlet *a*, is an upright, long, and relatively narrow cold compartment C, (see Fig. 2,) communicating by the outlet *a* with the chamber and at its bottom communicating with the heater at its side, at $h^{\times}$, the rear end wall h^{2} of the heater crossing below the floor A′ diagonally, as shown by dotted lines, Fig. 2, to give the air-current a gradual sweep into the heater and to avoid dead-air spaces or pockets. A condensing device is located within the compartment C, below the outlet *a*, shown as a series of coils or piping $C^{\times}$, through which any suitable cooling or refrigerating medium is passed to reduce the temperature of the compartment to the desired point.

At the front end of the chamber A a closed feed-hopper A^{3} is provided, opening into the chamber above the conveying means, to be described, the material being fed into the hopper by any suitable means, forming no part of my invention, and a suitable discharge-opening A^{4} is provided at the opposite or rear end of the chamber and covered by a curtain or other suitable closure a^{4} to prevent outside air entering the chamber and reducing to a very small quantity the escape of air from the chamber.

Within the chamber I have arranged conveying means to receive the material at the feed end, traverse it through the chamber, and deposit it at the discharge end thereof. Herein I have shown three endless traveling conveyers C′, C^{2}, and C^{3}, which may be foraminous or reticulated belts or aprons or slatted flexible belts, the particular character of the conveyer depending upon the nature of the material to be supported and moved thereby. These conveyers or conveyer-sections are arranged one above the other and extend substantially from one to the other side wall of the chamber, the uppermost one being located below the outlet *a*. The arrows show the direction of travel of the upper runs of the several conveyer-sections, Fig. 1, a slight inclination being preferably given the sections C′ and C^{3}, so that the material will travel in a zigzag course as it traverses the chamber. As each section is sustained and operated like its fellows, only one need be described in detail. The flexible carrier or conveyer is supported at its ends on suitable cylinders *c c′*, one of which is positively driven, the other running idle, the journals of the cylinders being sustained by suitable bearings on the side walls of the chamber. The journal of the driving-cylinder will extend through one side wall and have an attached pulley or sheave $c^{\times}$, Fig. 2, for a belt, (not shown,) by which it may be driven from any suitable source of power. I have indicated the several driving-cylinders at *c′*, Fig. 1, the upper run of each conveyer running between the two cylinders *c* and *c′*, while the lower run is supported on idlers c^{2}, which serve to maintain the conveyer properly taut. The right-hand end of the conveyer-section C^{2}, Fig. 1, is extended beyond the adjacent end of the section C′ above it, so that as the material on the latter passes over the cylinder *c′* it will drop onto the upper run of section C^{2} and be thereby carried back through the chamber toward its front end, whence it drops on the section C^{3}. The left-hand end thereof is extended beyond the discharge end of the section C^{3} to catch the material as it drops from section C^{3} onto the upper run of section C^{3} to be carried thereon to the discharge end of the chamber. The upper run of the topmost conveyer-section C′ is located below and quite near the lower edge of the outlet *a*, and as it is better to have the air-current as uniform as possible across the material on such upper run I incline the lower edge of the outlet in parallelism with the upper run of the conveyer-section C′. (See Fig. 1.)

Manifestly the air-blast will act with greater effect at the feed end of the chamber on the fresh material, the force of the blast diminishing toward the opposite end of the chamber, and while there will be an air-current passing across the chamber and out of the outlet *a* it will not have sufficient force to blow about the dry material on the lower conveyer-sections. Some of the material will fall past the conveyers to the floor A′, and this is particularly true of the finer dried particles, and in order to automatically clear the same from the floor I have provided endless bands *g*, just above the floor, carried around suitable cylinders *g′* g^{2}, one of which is positively driven.

Suitable brush-rolls $g^{\times}$ are secured to the bands and are adapted to sweep the material collecting on the floor to the lower end of the floor for removal at the discharge-outlet A^{4}. Any suitable cleaning or sweeping means may be employed, the particular form shown herein being merely an illustration of one convenient device for performing the desired action.

Referring to the drawings, I have shown at the right-hand end of the conveyer-section C′ a roll C^{5}, which may be termed a "breaker-roll," its object being to crush or break up unduly large lumps of material which may be fed onto the conveyer. By breaking up such large lumps into smaller pieces the extraction of moisture therefrom is greatly facilitated. The journal of this breaker-roll may be supported in a yielding manner, so that the roll can yield or give somewhat if very refractory or hard lumps are encountered.

In the operation of the apparatus the air from the heater H, hot and dry, is drawn therefrom through the drum D by the fan F and forced through the opening a^{3} into the front end of the chamber. The blast or cur-

rent of air thus introduced sweeps along the chamber in the direction of its length, passing up, around, and through the material on the upper run of the conveyer-section C', as shown by dotted arrows, Fig. 1. The hot dry air rapidly takes up moisture from the material and such moisture-ladened air passes through outlet *a* in the side wall of the chamber into the cold compartment C and is cooled therein. As the temperature of the air is reduced its contained moisture is condensed by the refrigerating action of the coils therein, the condensate being removed as formed by means of suitable drip-troughs *t*. (Shown in Fig. 2.) The cool and dry air descends and is sucked into the hot compartment H through the opening $h^{\times}$, and as it traverses said compartment it is again heated by the heating-coils *h* therein, so that the hot dry air is again introduced by the fan into the chamber, the air thus being used over and over again, with alternate heating and cooling.

By this arrangement and operation the material is always subjected to the action of heated dry air, and the moisture taken up thereby from the material is promptly condensed and removed, making the operation of the apparatus rapid, efficient, and highly economical.

My invention is not restricted to the precise construction and arrangement herein shown and described, as the same may be varied or modified in different particulars by those skilled in the art without departing from the spirit and scope of my invention.

Having fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a continuous-action drying apparatus, an elongated closed chamber having an outlet near its top, an endless traveling conveyer below the outlet to sustain within and move longitudinally through the chamber the material to be treated, a heater exterior to the chamber, means to draw dry air from the heater and force it in a substantially horizontal blast into the chamber at or near the feed end of the conveyer, to take up moisture from the material thereon and pass through the outlet, and means to continuously condense the moisture in and cool the air passing therethrough, the dry cold air being returned to the heater and reheated to be again withdrawn therefrom and forced into the chamber.

2. In a continuous-action drying apparatus, an elongated closed chamber having an outlet near its top, a condensing-compartment, communicating with the outlet, a heater beneath the chamber and connected with the condensing-compartment, means to convey the material from one to the other end of the chamber, and means to draw dry cold air from the condensing-compartment into and through the heater and to force it in a substantially horizontal blast into the chamber adjacent the feed end of the conveying means, to take up moisture from the material thereon and pass through the outlet into the condensing-compartment, wherein the contained moisture is condensed to dry the air prior to its reëntrance to the heater.

3. In a continuous-action drying apparatus, an elongated closed chamber having an outlet near its top, a traveling conveyer below the outlet to sustain within the chamber the material to be treated and to carry it back and forth in the chamber and discharge it at the end opposite that in which it is fed, and means to alternately heat and cool, externally to the chamber, a continuous current of air directed upon the material at the inlet end of the chamber, the hot, incoming air taking up moisture from the material and passing through the outlet to be cooled, such cooling condensing the contained moisture prior to reheating of the air and its reintroduction to the chamber, the action of the air-current upon the material diminishing as the latter approaches the discharge end of the chamber.

4. In a continuous-action drying apparatus, an elongated closed chamber having an outlet near its top, a condensing-compartment communicating with the outlet, a heater outside the chamb and connected with the condensing-compartment, a plurality of endless traveling conveyers within the chamber one below the other, to convey material through the chamber, the material being discharged from an upper conveyer to the one next below it and thereby caused to traverse the chamber several times before its discharge, and a fan at one end of the chamber to direct the hot, dry air from the heater upon the material on the conveyers, to take up moisture from such material and then pass through the outlet to be cooled and the contained moisture condensed prior to reheating of such dry cold air in the heater and its reintroduction to the chamber.

5. In an apparatus of the class described, an elongated, closed chamber having a long outlet near its top, an external cold compartment communicating with the outlet and having a condenser therein, an endless traveling conveyer in the chamber below and extending the length of the outlet, a hot compartment beneath the chamber and provided with heating-coils, the inlet of said compartment communicating with the cold compartment below the condenser, and means to draw hot dry air from the hot compartment and continuously force it into the chamber at the end of the conveyer, to act upon the material thereon and pass thence through the long outlet to the cold compartment, the condenser therein condensing the contained moisture in the air, the dried and cooled air

thereafter returning to the hot compartment to be again forced into the chamber.

6. In apparatus of the class described, an elongated, closed chamber having an outlet near its top, a traveling conveyer to carry material through the chamber, a condensing-compartment at the side of the chamber, and communicating therewith through the outlet, a heater extended longitudinally beneath the chamber, and connected with the bottom of the said compartment, a conduit connecting the outlet of the heater with the adjacent end wall of the chamber, and a fan in the conduit, to draw dry, cold air from the condensing-compartment through the heater and direct the hot, dry air in a substantially horizontal blast into and lengthwise of the chamber to take up moisture from the moving material on the endless conveyer, the moisture-laden air passing thence upward through the outlet to the condensing-compartment to be again used.

7. In apparatus of the class described, a closed chamber having an outlet near its top, means to continuously move material to be treated through the chamber from one to the other end thereof, means to heat rapidly a current of air, means to circulate the same through the chamber to act upon the material to be dried, the heating means being located outside the chamber, means to cool and dry the air acting upon such material, the air cooling and drying means communicating with the chamber through the outlet, the hot dry air taking up moisture from the material and passing through the outlet to be cooled and thereby have its contained moisture condensed prior to reheating of such air.

8. In a continuous-drying apparatus, an elongated, closed chamber having an outlet near its top and a floor inclined in the direction of the length of the chamber, a heater beneath the floor, a cold compartment outside the chamber and communicating therewith by the outlet and also communicating with the heater at a distance from said outlet, means to draw hot, dry air from the heater and force it into one end of the chamber, to take up moisture from the material therein and pass through the outlet to the cold compartment, cooling of the air therein condensing its contained moisture, the cooled, dry air returning to the heater to be reheated, a plurality of endless conveyers arranged one above the other in and moving lengthwise of the chamber in opposite directions, to support the material on their upper runs and traverse it back and forth in the chamber from the feed to the discharge end thereof, and means to automatically brush the material falling onto the floor to the discharge end of the chamber.

9. In a continuous-drying apparatus, an elongated, closed chamber having an outlet near its top, a heater exterior to the chamber, means located at one end of the chamber, to draw heated dry air from the heater and circulate it through the chamber to act upon the material to be dried, and take up moisture therefrom, the moisture-laden air passing through the outlet, a cooling-compartment into which the outlet opens, to cool the air and condense the moisture therein, said compartment at its opposite end communicating with the heater, to convey the cooled dry air thereto to be reheated, and a plurality of endless conveyers arranged one above the other in and moving lengthwise of the chamber in opposite directions, to support the material on their upper runs and traverse it back and forth through the chamber, the material being turned over and loosened as it drops from one conveyer to the next one below it.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ELMER E. PERKINS.

Witnesses:
JOHN C. EDWARDS,
ELIZABETH R. MORRISON.