

(No Model.)

2 Sheets—Sheet 1.

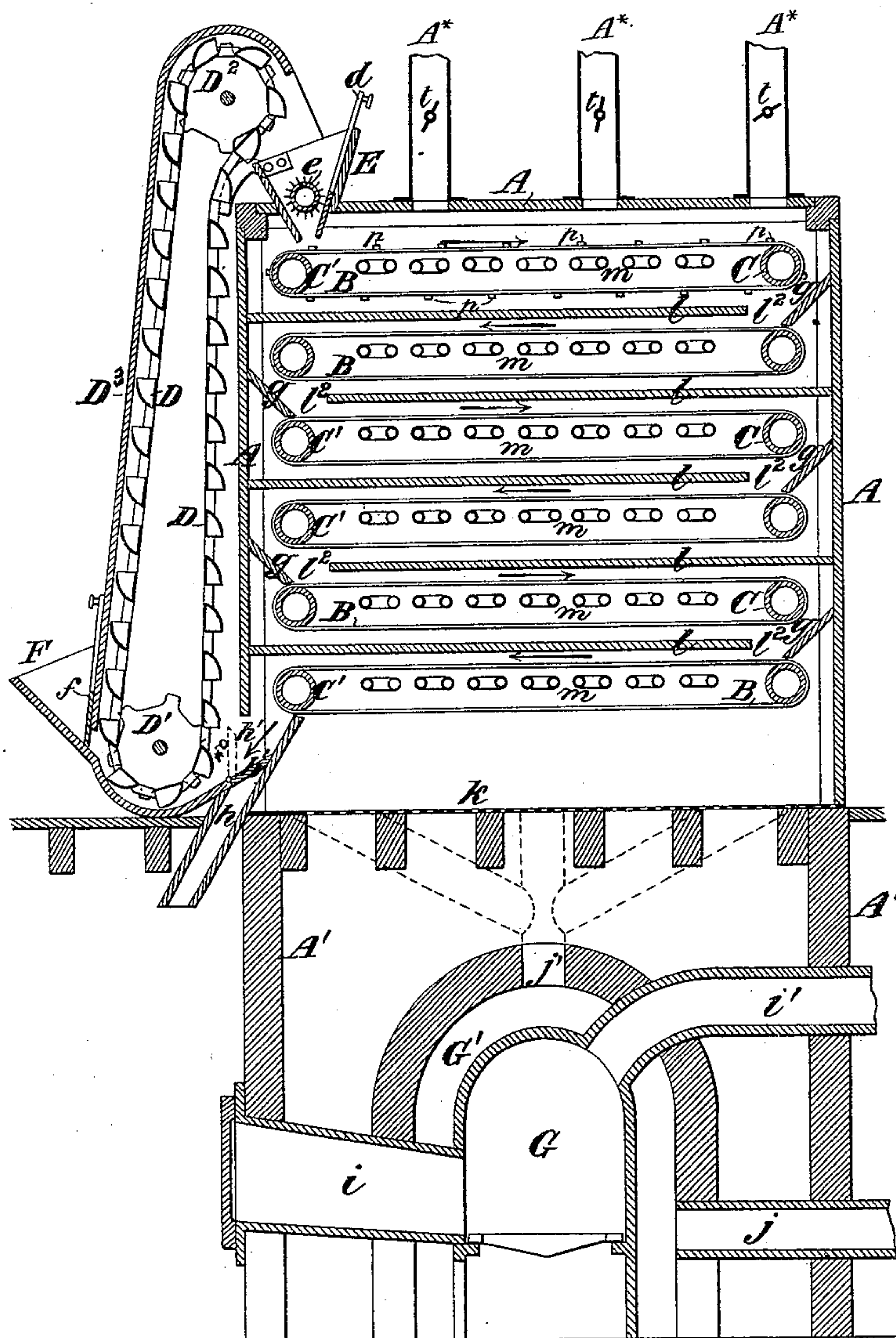
W. DURYEA.

APPARATUS FOR DRYING STARCH &c.

No. 312,341.

Patented Feb. 17, 1885.

Fig. 1.



Witnesses:

C. E. McDonald  
Emil Schwartz

Inventor:

Wright Duryea  
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Fig. 2.

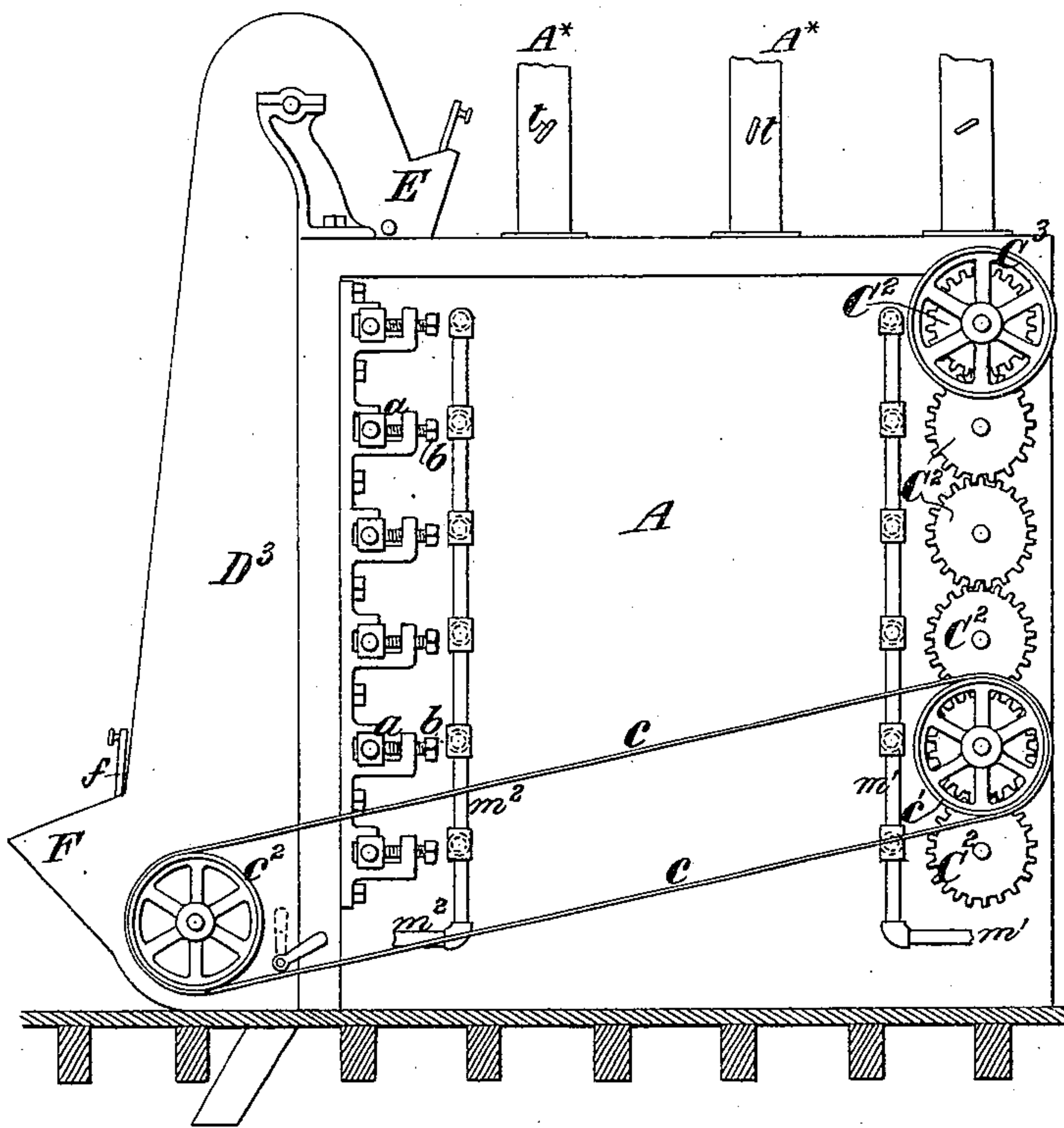


Fig. 3.

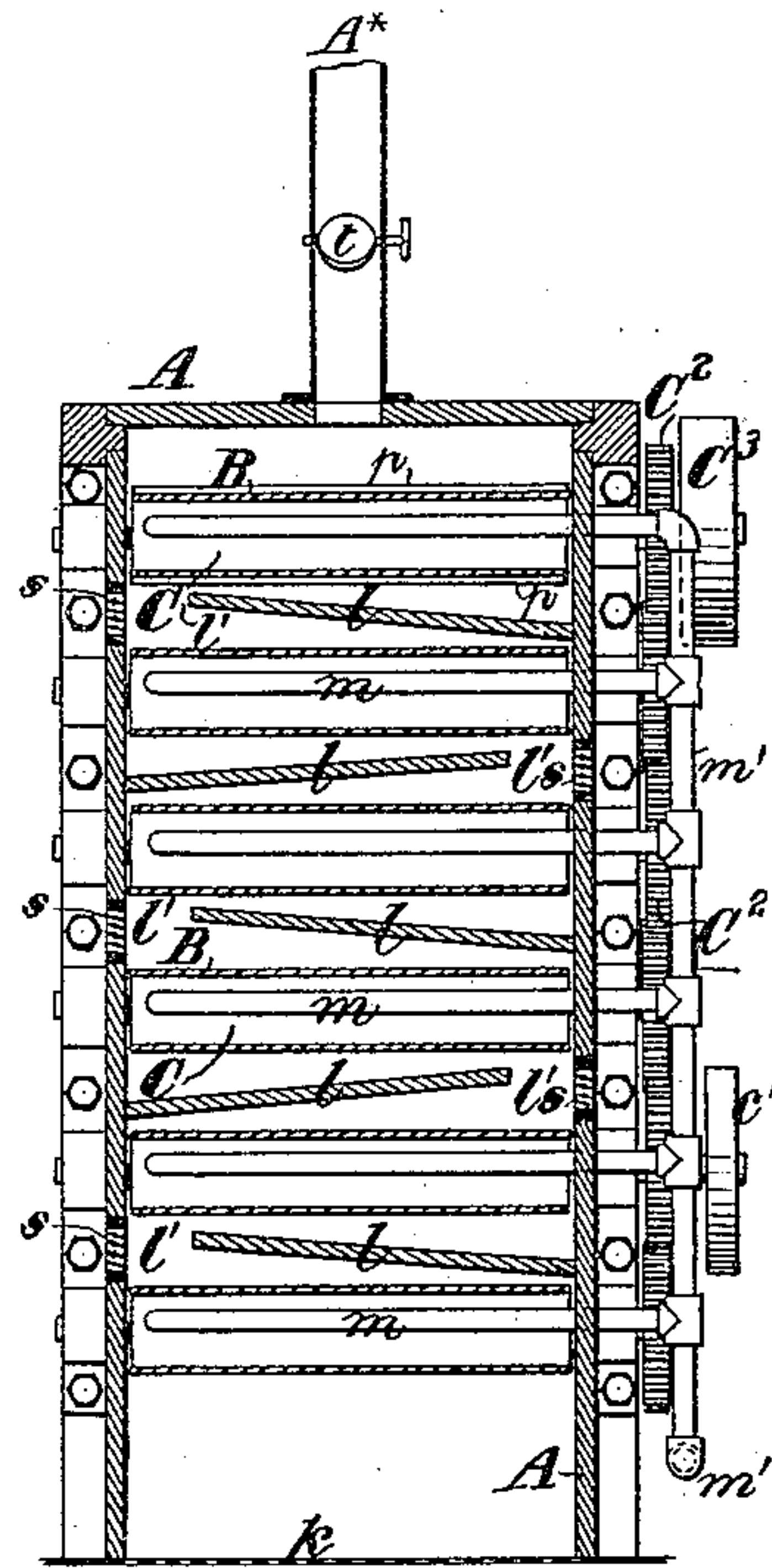
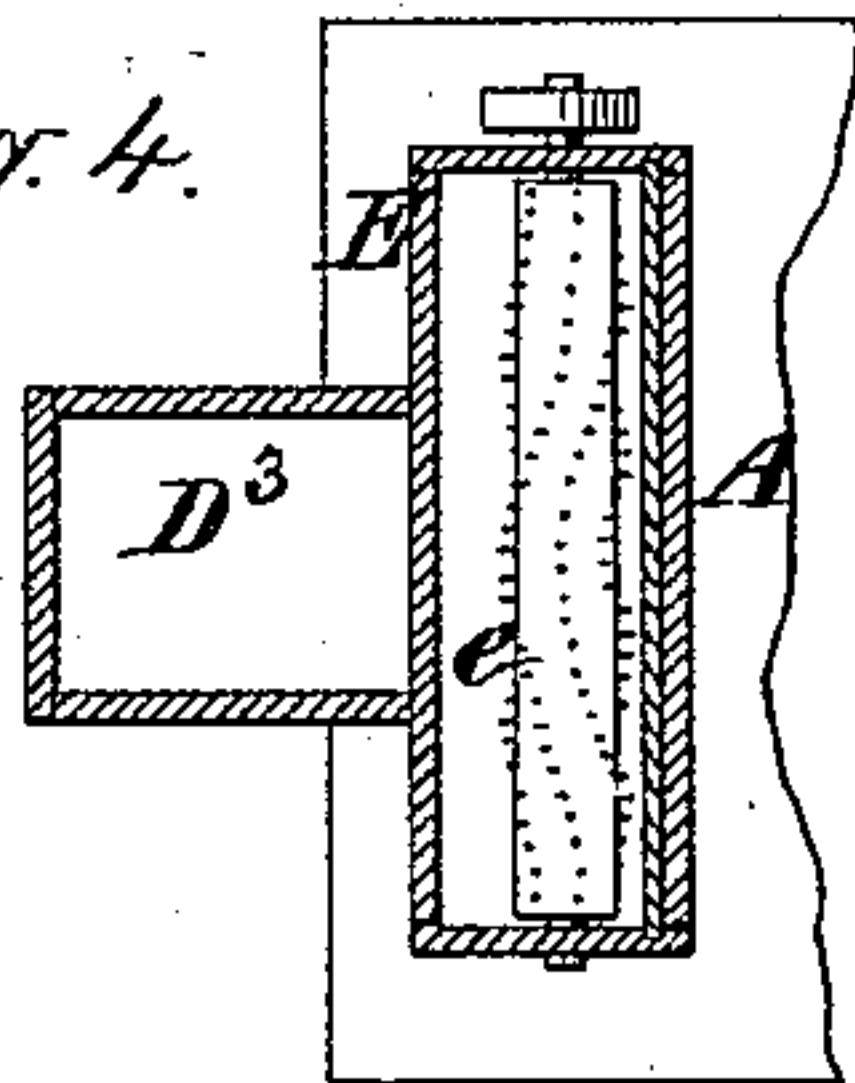


Fig. 4.



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# UNITED STATES PATENT OFFICE.

WRIGHT DURYEA, OF BROOKLYN, NEW YORK.

## APPARATUS FOR DRYING STARCH, &c.

SPECIFICATION forming part of Letters Patent No. 312,341, dated February 17, 1885.

Application filed August 30, 1884. (No model.)

*To all whom it may concern:*

Be it known that I, WRIGHT DURYEA, of the city of Brooklyn, in the county of Kings and State of New York, have invented a new and useful improvement in apparatus for drying starch, the corn-refuse resulting from starch-making, and other vegetable matters, of which the following is a specification.

In carrying out my invention, in addition to other apparatus described, I make use of endless aprons, belts, or carriers, mounted on rollers and arranged one above another in a closed chamber. These aprons, belts, or carriers move alternately in opposite directions, and by them the material to be dried is carried back and forth through the chamber, gradually descending from apron to apron.

An important object of my invention is to provide for maintaining a uniform or nearly uniform and effective temperature throughout the whole extent of the closed chamber by means which will not contaminate or have an injurious effect upon the matter to be dried, whether it be starch, corn-refuse, or any other material to be used as food for man or beast, or for other purposes.

The invention relates to that class of apparatus which comprises a drying-chamber, either with or without steam-pipes therein, a hot-air furnace communicating therewith, and endless aprons or carriers arranged one above another and serving to convey through the chamber the material to be dried.

The invention consists, essentially, in the combination, with the above-mentioned chamber, steam-pipes, hot-air furnace, and aprons or carriers, of deflectors extending alternately from opposite sides of the chamber nearly across the same, whereby the heated air is caused to pass directly across the drying-chamber and over the material to be dried.

The invention also consists in the combination, with the aforesaid chamber, furnace, and aprons or carriers, of an elevator for taking material from the bottom of said chamber or delivered from the lowermost apron and delivering it at the top of the chamber or upon the uppermost apron.

The invention also consists in the combination, with the aforesaid chamber, furnace, and aprons or carriers, of ventilators or escape-openings at different points in the height of the chamber, whereby the escape from the

chamber of air laden with moisture may be controlled and regulated.

The invention also consists in the combination, with the aforesaid chamber, furnace, and aprons or carriers, of deflectors, arranged as above described, whereby the heated air will be caused to pass directly over the drying material, and ventilators or escape-openings in the walls of the chamber at points opposite the deflectors.

The invention also consists in the combination of a drying-chamber having a floor of open construction, a lower chamber containing a hot-air furnace from which heated air rises through said open floor, and endless aprons or carriers arranged one above another and serving to convey through the chamber the material to be dried.

In the accompanying drawings, Figure 1 is a longitudinal vertical section of an apparatus and air-heating furnace embodying my invention. Fig. 2 is a side elevation of the apparatus, omitting the furnace. Fig. 3 is a transverse vertical section, also omitting the furnace; and Fig. 4 is a horizontal section of a part of the apparatus hereinafter referred to.

Similar letters of reference designate corresponding parts in all the figures.

A designates a chamber or casing, which may be constructed of wood, and in which are a number of endless aprons or carriers, B, arranged approximately horizontally and one above another. These aprons or carriers may be of canvas or any other suitable woven or other material. They are carried or supported and operated by rollers C C', which may be composed of iron pipe or otherwise made hollow to reduce weight. The rollers C are positively driven by any suitable means which will impart to the carrying portions of the apron motion in reverse directions, as indicated by the arrows in Fig. 1, each apron moving in a reverse direction to the apron above it. In this example of my invention I have shown the rollers C as geared together by spur-wheels C<sup>2</sup>, secured upon their shafts, and one roller-shaft being provided with a pulley, C<sup>3</sup>. A driving-belt passing around said pulley will impart the requisite motion to all the rolls and aprons. The rollers C' are turned by the aprons themselves, and their bearings may be in boxes a, which are adjustable by set-screws b, as shown in Fig. 2, to take up slack in the



aprons and keep them under proper tension. The aprons may also be supported and prevented from sagging by idlers or bars *p*, made of wood or other material, as shown in Fig. 1, extending laterally across the aprons.

D is an endless carrying-chain of buckets, or an elevator, which is mounted on suitable drums or wheels,  $D^1 D^2$ , and inclosed in a casing,  $D^3$ . The elevator is operated by a belt or chain, *c*, passing from a pulley,  $c^1$ , on the shaft of a roller, C, to a pulley,  $c^2$ , on the shaft of the lower drum or wheels,  $D^1$ .

At the top of the chamber A is a hopper, E, into which the elevator delivers, and which is arranged to deposit on the upper belt or apron, B, the material raised by the elevator. On one side of the hopper E is a gate, *d*, whereby the quantity of material and the thickness of the layer of material delivered to and carried along by the carrying portion of the upper apron or belt, B, may be regulated.

In the hopper E is a roller or drum, *e*, which may consist of a spiked cylinder, the spikes being so arranged as to have the effect of distributing the material to be dried, and which may be rotated by any suitable means. The rotation of this drum or cylinder serves not only to distribute the material, but also to prevent its packing in the hopper. I have also provided another hopper, F, controlled by a gate, *f*, and from which the wet material may be delivered to the elevator and to the hopper E, and thence to the uppermost apron, B, in starting the apparatus. The gate *f* serves to regulate the delivery of the wet material to the elevator.

At the top of the chamber A, I have shown escape-pipes  $A^*$ , through which the heated air may pass after being charged with moisture taken up from the drying material. These escape-pipes  $A^*$  may be provided with dampers *t*, to regulate and control the flow of air through them.

I have shown inclined boards or chutes *g* at the delivery end of each apron, by which the material delivered thereby is directed to the receiving end of the next lower apron, which moves in an opposite direction. At the delivery end of the lowermost apron is a chute, *h*. When this valve or gate is swung down, as shown in Fig. 1, so as to close the mouth of the chute *h*, the material will pass over the same to the lower portion of the elevator-casing  $D^3$ . When it is desired to deliver the dried material through the chute *h*, the valve *h'* is swung back against a stop,  $*$ , as shown in dotted lines in Fig. 1, and thereby cuts off the supply to the elevator-casing.

$A'$  designates a lower chamber, which may be of brick, and in which I have shown an arbitrary illustration of a hot-air furnace.

G designates the fire-chamber, which has a long feeding chute or passage, *i*, extending to the exterior of the chamber  $A'$ , and an outlet-pipe,  $i'$ , for the products of combustion, also extending to the exterior of the chamber  $A'$ .

$G'$  designates the air-chamber around the fire-pot G, to which cold air is supplied by a pipe, *j*, and from which heated air is delivered through an aperture,  $j'$ , into the lower chamber,  $A'$ . By thus arranging the furnace all the heat from the air-chamber as well as that radiated from the furnace is utilized, and a large volume of heated air may be thus obtained in a pure state, and without being contaminated by the products of combustion. This is of special importance, as starch, corn-refuse designed for animal food, and other materials for the drying of which my apparatus is designed would be tainted and their value greatly impaired if dried by direct contact with the impure products of combustion. The lower chamber,  $A'$ , is in communication with the upper chamber, A, and, as here shown, they are separated by a wire screen, or floor of open construction, *k*, through which the hot air may pass over its whole surface freely; or one or more pipes or flues may convey it, as shown by dotted lines, extending from the aperture  $j'$  in Fig. 1. The floor of the chamber A may be of wood or metal and provided with one or more hot-air registers.

In the chamber A are horizontal or inclined boards or plates, *l*, which may be removable, and which extend alternately from opposite sides and nearly across the chamber, leaving openings  $l'$  for the passage of heated air upward through the chamber. I have also shown these deflectors as forming openings  $l''$  at opposite ends of the chamber, as will be seen from Fig. 1. I may also have registers or openings for the escape of heated air in the sides or ends of the chamber A, according to the requirements of the particular material being dried. These registers or openings are shown at *s* in Fig. 3. The air takes up the aqueous vapors arising from the material, and finally escapes at the outlet-pipes  $A^*$  or through the openings *s*. The heated air will of course lose its original heat as it passes upward through the chamber, and, if allowed to become cool, will not perform its function properly.

To prevent the cooling of the air, or rather in order to maintain a uniform and effective temperature throughout, I arrange in the chamber A coils or radiating systems, *m*, of steam-pipes, whereby heat is imparted to the air as it rises in the chamber, thus hindering and preventing the tendency to cool.

The several series or systems of heating-plates *m* all receive steam from a supply-pipe,  $m^1$ , and are connected into an exhaust-pipe,  $m^2$ , common to all. These pipes are shown in Fig. 2.

The elevator-casing  $D^3$  may be as wide as the chamber A, or it may be very much narrower, as shown in Fig. 4, and the distributing roller or drum *e* may in such case have spirally-arranged spurs, as shown in Fig. 4, whereby the material will, by the rotation of the roll or drum, be moved toward its ends



and so distributed over the uppermost apron throughout its width.

The apparatus may be operated in various ways. I may, for example, operate the aprons B, and supply material to them from the hopper F, the elevator D, and the hopper E until all the aprons are loaded, and then stop the movement of the aprons until the material upon them is dried, when the aprons are again started, so as to deliver the dried material through the chute h, the elevator not being used. I may also supply wet material to the aprons, as above described, and continue to operate them until the material is dried, taking the material from the lowermost apron, raising and delivering it to the uppermost apron by means of the elevator. After the material is dried the elevator is stopped, the valve h' is turned up into the position shown by dotted lines, and the aprons B are operated to deliver the dried material through the chute h.

I do not claim, broadly, as of my invention a drying apparatus comprising a drying-chamber either with or without steam-pipes therein, a hot-air furnace communicating therewith, and endless aprons or carriers arranged one above another and serving to convey through the chamber the material to be dried.

By combining with the drying-chamber and hot-air supply deflectors which extend alternately from opposite sides nearly across the chamber and by which the heated air is caused to pass directly across the drying material, by providing ventilators or air-escapes at different points in the height of the drying-chamber, and by placing such ventilators or air-escapes opposite the deflectors, I provide for carefully regulating the escape of air, thus affording provision for the escape of air at any point in the height of the drying-chamber when such air has become so saturated or charged with moisture that its farther passage across the drying material would not be effective or desirable. By employing an elevator to take the material from the lowermost apron, raise it, and deliver it upon an uppermost apron, I provide for passing material to be dried repeatedly through the drying-chamber and for rendering the apparatus automatically continuous in its operation. By the open floor or division between the drying-chamber and the lower or furnace chamber I provide for the uniform distribution of the heated air upward through the whole area of the drying-chamber, thereby producing an easy and not too rapid circulation, and avoiding rapidly-moving and limited currents, such as might be produced by a comparatively small hot-air pipe entering the drying-chamber, and which might interfere with the maintenance of a drying temperature uniform throughout the chamber.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The combination, in a drying apparatus, of a chamber, endless aprons or carriers ar-

anged therein one above another, an air-heating furnace having its hot-air outlet communicating with said chamber, and a separate outlet for the products of combustion, deflectors extending alternately from opposite sides of the chamber nearly across the same, whereby the heated air is caused to pass directly across the drying-chamber and over the drying material, and steam pipes or heaters over and in contact with which the heated air passes and by which the temperature of the air is maintained nearly uniform during its passage through the chamber, substantially as and for the purpose herein described.

2. The combination, with a drying-chamber and endless aprons for moving material to be dried through said chamber, and arranged one above another, of a furnace for heating air having its air-outlet communicating with said chamber, and a separate outlet for the products of combustion, and an elevator for taking material from the bottom of said chamber or delivered from the lowermost apron and delivering it at the top of said chamber or upon the uppermost apron, substantially as herein described.

3. The combination, in a drying apparatus, of a chamber, endless aprons or carriers arranged therein one above another, an air-heating furnace having its hot-air outlet communicating with the chamber, and ventilators or escape-openings at different points in the height of said chamber, whereby the escape of air laden with moisture from the chamber may be controlled and regulated, substantially as herein described.

4. The combination, in a drying apparatus, of a chamber, endless aprons or carriers arranged therein one above another, an air-heating furnace having its hot-air outlet communicating with the chamber, deflectors extending alternately from opposite sides of the chamber nearly across the same, whereby the heated air is caused to pass directly across the drying-chamber and over the drying material, and ventilators or openings in the sides of the chamber at points opposite the deflectors, whereby provision is afforded for the escape of air after passing across the chamber and over the drying material on the several aprons or carriers, substantially as herein described.

5. The combination, in a drying apparatus, of a drying-chamber having a floor of open construction, a lower chamber containing a hot-air furnace from which heated air rises through the said open floor, and endless aprons or carriers arranged in the drying-chamber one above another, and serving to convey through the drying-chamber the material to be dried, substantially as herein described.

In testimony whereof I have hereunto affixed my signature, in the presence of two subscribing witnesses, this 28th day of August, 1884.

WRIGHT DURYEA.

Witnesses:

FREDK. HAYNES,  
EMIL SCHWARTZ.