G. W. McMULLEN.

PROCESS OF DRYING AND APPARATUS THEREFOR.

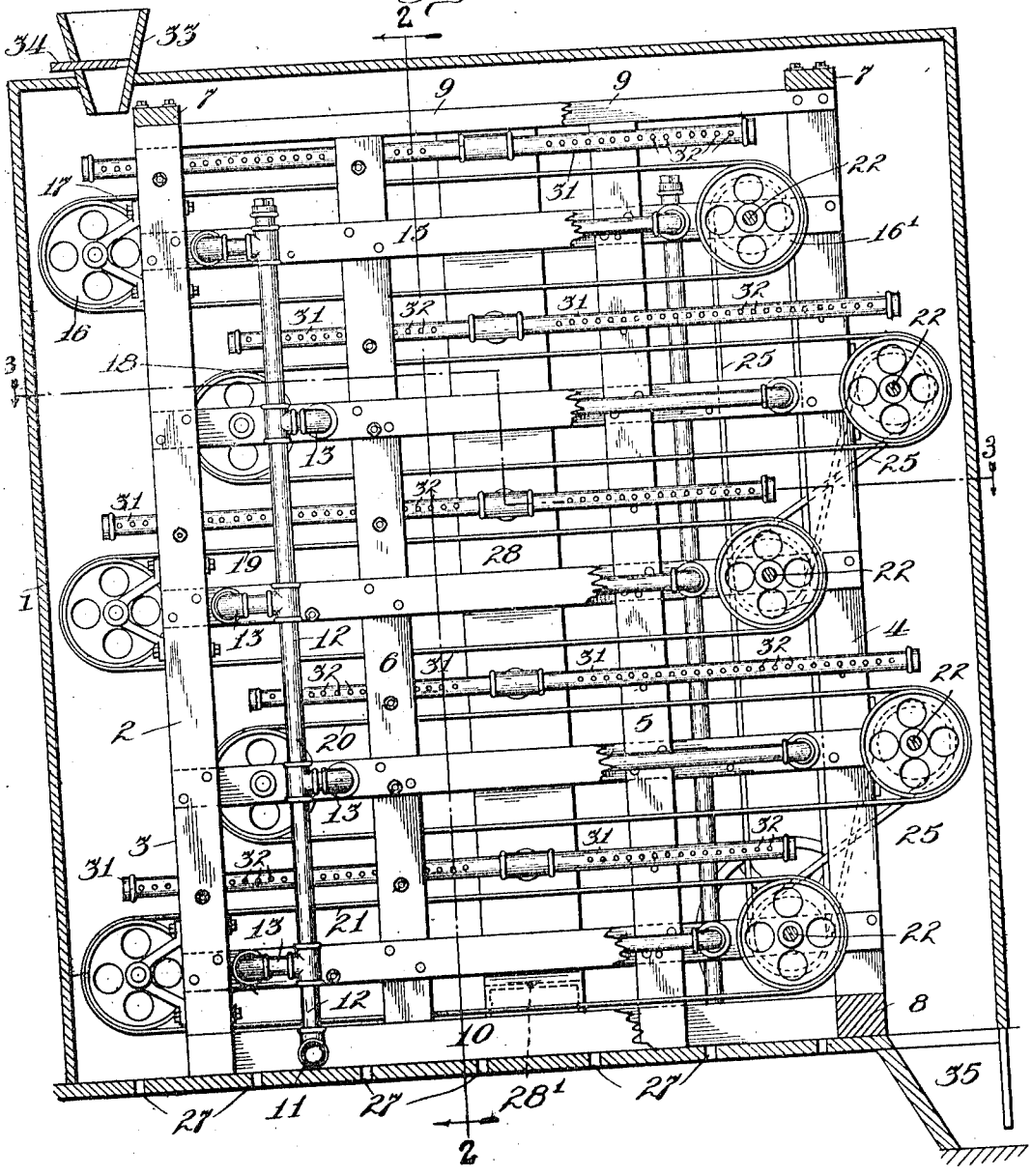
APPLICATION FILED APR. 7, 1908.

Patented Oct. 8, 1912.

1,040,556.

2 SHEETS—SHEET 1.

Fig. 1.



Witnesses
Milton Lenoir
Emilie Rose

Inventor
George Whitman McMullen
By Albert N. Graves,
Attorney.

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2 SHEETS—SHEET 2.

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Fig. 2.

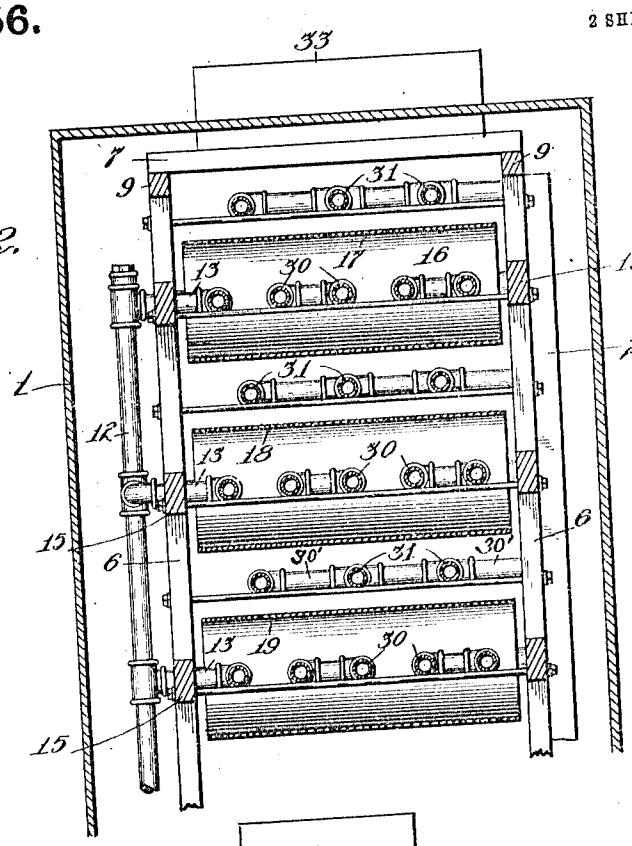
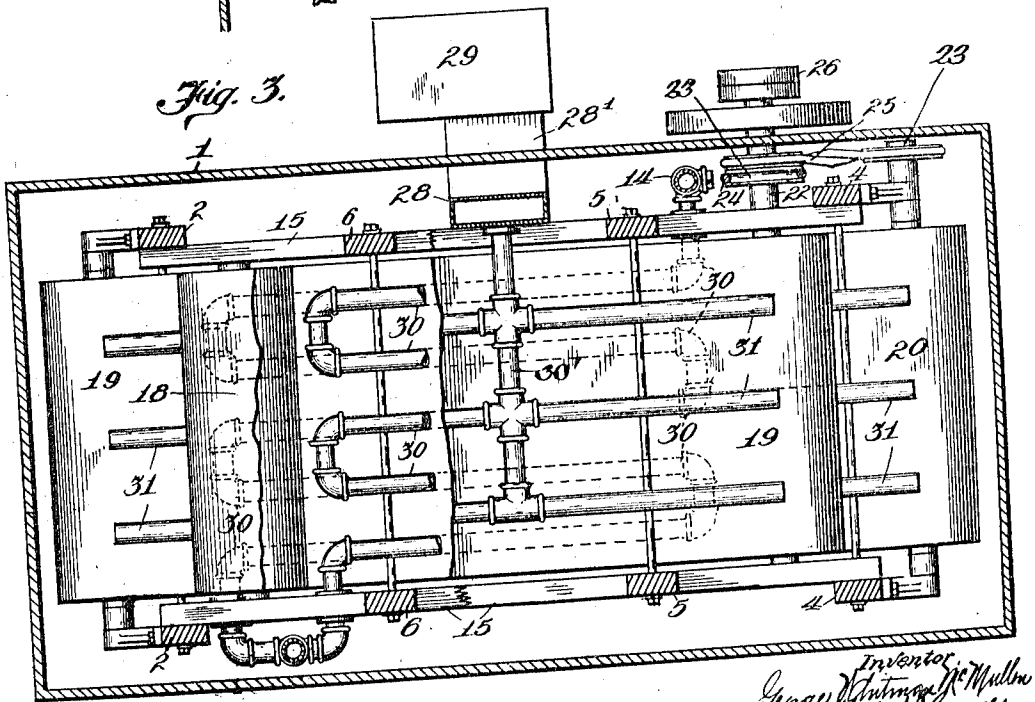


Fig. 3.



Witnesses
Milton Denvois
Emilie Rose.

Inventor
George Washington McMullen
By Albert N. Graves.
Attorney.

UNITED STATES PATENT OFFICE.

GEORGE WHITMAN McMULLEN, OF CHICAGO, ILLINOIS.

PROCESS OF DRYING AND APPARATUS THEREFOR.

1,040,556. Specification of Letters Patent. Patented Oct. 8, 1912.

Application filed April 7, 1908. Serial No. 425,614.

To all whom it may concern:

Be it known that I, GEORGE WHITMAN McMULLEN, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and Improved Process of Drying and Apparatus Therefor, of which the following is a specification.

This invention consists in an improved process of drying and in apparatus for use in connection therewith, and it has for its salient object to provide a method and apparatus whereby those materials or substances which are detrimentally affected by being kept for any considerable length of time in the presence of a moist warm atmosphere may be effectively dried without incurring such detrimental effect.

Another object of the invention is to provide a method and apparatus whereby the drying of relatively large quantities of material may be effected with great uniformity and in a relatively rapid manner, the uniformity of action doubtless contributing to the success of the method in avoiding spoiling.

In developing a practical method for drying comminuted vegetables, particularly sugar beets, and for drying liquids and semi-solids, peculiarly susceptible to bacteriological changes, I have discovered that if the material being dried be so treated that fresh supplies of dry or moderately dry air be constantly provided, and the air which effects the drying be bodily separated in the immediate locality and promptly carried away from the place where it so becomes moisture laden, thus permitting the fresh supply of air to flow in and take its place, the difficulties due to bacterial changes are substantially if not entirely overcome. It is, of course, obvious that any method or process which is susceptible of use in a commercial way for drying considerable quantities of material must be one that can be so carried out as to effectively subject large areas of the material to the drying treatment simultaneously, and must furthermore enable this to be done within a comparatively small space.

With the foregoing matters in mind, I have devised the method and apparatus constituting my present invention, a ready comprehension of which will be had from a description thereof as carried out by a suitable apparatus shown and described in the accompanying drawings.

In said drawings—Figure 1 is a vertical sectional view of a drying chamber containing apparatus in accordance with my invention and adapted for carrying out my method the apparatus being shown chiefly in side elevation; Fig. 2 is a transverse vertical sectional view taken approximately on line 2—2 of Fig. 1 and looking in the direction of the arrows; Fig. 3 is a horizontal sectional view on the indirect line 3—3 of Fig. 1 and looking downwardly.

Describing first the apparatus, within a suitable chamber or inclosure 1 is arranged an upright-frame, designated as a whole 2, and comprising as its chief features a series of uprights 3, 4, 5 and 6 at each side, a series of cross frame members 7, 7, and 8, 8, above and below, and suitable longitudinal horizontally disposed frame members above and below, as 9 and 10, all suitably secured together.

11 designates a heating fluid supply pipe, as for example a steam pipe, connected with a suitable source of steam, leading into the lower part of the chamber and connecting with the riser 12. With the riser 12 are connected a plurality of flat horizontally disposed heating coils 13,—one for each of the several stages or levels at which the drying is performed in the chamber. These heating coils are severally so formed as to spread across the chief area of the interior of the drying chamber, and they are severally connected, conveniently at the opposite side of the chamber, with an eduction pipe 14 which serves to carry away the water of condensation and whatever steam passes through the system. The several heating coils are conveniently supported by means of cross rods 15 extended through the upright supports 5 and 6 from side to side of the frame.

Upon the frame are supported sets of belt pulleys or drums, as 16, 16′, there being one set of such pulleys for each heating coil, and the pulleys or drums being so disposed that a belt, as 17, 18, 19, 20 and 21 may be mounted on the pulleys and arranged to travel horizontally above and below the respective heating coils. Each belt is preferably perforated or consists of a suitable open structure adapted to permit passage of the air therethrough; and is longitudinally offset a

short distance relatively to the next subjacent belt, so that material carried by the upper lap of one belt may be carried over and discharged into the next belt below, which in turn similarly discharges it to the next, and so on downwardly. To drive these several belts, the several shafts 22 which support the belt pulleys at one end of the machine carry drive belt pulleys 23, which are properly connected so as to drive one another through the medium of connecting belts 24 and 25. The lowermost shaft 22 is also provided with a driving pulley 26, to which power is transmitted from any suitable source.

To provide for a suitable circulation, and the constant supply and continuous removal of a drying gaseous agent, usually atmospheric air, the lower portion of the chamber 1 is provided with a plurality of inlets, as 27, and a set of eduction pipes or conduits is provided which will now be described.

28 designates a main eduction trunk arranged to rise vertically alongside of the supporting frame 2 and connecting at its lower end with a lateral extension 28′ which extends out through the side wall of the chamber and connects with any suitable exhaust mechanism, as for example an exhaust blower 29. With the side of the trunk 28 is connected a plurality of laterally extending branches 30′,—one for each of the several stages of the drier and arranged to extend horizontally above and at a short distance from the upper lap of the corresponding belt. With each of these lateral branches 30′ are connected longitudinally extending intake pipes 31; there being shown in the present construction three such pipes extending in each direction from each branch 30′. These intake pipes are as nearly as practicable so disposed above their respective belts as to uniformly divide up the space above said belt, and they are capped at their ends and provided throughout their lengths with relatively small inlet openings or perforations 32 whereby the moisture laden air is drawn in and conveyed away from practically all points of the material-supporting area or surface of the corresponding drying belt. The chamber is provided at its upper side with a hopper-like inlet 33 of a length corresponding to the width of the belt substantially, and arranged so as to discharge upon the receiving end of the uppermost conveyer belt. This hopper is provided with a suitable valve or slide 34 whereby the admission of material is controlled. Similarly a discharge chute 35 is provided at the delivery end of the lowermost conveyer belt which leads out through the bottom wall of the chamber. It will be understood that both the inlet and outlet openings through which the material is fed will be maintained substantially sealed, either by the material or by being closed during the normal operation of the apparatus.

The apparatus described is, of course, of a type suitable for drying small or comminuted solids, and it will be understood that for drying fluids or semi-solids the apparatus must be correspondingly modified.

The method as carried out by the use of the apparatus shown proceeds substantially as follows: The belts being driven so as to move either very slowly and continuously, or intermittently and from time to time as the drying proceeds, and the heating coils being supplied with steam and the exhausting system being in operation, the material is fed down gradually through the inlet hopper and by the travel of the belt which receives the material spread out and thoroughly distributed over the belt. When the apparatus is in full operation all of the belts will be thus charged with material, it being obvious that inasmuch as the conveyer belts are interconnected and driven together, and at the same speed, the material will be transferred from one to the other progressively and so distributed through the whole drying system. Assuming, then, that the apparatus is in full operation, the relatively dry air, entering the several inlet openings distributed over the area of the bottom of the chamber immediately encounters the lowermost heating coil, is thus warmed and rises against and through the upper lap of the lowermost conveyer belt, and, of course, through the material resting thereon, thus simultaneously heating said material and bathing it in relatively dry air. The warm air, of course, immediately absorbs moisture from the material, and, owing to the exhausting action of the eduction pipes immediately above the belt and the natural tendency of the air to rise, is immediately after it becomes moisture laden drawn in to the nearest drawing off pipe and thus effectually separated from the replenishing supply of air and from contact with the material being acted upon. Of course, other supplies of fresh air flow up along the sides and ends of the chamber, and through and between the laps of the several belts, so that what has been described as taking place as to the material resting upon the upper lap of the lowermost belt is likewise taking place as to the material upon each of the several other conveyer belts. In other words, fresh air is being supplied to each of the several heating coils, is being heated and carried upwardly through the belt and around the material resting thereon, and so becoming charged with moisture, and is being promptly separated and drawn into the corresponding eduction pipes practically as soon as moistened, throughout all parts of the apparatus. Moreover, the air which

reaches the uppermost parts of the chamber will obviously be somewhat warmer than that which is drawn off in the lower stages, from which it follows that the relatively moist and undried material which has just entered the chamber is subjected to that air which is most effective in absorbing the moisture, viz: the air which is hottest and at the same time dry.

The rate of circulation of the air through the drying apparatus may be and is effectually controlled by the rate at which the exhausting mechanism is operated; it being obvious that the more rapidly the air is drawn off the more rapidly it will flow in through the inlets to the drying chamber.

It will, of course, be obvious that the method can be practically carried out with various forms of apparatus.

I claim as my invention:

1. The method of drying which consists in disposing the material to be dried in a plurality of superposed longitudinally off-set spaced-apart relatively thin sheets or layers and within a closed drying chamber, continuously supplying relatively dry air to said chamber so that it flows to all parts of the material to be dried, continuously and directly heating said air beneath and in close proximity to each of the several layers or sheets of material, and continuously separating and removing the moisture-laden air from the replenishing supply of air in the immediate locality where it becomes moisture laden and substantially as fast as it becomes so laden.

2. An apparatus for drying which consists in a plurality of superimposed endless belts longitudinally off-set relative to each other, of means for driving said belts, a closed heating system for locally heating each of said belts, a plurality of inter-connected perforated pipes for removing the moisture laden air in the immediate locality where it becomes moisture laden, and an exhaust pump connected to the air pipe system.

GEORGE WHITMAN McMULLEN.

Witnesses:
ALBERT H. GRAVES,
EMILIE ROSE.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."