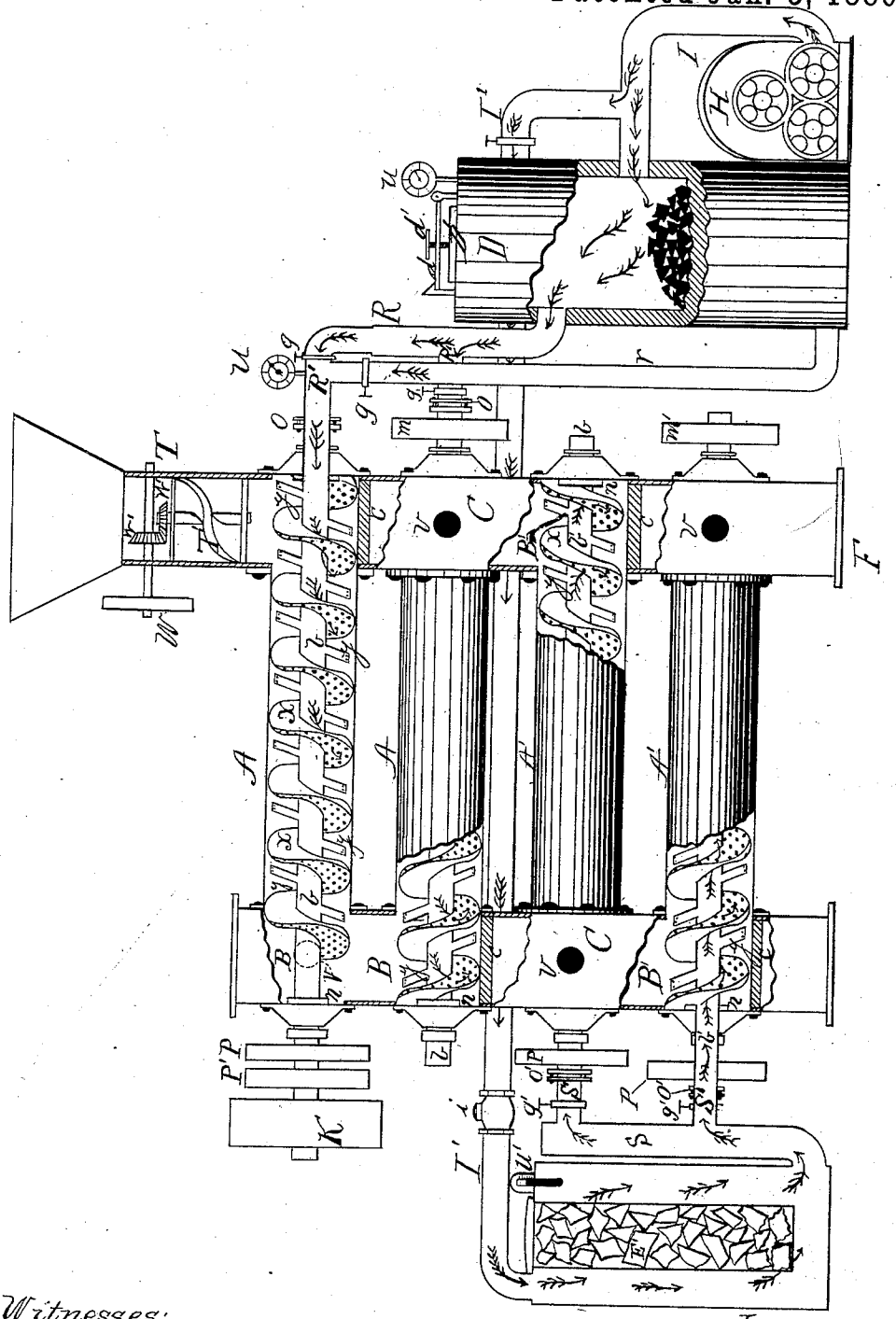
(No Model.)

H. R. FOOTE.

GRAIN DRIER.

No. 333,939. Patented Jan. 5, 1886.



Witnesses:
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N. PETERS. Photo-Lithographer. Washington, D. C.

UNITED STATES PATENT OFFICE.

HENRY R. FOOTE, OF NEW YORK, N. Y.

GRAIN-DRIER.

SPECIFICATION forming part of Letters Patent No. 333,939, dated January 5, 1886.

Application filed February 2, 1885. Serial No. 154,751. (No model.)

To all whom it may concern:

Be it known that I, HENRY R. FOOTE, of New York city, county of New York, and State of New York, have invented certain new and useful Improvements in Grain-Driers, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

My invention has relation to that class of devices which are employed for drying grain and other substances, and ordinarily known as "grain-driers."

The object of my invention is to effect the drying of wet and the cooling of heated grains or other products by exposure to direct contact with heated atmospheric air or gases from which the moisture has been purposely removed by desiccation before such contact, and subsequently to cool the heated grain in the same machine with air or gases from which the heat has been previously abstracted. The absorbent power of atmospheric air for moisture depends upon its dryness and temperature, its ability to take up water being greatly increased by increasing the temperature, provided the air is dry.

To accomplish the object of my invention, as above set forth, and to produce a simple, durable, efficient, and easily-operating machine, my improvements involve certain novel and useful arrangements or combinations of parts and principles of operation, all of which will be herein first fully described, and then pointed out in the claims.

In the accompanying drawings, forming part of this specification, I have shown a partial section and elevation of an apparatus constructed and arranged for operation in accordance with my invention, and involving the principles thereof. The drying-cylinders A A are made of iron pipe, closed except at the ends, and they are connected to the head-blocks C C by suitable flanges held in place by bolts and nuts, and the cylinders A A are provided with the conveyers B B. These conveyers B B are composed of hollow shafts *b b*, around each of which is a hollow screw or helix, *x x*, slight openings being preferably left between the screws and the shafts, through which air may pass. One end of the shaft of each conveyer is closed, the other end receiving hot air from the hot-air pipe R through the branches R′ R′, upon which are expansion-joints, (represented at O O.) The advancing side of the screw is made of perforated metal, having orifices about one-sixteenth of an inch in diameter. The arms *y y*, inserted in the shaft, are also hollow, and have small perforations at their ends, similar to those in the screws. The pulleys P′ P′, P P, *m*, and *m′* are to be furnished with belts to revolve the conveyers. The pulley K is belted to the main shaft of a steam-engine or any other suitable motor. The endwise thrust of the shafts is prevented by the collars *u u*. The head-blocks C C are preferably made of cast-iron, and are fitted with partitions *c c* and provided with vent-holes V V. The heating and desiccating stove D is an air-tight boiler-iron shell made strong enough to sustain heavy pressure, lined with fire-brick, and has a charging-door, D′, which is held in place by a bar, *d*, and a tightening-screw, *d′*. A cold-air-supply pipe, I, the dry and hot air pipes R and *r*, and the pyrometers U U are located and arranged substantially as shown. Branch pipes R′ R′ connect the hot-air pipe with the hollow shafts *b b*, and are provided with expansion-joints O O, as previously explained and for purposes well understood. Regulating and stop valves *g g* serve to govern the supply of hot air. The superheating-pipe *r* is connected with the branch pipe R′ which leads to the conveyer of the top cylinder, and is also provided with a regulating and stop valve. The cooling-cylinders A′ A′ are made like the drying-cylinders A A, and are furnished with conveyers B′ B′, with hollow shafts and screws and arms. Branches S′ S′ of the cold-air pipe S are connected with the hollow shafts *b′ b′*, and they have expansion-joints O′ O′ and regulating and stop valves *g′ g′*.

E is a refrigerating air-receiver, of strong boiler-iron, made to sustain pressure, and containing a receptacle, E′, for ice or any refrigerating device or freezing-mixture. The receiver E is connected with the blower H by pipe I′ I′, which is furnished with a check-valve, as at *i*.

The blowing-machine H may be any type of pressure-blower, and communicates with the stove by a pipe, I. This blower may be driven by any suitable means.

The feeding and regulating device T for the material to be dried is provided with a screw, T′, which is operated by a band-wheel and shaft, as W, and gear-wheels W′ W′.

To operate the machine the stove D is first charged with anthracite coal, charcoal, or coke, (carbonaceous fuels,) and after ignition the charging-door D′ is closed and held in place air-tight by bar *d* and tightening-screw *d′*. The ice-box of the air-receiver E is filled with ice. The blower H and the conveyers B B and B′ B′ are then set in motion by the moving machinery. As soon as the drying-cylinders are hot and the cooling-cylinders cold the wet products to be dried are fed into the machine by the feeding device T in quantity to keep the cylinders about one-half full. The grain or other material in falling into the first cylinder A is conveyed from right to left of the cylinder by the conveyer B, and at the end falls into the second cylinder A, where it is conveyed from left to right. At the end of this cylinder it drops into the first cooling-cylinder A′, and is again reconveyed from right to left, and in the second of the cooling-cylinders is reconveyed from left to right, and is discharged through F at the bottom of the head-block. During this alternating movement through the drying-cylinders the wet products are constantly in direct contact with hot desiccated air, which, supplied by the blower H, is forced under pressure into the stove D, where, coming in contact with the ignited carbon, the moisture is absorbed, and the air, desiccated and heated, passes into the pipe R, and by its branches into the hollow shafts and screws *x x*, and is discharged into and among the grain in the cylinders through the perforations in the advancing side of the screw or helix. The air which has performed its work in the first drying-cylinder, and has to a great extent become saturated with moisture, is allowed to escape through the vent V, and the grain on reaching the next cylinder comes in contact with fresh currents of dry and heated air. The products as they pass backward and forward through the cylinders are not only stirred and rolled over by the screws, but are also stirred and agitated by the hollow arms *y y*, which, in revolving, prevent the formation of masses or lumps, and by increasing the amount of motion in the grain bring it more and more in contact with the heated air, and thereby increase the rapidity with which the drying can be effected.

In the process of extracting the moisture the grain becomes so hot that it cannot be stored until its temperature is reduced, for when heated and stored in quantities it spoils very rapidly.

To obtain a reduction of temperature—such that the material may leave the machine ready for storage or use—it is exposed to the refrigerating effect of cold air which has been cooled for this purpose by contact with the cold surfaces of the refrigerator. Air from the blower H, conveyed by pipe I′ I′ to the air-receiver E, coming in contact with the side of the ice-box E′, has its temperature greatly reduced and the most of its moisture precipitated. It then passes by the branch pipes into the hollow shafts and hollow screws of the conveyers B′ B′, discharges through the perforations, and comes in direct contact with the hot grain, producing a rapid reduction of temperature, as desired. The desiccation of the air may be increased by having it passed over caustic lime before entering the blower.

The air enters the stove D over the surface of the fuel, and, being maintained in the stove under considerable pressure, a uniform temperature and perfect desiccation is obtained.

To increase the heat of the air for the top cylinder, wherein is the grain which contains the most water, the pipe *r* conveys the air and products of combustion from near the bottom of the stove D. It will be readily seen that any air passing downward through the incandescent fuel will be very much hotter than that which simply passes over it. By means of the regulating-valves *g g g′ g′* the quantity of air entering the conveyers is governed.

The expansion-joints O O O′ O′ may be fitted with stuffing-boxes that prevent the escape of any air.

By means of the pyrometers U U and the thermometer U′ on the refrigerator the temperature of the air can be readily determined. Care should be taken that the temperatu s not so high as to scorch the grain.

The improved apparatus may be made of any desired size to operate upon any required amount of material, and the number of heating and cooling cylinders may be increased, preserving the same general principles of operation.

When constructed and arranged for operation as above explained, the device or drier will be found to admirably answer the purpose or object of the invention, as previously set forth.

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

1. In a machine for drying and cooling wet products and provided with separate and independent drying and cooling cylinders, each having a conveyer mounted therein, a hot-air conduit leading from the interior of the combustion-chamber of the stove to the drying-cylinders, and a cold-air conduit leading from the refrigerating-chamber to the cooling-cylinders, the parts being combined and arranged substantially as set forth, so that the air-currents shall pass through the

products, and back and forth through the cylinders, in the manner and for the purposes explained.

2. In a machine for drying and cooling grain or wet products, the independent heating and cooling cylinders, within which the material is moved, the heating and desiccating stove D, and the pipe connecting the combustion-chamber thereof with the interior of the heating-cylinders, the refrigerating air-receiver E, and the pipe connecting the same with the interior of the cooling-cylinders, the connecting-pipes being provided with valves, substantially as shown and described.

In testimony that I claim the foregoing I have hereunto set my hand in the presence of two witnesses.

HENRY R. FOOTE.

Witnesses:
JOHN BUCKLEN,
WORTH OSGOOD.