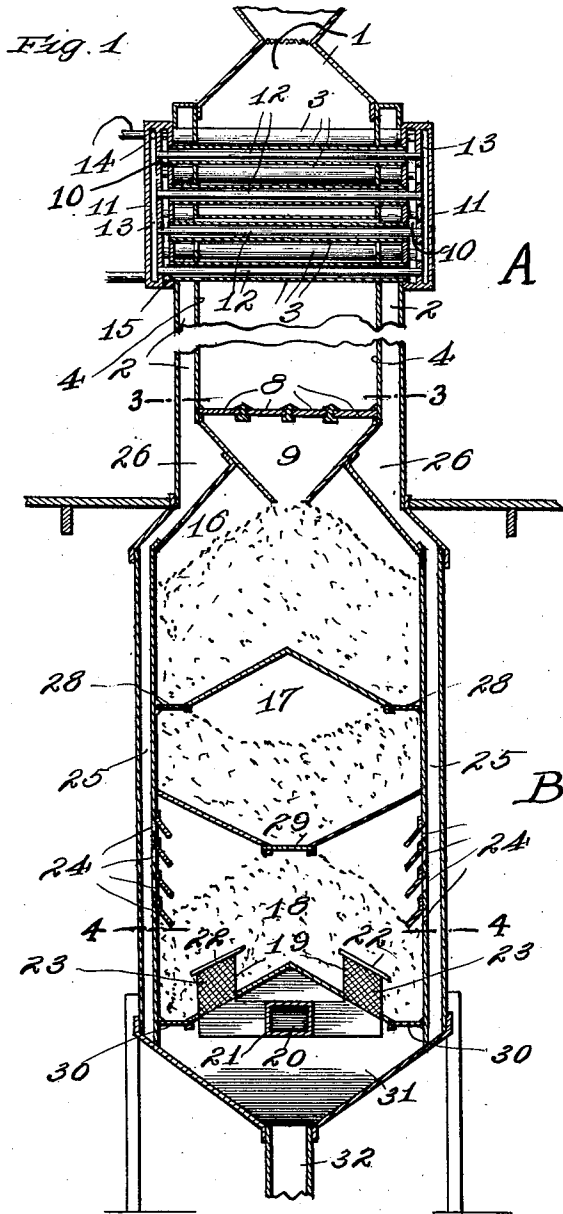


L. J. DENNIS.
PROCESS OF DRYING GRAIN.
APPLICATION FILED NOV. 23, 1912.

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Patented Apr. 8, 1913.

2 SHEETS—SHEET 1.



WITNESSES

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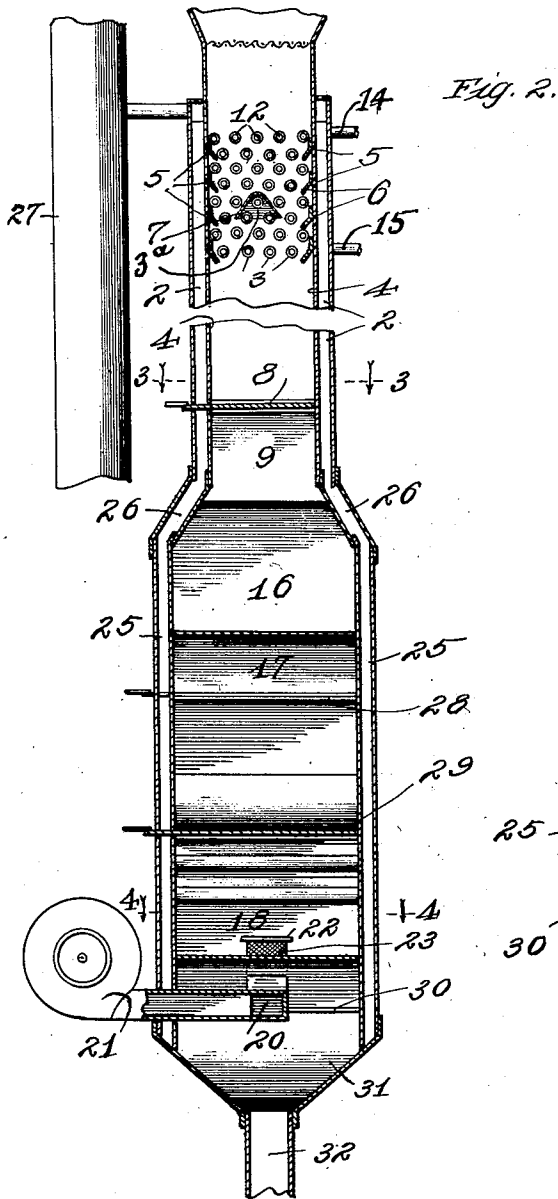


Fig. 3

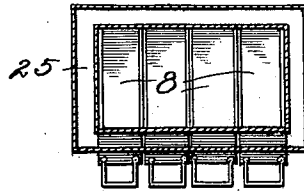
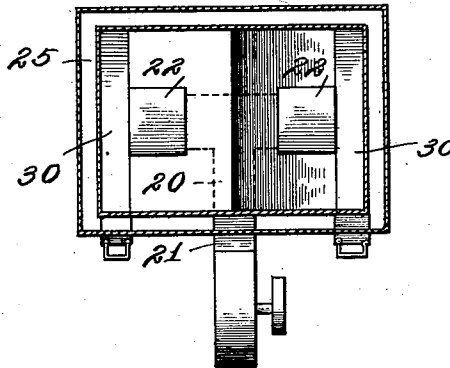


Fig. 4.



WITNESSES

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PROCESS OF DRYING GRAIN.

1,058,291.

Specification of Letters Patent.

Patented Apr. 8, 1913.

Application filed November 23, 1912. Serial No. 733,080.

To all whom it may concern:

Be it known that I, LEE J. DENNIS, a citizen of the United States, residing at Memphis, in the county of Shelby and State of Tennessee, have invented certain new and useful Improvements in Processes of Drying Grain, of which the following is a specification.

This invention relates to the art of properly conditioning grain for storage or shipment in bulk without deterioration.

The object of the invention is to accomplish this result at a cost greatly reduced over that incident to methods that have heretofore been employed, and also to accomplish the result not only without developing in the grain objectionable conditions which have been incident to processes heretofore employed, but with improvement in the physical condition of the grain.

A further object of the present invention is to render the process accurately controllable so that the desired percentage of moisture can be removed with exactness so as to avoid loss in weight beyond that which is necessary to insure the grain against fermentation.

Methods heretofore pursued have generally proceeded upon the theory of separating the grain into comparatively thin bodies, through which the heating and drying medium can be readily forced with more or less rapid action. Such processes, however, proceed upon an incorrect theory, for the reason that they so localize or intensify the heating and drying effects either on the outer layers of the grain or on one side only of many of the grains, that the effect is not uniform and as a consequence the grain subsequently stored in bulk may again become heated and caused to ferment or the surface is rendered dull, or parts of the grain are rendered so brittle as to become broken in subsequent handling.

One feature of my present invention consists in handling the grain in bulk both in the preheater or preliminary drier and cooler, so that the effects produced are necessarily distributed with great uniformity throughout the individual grain as well as the entire body of the grain.

Another feature consists in moving the grain, while in bulk and during the heating process, so that each individual grain progresses slowly through the heater, constantly changing its position, as well as its direction

of movement, and is repeatedly brought with first one side and then the other against the heating surfaces, while it is at all times so surrounded and closely packed with the other grains that the heat is forced to penetrate each grain uniformly until it emerges from the heater or reaches the end of the heating stage. In this way, while there is driven off a considerable proportion of the moisture sweated out of the grain, as a result of the rising temperature of its contained moisture, the surface of the grain is not dried out to retard escape of the innermost moisture as where the grain is subjected in thin layers to a hot blast. In my process, the pores of the grain remain open for the escape of the moisture in the subsequent stages of the process. Moreover, the bran or skin of the grain is not rendered dull in appearance or brittle.

Some kinds of grain and particularly corn are extremely hard to penetrate in the vaporizing action; that is to say, moisture contained in the innermost parts is very difficult to vaporize and drive out. This condition not only increases the difficulty of getting satisfactory results with old processes, but greatly adds to the expense of operation if the application of the heating medium is to be continued until the grain becomes thoroughly soaked.

Another feature of my invention consists in confining the grain, still in bulk, after the preheating and preliminary drying action above described, and permitting it to continue the heating effect and even raising its own inherent temperature after it has been removed from the influence of the artificial heating medium or after the latter has been cut off; this step in the treatment continuing until the grain is thoroughly soaked throughout and all parts have their moisture vaporized and seeking exit through the structure of the grain. Here again the confinement of the grain in bulk acts not only to favor the process, but to maintain the conditions of surface porosity already referred to which insure the desired ends of uniform treatment and subsequent conditions of marketability. This self-heating or conditioning of the grain being continued for such period as experience shows to be sufficient, the grain is next subjected to the drying step.

The next feature of my invention, therefore, consists in drying and cooling the grain while still in bulk and while in condition

to give up its moisture to the innermost parts of each grain, by supplying thereto at the bottom of the body of grain a sufficient quantity of dry air, preferably under low pressure, to cause the air to rise gently through the entire body, when assisted by the natural levity of the air as it takes on heat from the grain, so that the cooling does not proceed too rapidly for the drying and the skin drying does not take place to check the escape of the moisture from the inner parts of the grains. This introduces the element of time sufficiently to enable the drying effect to be carried on to exactly the degree or percentage desired, so that while on the one hand, the grain is thoroughly conditioned against subsequent heating or fermentation, on the other hand, it is not dried to a point of excessive loss in weight. Moreover, the grain emerges from the drier with bright lustrous appearance, sufficiently hard but not sufficiently brittle on the surface to fracture when being elevated or spouted into storage bins.

One form of apparatus suitable for carrying out the several steps of my process is illustrated in the accompanying drawing, in which,

Figure 1 is a vertical section through both the preheating portion and the sweating and cooling portion of the apparatus; Fig. 2 is a vertical section of the same, in a plane at right angles to Fig. 1; Fig. 3 is a horizontal section on the line 3—3 of Figs. 1 and 2, and Fig. 4 is a section on the line 4—4 of Figs. 1 and 2.

The apparatus selected for illustration comprises a combined preheating and preliminary drying section A, and a combined sweating and cooling section B. The section B is so related to the section A as to receive the grain therefrom either by gravity or some other approved means of transfer.

The section A comprises a preheating chamber 1 surrounded by flues 2 for taking off moist air and having arranged transversely therein heating pipes 3 for preheating the grain. Pipes 3 are arranged in horizontal series, one series above another and with the pipes of adjacent series staggered or alternated in position so as to develop among the pipes, a series of zig-zag passageways for the grain. The walls 4 of the chamber 1 are provided at intervals with guard plates 5 overlying air vents 6 and inclined downwardly and inwardly so as to serve the combined purpose of deflecting the grain inward toward the pipes and preventing the escape of the grain through the vents, while leaving said vents open for the escape of air. Certain of the pipes 3, for instance central triangular groups 3^a at different vertical intervals, are provided with inverted V-shaped troughs 7 which extend between and through opposite

end walls of the chamber 1 so as to provide escape passages for the moist air from the middle portion of the chamber. The bottom of the chamber 1 is made up of a series of cut-off slides 8 for controlling the escape of the grain into the hopper 9, through which it is delivered to the section B. Each of the pipes 3 is tapped at its ends into the expansion chamber 10 of the manifold castings 11, while within each pipe 3, is a steam pipe 12 which taps into the steam chambers 13 of the castings 11. Steam supply pipe 14 and steam outlet 15, suitably connected to the castings, are adapted to keep up a steam circulation through the heating pipes of such temperature as may be desired and predetermined by suitable control of steam valves.

The section B comprises essentially a chamber in which to permit the grain to stand a sufficient time to sweat or permit the heat to soak thoroughly through it after leaving the preheating chamber; also means for subsequently cooling the grain and carrying off its evaporated moisture, which may be applied either to the same chamber as that in which the sweating takes place or a separate chamber to which the grain is delivered from the sweating chamber. For convenience in conducting the process continuously and treating one batch of grain after another, the section B is constructed with a receiving chamber 16 which the grain enters from the hopper 9; a sweating chamber 17 in which a given quantity of grain can be stored and confined under conditions which cause it to heat; and a cooling chamber 18 having air stacks 19 supplied through an air trunk 20 from any suitable source of dry air, such for instance as a fan 21. The air stacks 19 are preferably provided with tight covers 22, but have their walls constructed of reticulated material 23 so that the air can escape freely over the entire lower area of the body of grain in the chamber 18, so as to rise uniformly through the entire body of grain and affect the entire body alike. The walls of the chamber 18, particularly above the body of grain, are provided with vents 24 communicating with the air flues 25 and extend upwardly on all four sides of the section B and communicate through flues 26 with the flues 2 surrounding the section A. The warm moist air from both the section A and the chamber 18 of the section B escapes through a stack 27.

In order to have in the chambers 17 and 18, a body of grain of substantially uniform vertical dimensions throughout its area, the bottom of the chamber in each instance is formed with inclined surfaces substantially parallel to the natural inclination developed by the flowing of the grain as it enters the chamber. Thus the bottoms are alternately inclined upwardly and downwardly from the middle point. The downwardly inclined

bottom for the chamber 18 and the upwardly inclined bottom for the sweating chamber 17 are preferred, because this arrangement leaves substantial air surfaces above the body of grain in the chamber 18 through which to provide escape for the moist air rising from the body of grain. This, however, is a matter of convenience rather than essential.

In carrying out the process, the chamber 1 is fed with grain which flows slowly through the circuitous passageways among the staggered pipes, so that the grain flows first in one direction and then in the other, bringing first one side of the grain and then the other against the pipes, so that it is heated uniformly. The chamber being filled during this flow, the grain is always in bulk and its moisture is prevented from being dissipated suddenly or locally on any particular part of the grain or on the exterior of the grain more rapidly than the moisture can pass outward from the interior. In this way, skin drying or overheating of the surface of the grain is avoided and when the grain escapes through the hopper 9, it is in a superior condition with the contained moisture remaining in the grain uniformly distributed therein, with the surface of the grain bright and not parched or dried out. A certain proportion of the moisture will have been withdrawn from the grain through the vents 6 and inverted troughs 7 and the grain will be thoroughly and uniformly heated to about 170° F. As the preheating and preliminary drying step which takes place in section A involves a slow and gradual feed of the grain, the chamber 16 will be employed to receive the discharged grain until a sufficient charge or quantity for sweating has been accumulated, or said grain will be allowed to pass immediately through the chamber 16 into the chamber 17, until the latter is filled, after which valves 28 will be closed and the self-heating or sweating of the grain in the closed chamber 17 will be allowed to proceed, say for one and one-half hours, while the slowly advancing grain from the section A will be allowed to accumulate in the chamber 16 ready for the next charge. After the grain has been sufficiently sweated, the cooling and final drying step in the process is introduced. This obviously could be carried on in the chamber 17 by opening suitable air circulating passages, but in order to have the cooling of one charge proceeding while the next charge is sweating, the grain is discharged through the valve 29, from chamber 17 into chamber 18, whereupon a gentle supply of dry air is delivered through the stacks 22 in a manner to permeate the entire lower stratum of the grain and said air is allowed to rise through the body of grain mainly by its levity resulting from

the acquired heat and to escape through the air ports 24 into the flues 25. Here again the too rapid drying of the grain on the outside is avoided with the result that the thoroughly and uniformly sweated grain can give off its entire moisture to be removed, as the moisture is taken up by the air. The grain will issue from the chamber 18 through flues 30 into the hopper 31 and spout 32 to storage with just the amount of moisture desired, with a lustrous skin surface, without brittleness that induces breaking of the grain and thoroughly conditioned for storage or shipment in warm climates. The slowness with which the cooling takes place and the retention of the grain in bulk during this step enable the degree of moisture to be determined to a nicety and insure the uniform treatment of the entire body of grain as well as the physical condition of the grain when the process is complete. The percentage of moisture to be driven out of the grain will vary greatly according to the character of the grain and the amount of natural evaporation that has taken place. Corn may under some extreme conditions have as much as 24% of moisture and this may decrease down to 16%, whereas not more than 15% of moisture should be present in the grain to insure its keeping in good condition in a warm climate. If 24% of moisture is contained in the corn, it may require as much as one and one-half hours' treatment in the slow drying step of the process. If, however, only 1, 2 or 3% of moisture is to be removed, the time required in the cooler will be proportionately less. About 20 minutes will ordinarily be required to thoroughly heat the grain in the preheater without injuring it. Hence, it will be seen that the grain passes slowly through the preheater, and it is quite practicable to arrange the subsequent stages of the process so that one charge can be cooled while other charges are being heated and sweated.

Any suitable mechanical means may be employed for gradually and uniformly discharging the grain into the hopper 9 in order to insure its uniform progress through the preheater.

I claim:

1. The process of drying grain which consists in preheating the grain, closely confining the preheated grain in bulk, and sweating it by its previously added heat and then slowly cooling and drying it by passing through the grain a cooling medium capable of taking up moisture.

2. The process of drying grain which consists in preheating the grain while in bulk with the grains closely associated, then closely confining the preheated grain in bulk and sweating it by its contained heat, and then slowly cooling and drying the

grain by passing through it a cooling medium capable of taking up its moisture.

3. The process of drying grain which consists in preheating the grain, closely confining the preheated grain and sweating it by its contained heat, then delivering uniformly throughout the bottom of the body of grain, a cooling and drying medium and permitting said medium to rise through the

body of grain as it takes up the heat from the grain.

The foregoing specification signed at Washington, District of Columbia, this 28th day of August, 1912.

LEE J. DENNIS.

In presence of two witnesses:

HERVEY S. KNIGHT,
BENNETT S. JONES.