A. HUHN.

PROCESS AND APPARATUS FOR DRYING MATERIALS.

APPLICATION FILED DEC. 29, 1917.

1,318,385. Patented Oct. 14, 1919.

3 SHEETS—SHEET 1.

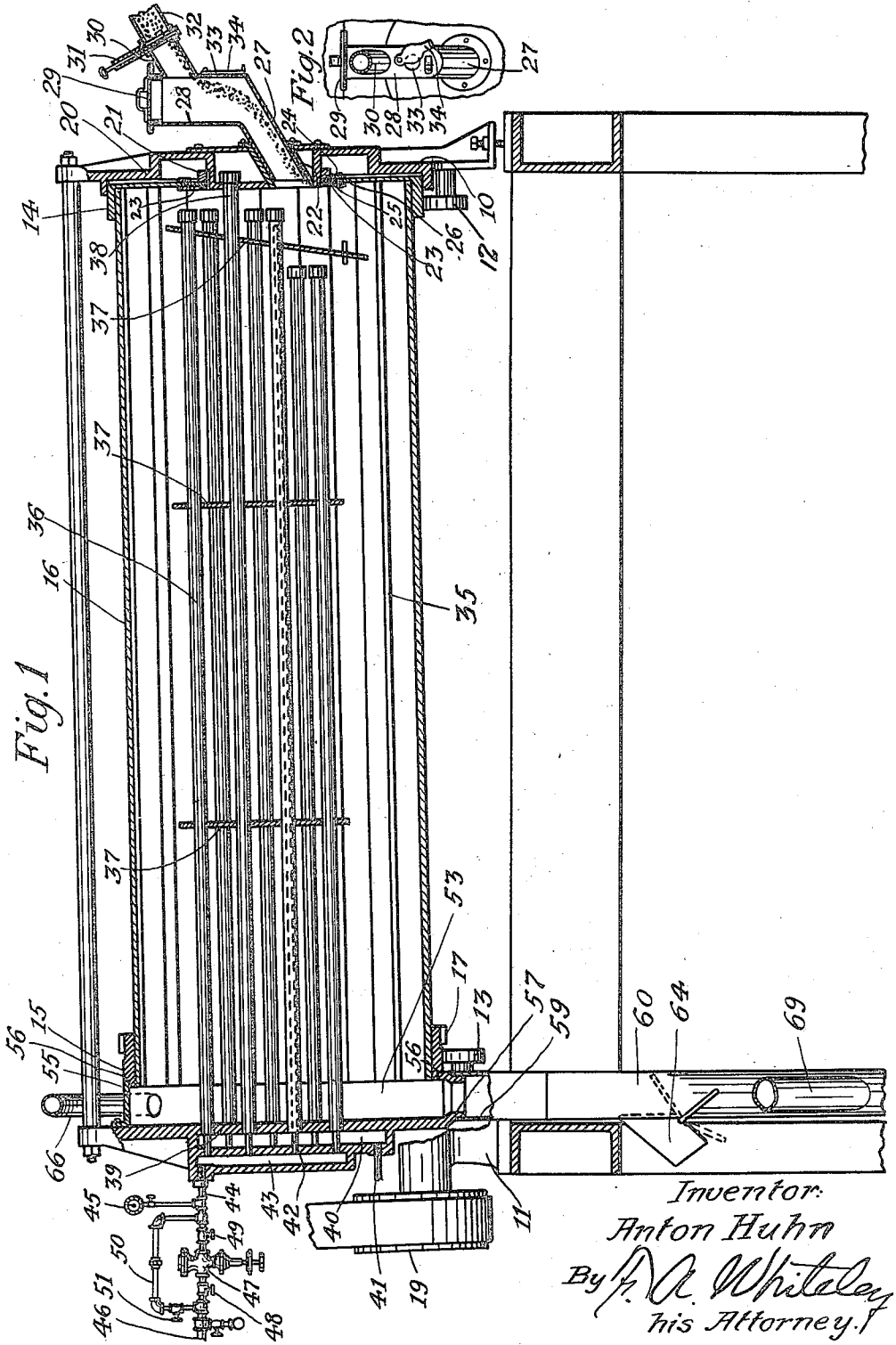


Fig. 1

Fig. 2

Inventor:
Anton Huhn
By F. A. Whiteley
his Attorney.

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3 SHEETS—SHEET 2.

Fig. 3

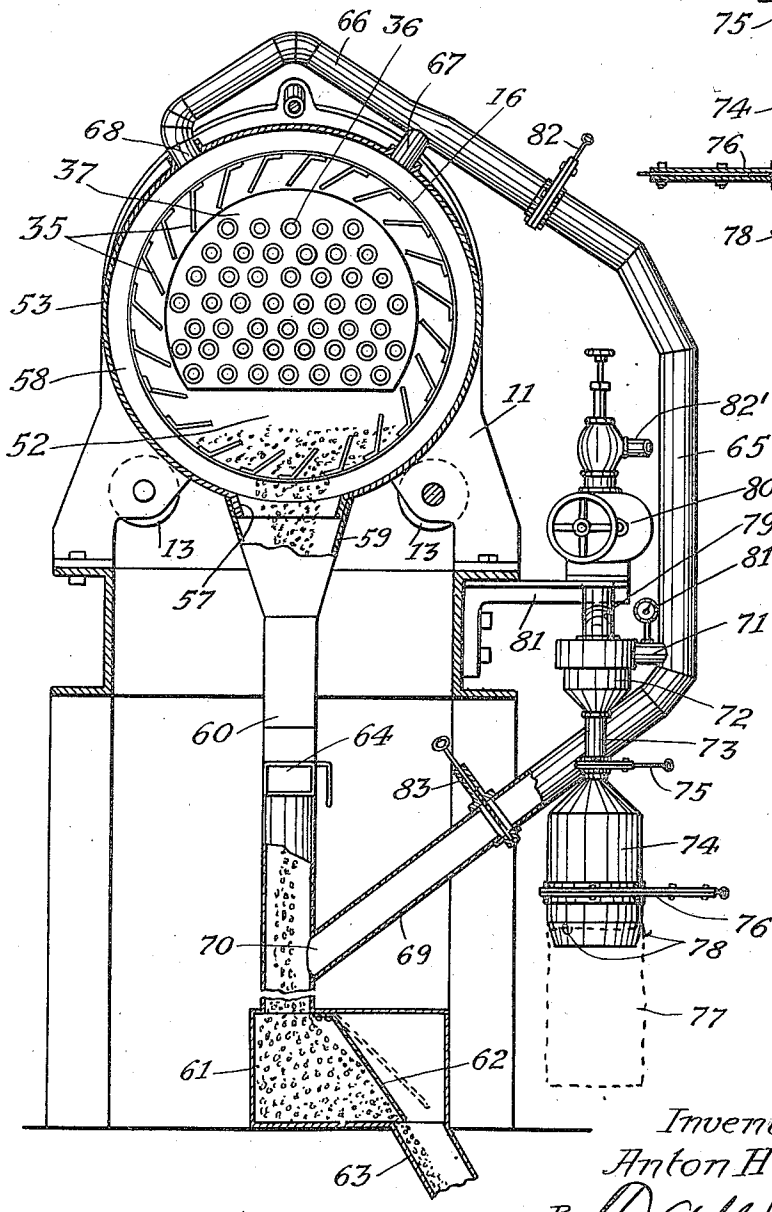
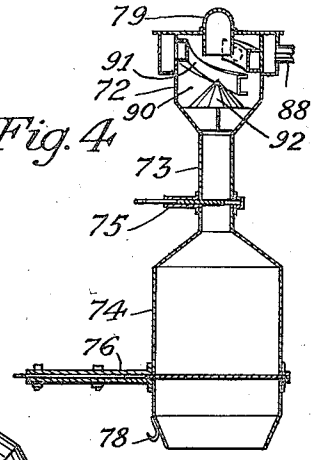


Fig. 4



Inventor:
Anton Huhn
By F. C. Whitelaw
his Attorney.

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3 SHEETS—SHEET 3.

Fig. 6

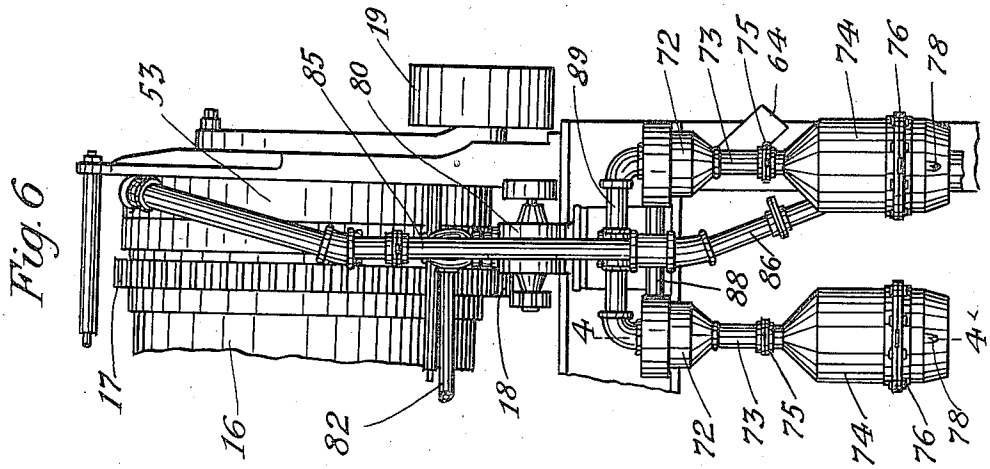
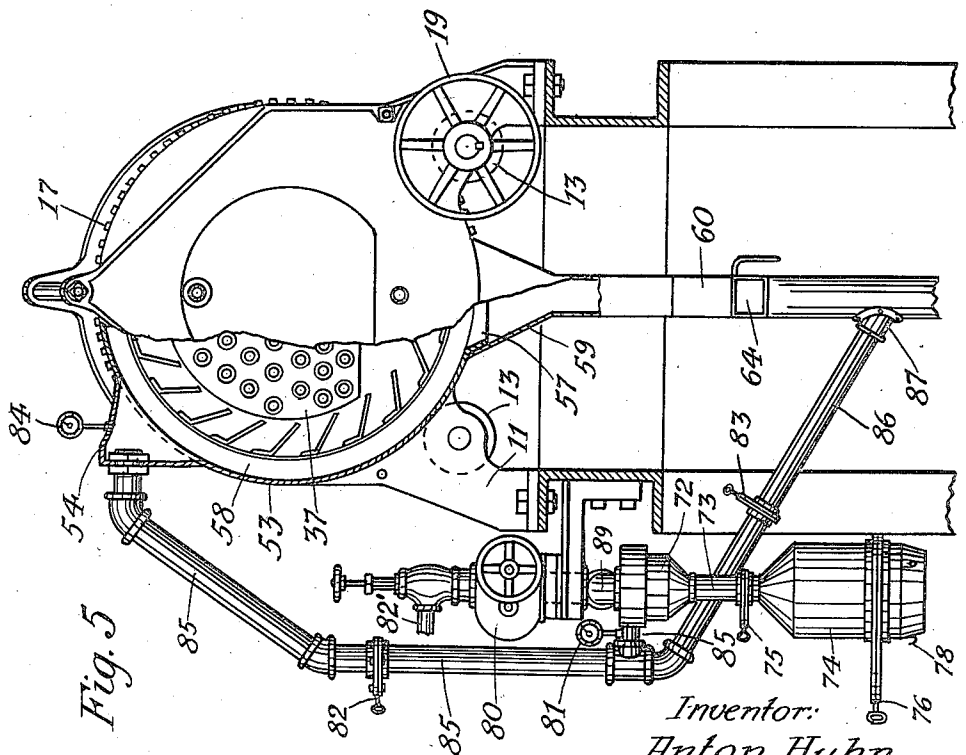


Fig. 5



Inventor:
Anton Huhn
By A. G. Whiteley
his Attorney

UNITED STATES PATENT OFFICE.

ANTON HUHN, OF MINNEAPOLIS, MINNESOTA.

PROCESS AND APPARATUS FOR DRYING MATERIALS.

1,318,385. Specification of Letters Patent. Patented Oct. 14, 1919.

Application filed December 29, 1917. Serial No. 209,579.

To all whom it may concern:

Be it known that I, ANTON HUHN, a citizen of the United States, residing at Minneapolis, in the county of Hennepin and State of Minnesota, have invented certain new and useful Improvements in Processes and Apparatus for Drying Materials, of which the following is a specification.

My invention relates to a process and apparatus for drying granular materials having in intimate association therewith an excess amount of moisture. The invention is particularly adapted to operate upon cereals either in the form of the original grain, such as wheat, oats, rye, etc., or in a milled form such as corn meal, wheat granules, etc. In operating upon such cereals sterilization is effected at the same time that the moisture is removed. The invention is, however, also operable upon other materials than cereal grain for the rapid removal of excess moisture, provided said materials are substantially granular in form or made up of a multiplicity of individual particles capable of relative movement and separation, such as various kinds of ores which have been reduced to a requisite degree of fineness, common salt, sand and similar materials.

In practising the steps of my invention I provide heating means within a chamber, means for feeding the material into, through and out of the chamber in a continuous and rapid stream and in such manner that entrance of air with the material is substantially excluded, means for causing the material during its progress through the chamber repeatedly to engage the heating means with its particles in a state of separation, together with means for producing a partial vacuum about the moving and separated particles during the heating thereof, said partial vacuum being induced by a volumetric withdrawal from the chamber of released vapor and admitted air tending to be greater than the actual volume of such released moisture and admitted air.

The practice of the process involves apparatus embodying a chamber substantially sealed from the outside air, excepting for a regulable opening thereinto, with inlet and outlet spouts through which the grain or other material may be fed in a continuous rapid stream in coöperation with means for sealing said spouts by and in connection with the feed of material, together with a battery of fixed pipes and means for heating said pipes to any desired temperature, and means for operating upon the grain so as to cause it to be poured in a shower over the pipes, all in combination with air and vapor withrawal pipes communicating with dust-collecting and blower means, and also with the upper part of the rear end of the chamber and with the discharge spout. It is essential that the blower means provided shall be such that the water vapor may be withdrawn as rapidly as it is formed so as to maintain the chamber always in a state of vacuum. It is sometimes desirable that some air shall be admitted to the chamber but in small and strictly regulated quantities, such air being withdrawn together with a small amount of water vapor from the air pipe which communicates with the discharge spout for the grain. The gas which reaches the blower will be largely water vapor which tends to condense rapidly. It is an important step of my process, therefore, that the dust particles carried by this gas shall be removed before reaching the blower, as condensation may begin to take place in the blower and will take place in the pipes leading from the blower to the discharge point, which, if such particles of dust are not removed, will form a mud or slime that would render the apparatus inoperative or necessitate frequent stoppage and expensive delay for cleaning purposes. Furthermore, the dust particles, especially from milled grain such as corn meal and wheat granules, is a valuable by-product the saving of which much more than meets the cost of operating the drying and sterilizing process.

The means for regulating the admission of air permits the amount admitted to be varied as required by the character of the material operated upon and its moisture content. The degree of heat of the heating means must also be varied, subject to the same conditions, for which reasons means are provided for varying the temperature of the heating means through a desired wide range.

The full objects and advantages of my

invention will appear in connection with the detailed description thereof and are particularly pointed out in the claims.

In the drawings, illustrating one form of an apparatus adapted to carry out the steps of my novel process,—

Figure 1 is a longitudinal sectional view of an apparatus suitable for effecting the steps of my process. Fig. 2 is a detail view of the grain and air inlet member; Fig. 3 is a transverse part sectional view of the outlet end of the apparatus showing one form of pipe connections. Fig. 4 is an enlarged sectional view on line 4—4 of Fig. 6. Fig. 5 is an end elevation, with some parts broken away, of an apparatus for performing my process showing a slightly different form of pipe connection. Fig. 6 is a side elevation view partly broken away of the device shown in Fig. 5.

As illustrated, the apparatus provides front and rear frame members 10 and 11 having journaled therein rollers 12 and 13 upon which rest front and rear rings 14 and 15 of a cylinder 16 being there held in an inclined position as indicated in Fig. 1. Cast integral with or secured to ring 15 is a spur gear 17 which meshes with a pinion 18 driven from a belt pulley 19 by which means the cylinder 16 may be rotated as desired. The front end of the support 10 has cast integral therewith a head 20 formed with an inwardly extended drum member 21 through which projects an obliquely-disposed pipe or chute 22. Upon the drum 21 is secured an annular flange 23 which extends between a pair of flanges 24 and 25 secured to an annular plate 26 which is in the plane of the flange 23 and is tightly secured to the end of drum 16. By this means the drum head is rotatably connected with the supporting member in such a manner that it is sealed excepting for the inlet opening 22. Extending within the inlet opening 22 is a pipe 27 connected with a chamber 28 which is closed air-tight at its top by a cover 29. A feed spout 30 enters the chamber 28 at any desired angle but out of alinement with the pipe 27. A sliding valve 31 in the spout cuts off grain flowing through the feed passage so that the spout above the valve member will at all times be full or choked with grain as indicated at 32. This spout will in practice be a number of feet in length running to the supply bin, perhaps 30 or 40 feet away, and being at all times full of grain this will effectively prevent any substantial amount of air passing with the grain into the feed passage 30. The rear wall of the chamber 28 is provided with an aperture indicated at 33 which is immediately below the inlet of the feed spout 30. The extent of opening of this aperture is controlled by a hinged slide 34. By this means the inlet of air into the cylinder at the grain inlet end is closely controlled and will always be relatively small. Within the drum 16 are located a multiplicity of flights 35 which are forwardly turned in such a manner that the grain, as it is fed into the drum at the forward end, will be repeatedly lifted and dropped from the upper part of the drum traveling by gravity to the rear end of the drum and the point of discharge.

Within the area bounded by the path of movement of the inner edges of the flights is a battery of pipes 36 held in spaced relation by plates 37, and supported at their front end by some of the pipes indicated at 38 which pass through the head of the drum extension 21. At their other ends all of the pipes 36 pass through a wall 39 forming in conjunction with the supports 11 the rear head of the machine. The pipes 36 enter an exhaust steam chamber 40 from which steam is discharged through a pipe 41. Within all of the pipes 36 are live steam pipes 42 which communicate with a steam chamber 43 fed by pipe 44 with steam from a boiler. A gage 45 shows the pressure and therefore the temperature of the steam in the live steam chamber 43. The main steam pipe 46 passes through a pressure-reducing valve 47 to the pipe 44 and is additionally controlled by cocks 48 and 49. A by-pass 50 controlled by a cock 51 enables the pressure quickly to be raised in order quickly to raise the temperature of the heating pipes to meet some instantaneously-developed change of condition of the material operated upon.

It is to be noted that the battery pipes 36 are crowded into the upper portion of the space within the limits of the travel of flights 35, leaving a part 52 within the lower part of the cylinder where there are no pipes. Connected with the rear head wall 39 is an inwardly-extended flange 53 which may be all circular in form as in Fig. 3 or, as in Fig. 5, may include an offset as indicated at 54. In either form a portion of the flange 53, as indicated at 55, enters a seat 56 in the ring 15, and the drum 16 and its flights 35 terminate just to the rear of this air tight joint. This provides a chamber 58 at the rear end of the drum of slightly larger diameter than the drum. A mouth 57 is provided at the bottom of this chamber to which is secured in air-tight relation a discharge hopper 59 connected with a discharge spout 60. The discharge spout 60 is of considerable extent and opens into a box 61 having a swing door 62 which is pushed over by the material in the box 61 so as to permit such material to escape through spout 63. The material such as grain thus seals the discharge spout so that substantially no air can come back from

spout 63 into the discharge spout 60 or the interior of the drum 16. A trap opening 64 of common construction is provided in the side of the discharge spout 60 to permit withdrawal and examination of material at that point.

As illustrated in Fig. 3, an air pipe 65 has a portion 66 thereof connecting through branches 67 and 68 with the upper portion of the chamber 58. A lower extension 69 of the pipe 65 communicates at 70 with the material discharge spout 60. From pipe 65 a branch 71 enters the upper part of an air cleaner 72 which discharges through a pipe 73 into a chamber 74. A slide valve 75 controls the area of discharge from 73 into 74 and a slide valve 76 is adapted to be opened to discharge the contents of 74 into a sack 77 adapted to be held by hooks 78 upon the lower end of the chamber 74. From the cleaner 72, which is of the form illustrated in Fig. 4, embodying an internal chamber 90, spiral passageways 91 and a conical baffle 92, as there shown, a pipe 79 leads to a blower 80 mounted upon a bracket 81 secured upon the supporting framework. This blower is a positive blower, capable of developing a high degree of vacuum on the inlet side which is measured by a gage 81 connected with pipe 71. The gas delivered from the blower goes through a pipe 82 to any desired point of discharge. The degree of opening of the branches 66 and 69 respectively to pipe 65 is determined by the slide valves 82 and 83, and the respective extent to which these valves shall be opened can be determined by the condition of the grain or other material when it reaches the trap opening 64. It is important that the withdrawal through branch 66 shall always be sufficient to take away the moisture vapor as rapidly as it is formed so as to leave the interior of the drum always at a vacuum which is effectively indicated by a gage 84 connecting with chamber 58. The opening of pipe 69 into discharge spout 60 should be sufficient to effect some cooling of the discharging grain and to withdraw free moisture from the material to the point that such grain or other material will not steam when withdrawn through 64.

In the form of the invention in Fig. 5 a cast pipe member 85 communicates directly with the extension 54 at the top of the chamber 58, a branch 86 enters the discharge pipe 60 at 87. A pipe extending from 85 goes to a cross pipe 88 which communicates with a pair of cleaners 72 such as have already been described. A pipe 89 communicates with the top of both cleaners 72 which by a T is connected to the blower 80.

In operation the above indicated apparatus effectively performs the steps of my process in the following manner. Steam is admitted to produce a degree of heat in the pipes 16 sufficient to bring the material at the end of its travel through the chamber within the cylinder to a temperature such that the moisture in said material will be expelled. The temperature will therefore necessarily vary in proportion to the amount of moisture to be withdrawn. The material such as grain completely fills the admission spout 32 up to the slide valve 31, from which it passes into the box 28, thus sealing said box against any substantial admission of air with the grain. The rotating drum 16 also is substantially sealed from the admission of air at both ends. The material is lifted by the flights and poured down over the battery of pipes, and by reason of the inclination of the drum such material travels toward the rear end thereof, finally passing into the chamber 58 and through the mouth 57 therefrom into the hopper 59 and discharge pipe 60, from which it goes to the valve box 61 which operates to seal against the admission of air from the discharge end. The pipes are located principally in the upper portion of the chamber within the flights, and the hot moisture, vapor or steam released from the heated grain as it passes through said pipes will tend to go into the upper part of the cylinder and to gravitate to the upper part of the chamber 58, which is in communication with the withdrawal pipe 66 or 85 at the upper portion thereof. The blower 80 is positive in its action and of such size as to be capable of withdrawing water vapor at a much greater rate than it can be formed under maximum conditions of wet material and heated pipes, thus insuring the production of a vacuum at all times within the cylinder. The vacuum is reduced to a desired degree by the regulated admission of air through the opening 33, which air passes with the grain into the cylinder and below the lower edge of the first plate 37 and will tend to move along the bottom of the cylinder in the space below the pipes because such air is colder than the released water vapor or steam, and also because air is heavier than water vapor even when at the same temperature. The withdrawal pipe 69 or pipe 86, communicating with discharge pipe 60, have their valves 83 set so as to draw through pipe 60 an amount of gas substantially equal to the air admitted at 33. The gas drawn through 60 therefore will be principally air and cooler than the water vapor or steam drawn from the upper part of the cylinder by pipe 66 or pipe 85. This air passing over the hot material as the same goes through the discharge pipe 60 exercises a slight cooling effect upon such material and removes by evaporation the last portions of moisture being expelled therefrom by the heat of the material. The valves

83 and 82 will be so regulated that at all times the withdrawal pipe 65 or 85 will operate to take all the moisture set free from the material by the heating thereof at a rate such as to produce a considerable degree of vacuum within the cylinder, while pipe 69 or 86 will operate to withdraw gas at substantially the rate of the admission of air through the regulated opening 33. It will be understood, therefore, that the drying of material is not effected by evaporation, but that the moisture is expelled by heat, rendered more effective for that purpose by the production of a vacuum within the cylinder, and the moisture vapor is withdrawn as rapidly as it is expelled, air being admitted only in sufficient quantities to stabilize the vacuum within the cylinder and to assist in the removal of the last water vapor expelled from the particles of material. This process applied to grain, corn meal and similar cereals effects the removal of moisture to any desired degree without scorching or chemical change, but with complete sterilization. Owing to the constant state of movement of material within the cylinder and through the pipes, the rapid release of moisture vapor and the high velocity of the currents of withdrawal of such vapor, and of the air, all very fine particles of the material will be drawn off with such water vapor and air. If this material passes directly to the blower with the water vapor, condensation will begin to take place in the blower and to a much larger extent in the discharge pipe, with the result that gum or mud would rapidly accumulate, which would soon render the blower and pipe inoperative until cleaned. For this reason and because the fine particles of material have a high commercial value, it is an important step in my process that such fine particles be removed from the air and vapor currents before the same reach the blower, and this is effected by the centrifugal dust collectors 72, which may be used in pairs as shown or singly, as desired. The material is thus removed from the rapidly-moving currents of air and vapor before it reaches the blower and is saved and sacked as indicated in Fig. 3.

My invention has been put in practice and is found to produce highly satisfactory results in drying wet corn and corn meal as well as other wet grains, which are also sterilized at the same time. The process is further valuable in operating upon grain which is infested with weevil, which are effectively destroyed and withdrawn, the bodies of the weevil being dried out during the process and the skeletons then becoming so light as to be withdrawn with the currents of air and vapor.

While I have shown an efficient and satisfactory apparatus for carrying out the steps of my process, it will be understood that I do not desire to restrict myself to the precise form of apparatus here shown, but reserve the right to employ the invention in connection with other forms of apparatus and modifications and changes within the scope of my invention.

I claim:

1. The process of drying granular materials containing moisture which consists in feeding said materials into, through and out of a closed chamber in a continuous stream, repeatedly impacting all of the particles of said material in a state of separation against heating means within the chamber maintaining a regulated temperature in the chamber such as to heat the particles during their passage through the chamber, the heat in the material being augmented by reason of said repeated impacts to a temperature sufficient to drive the desired amount of moisture therefrom, and withdrawing air and moisture from the atmosphere surrounding said particles at a sufficiently rapid rate to produce a partial vacuum within the chamber.

2. The process of drying granular materials containing moisture which consists in feeding said materials into, through and out of a closed chamber in a continuous stream, controlling said stream so that the material itself will act to substantially exclude unregulated admission of air into the chamber with the material, heating the material as it is passed through the chamber to a temperature sufficient to drive the desired amount of moisture therefrom by causing the particles thereof repeatedly to impact against heating means within the chamber, and withdrawing air and vapor from the atmosphere surrounding said particles at a sufficiently rapid rate to produce a partial vacuum within the chamber.

3. The process of drying granular materials containing moisture which consists in feeding said materials into, through and out of a closed chamber in a continuous stream, controlling said stream so that the material itself will act to substantially exclude unregulated admission of air into the chamber with the material, heating the material as it is passed through the chamber to a temperature sufficient to drive the desired amount of moisture therefrom by causing the particles thereof repeatedly to impact against heating means within the chamber, admitting a regulated amount of atmospheric air to the chamber, and withdrawing a portion of the atmosphere surrounding said particles including the released moisture vapor and admitted air at a sufficiently rapid rate to produce a partial vacuum within the chamber.

4. The process of drying granular materials which consists in feeding said material in a continuous stream into, through and out of a chamber substantially sealed against the admission or withdrawal of unregulated currents of air or vapor, heating the particles of said material during their passage through the chamber to a temperature sufficient to drive the moisture therefrom, admitting a regulated amount of air to the chamber, and withdrawing said air and the released moisture vapor by applying a degree of suction to the chamber such as to tend to withdraw said vapor and air faster than it is formed and admitted and thereby to produce a state of vacuum within said chamber.

5. The process of drying granular materials which consists in continuously feeding said material into, through and out of a chamber substantially sealed against the admission or withdrawal of unregulated currents of air or vapor, heating the particles of said material during their passage through the chamber to a temperature sufficient to drive the moisture therefrom, withdrawing the released vapor from the upper portion of the discharge end of said chamber, admitting a regulated amount of air to the chamber, and withdrawing air and moisture vapor from the chamber through the material discharged therefrom.

6. The process of drying granular materials which consists in continuously feeding said material into, through and out of a chamber substantially sealed against the admission or withdrawal of unregulated currents of air or vapor, heating the particles of said material during their passage through the chamber to a temperature sufficient to drive the moisture therefrom, withdrawing the released moisture vapor from said chamber as rapidly as it is formed, and collecting particles of material carried off with the moisture vapor shortly after its withdrawal from the chamber.

7. The process of drying granular materials which consists in feeding said material in a continuous stream into, through and out of a chamber substantially sealed against the admission or withdrawal of unregulated currents of air or vapor, heating the particles of said material during their passage through the chamber to a temperature sufficient to drive the moisture therefrom, admitting a regulated amount of air to said chamber, and effecting regulated withdrawal of the air and released moisture vapor as rapidly as it is formed.

8. Apparatus for drying granular materials comprising a casing, means for feeding the material into the casing so as to prevent entrance of air therewith, means for withdrawing the material from the casing so as to prevent the entrance of air through the withdrawing means, means for progressively moving the particles of the material in a state of separation about and through said casing from the point of entrance to the point of discharge, means for progressively heating the material as it is moved, and means for subjecting the material so moved to regulated currents of air during the entire period of moving and heating.

9. Apparatus for drying granular materials comprising a casing, means for feeding the material into the casing so as to prevent entrance of air therewith, means for withdrawing the material from the casing so as to prevent the entrance of air through the withdrawing means, means for progressively moving the particles of the material in a state of separation about and through said casing from the point of entrance to the point of discharge, means for progressively heating the material as it is moved, means for subjecting the material so moved to regulated currents of air during the entire period of moving and heating, and means for withdrawing released water vapor and air from the casing so as to produce a partial vacuum therein.

10. Apparatus for drying granular materials comprising a casing, means for feeding the material into the casing so as to prevent entrance of air therewith, means for withdrawing the material from the casing so as to prevent the entrance of air through the withdrawing means, means for progressively moving the particles of the material in a state of separation about and through said casing from the point of entrance to the point of discharge, means for progressively heating the material as it is moved, and means for withdrawing released water vapor and air from the casing so as to produce a partial vacuum therein.

11. Apparatus for drying granular materials comprising a rotating drum, a battery of pipes in the drum, means for admitting steam at varying pressures to produce a predetermined temperature in said pipes, means for admitting material at one end and withdrawing it at the other end of said drum while substantially excluding admission of air with or past said material as it is admitted and withdrawn, and means for withdrawing released water vapor from the upper part of the forward end of the casing.

12. Apparatus for drying granular materials comprising a rotating drum closed at each end and substantially sealed from the admission of air, a battery of heating pipes within the drum, means for feeding material into the drum at one end so as to prevent the entrance of air therewith, means for permitting discharge of the material at the other end so as to prevent the entrance

of air through the discharging means, and a blower having connection with the chamber within the drum and with the discharge means for withdrawing released moisture vapor from said drum.

13. An apparatus for drying granular materials comprising a rotating drum, a battery of pipes in the drum, means for admitting steam at varying pressures to produce a predetermined temperature in said pipes, means for admitting material at one end and discharging it at the other end of said drum while substantially excluding admission of air with or past said material as it is admitted and withdrawn, means for withdrawing released water vapor from the upper part of the forward end of the casing, means for admitting a regulated amount of air into the casing, and means for withdrawing said air through the discharging means for the material.

14. Apparatus for drying granular materials comprising a casing, means for admitting and discharging material while substantially excluding the admission of air with or past said material as it is admitted and withdrawn, means for progressively heating the material within the casing, an air pump having connection with the casing of a capacity sufficient to withdraw the released moisture from the casing as rapidly as it is formed and create a vacuum in said casing, and a dust-collector between the pump and the casing for removing particles of dust withdrawn from the casing with the moisture vapor.

15. Apparatus for drying granular materials comprising a casing, means for admitting and discharging material while substantially excluding the admission of air with or past said material as it is admitted and withdrawn, means for progressively heating the material within the casing, an air pump having connection with the casing of a capacity sufficient to withdraw the released moisture from the casing as rapidly as it is formed and create a vacuum in said casing, and a multiplicity of dust-collectors arranged in the connection between the pump and the casing for withdrawing particles of dust from the moisture vapor.

16. Apparatus for drying granular materials comprising a casing, means for feeding the materials in a continuous stream into and for progressively moving the particles of material in a state of separation about and through said casing to the discharge end thereof, means for progressively heating the material as it is moved, means for causing said stream of material substantially to seal the casing against air admission by reason of the feed and discharge of the materials, and means for withdrawing the released moisture from the casing.

17. Apparatus for drying granular materials comprising a casing, means for feeding the materials into and for progressively moving the particles of material in a state of separation about and through said casing to the discharge end thereof, means for progressively heating the material as it is moved, means for substantially sealing the casing against air admission by reason of the feed and discharge of the materials, means for admitting a regulated quantity of air to the casing, and means for withdrawing the released moisture and admitted air from the casing.

18. Apparatus for drying granular materials comprising a casing including a rotating drum, means for sealing the ends of said drum in said casing against the admission of air, a battery of pipes within the casing, means for supplying steam to said pipes to vary the temperature thereof as desired, means for feeding the material into and out of the casing in a continuous stream, means for causing said stream of material substantially to seal the casing against air admission in connection with the feed and discharge of the materials, and means for withdrawing released moisture from the casing.

19. Apparatus for drying granular materials comprising a casing including a rotating drum, means for sealing the ends of said drum in said casing against the admission of air, a battery of pipes within the casing, means for supplying steam to said pipes to vary the temperature thereof as desired, means for feeding the material into and out of the casing in a continuous stream, means for causing said stream of material substantially to seal the casing against air admission in connection with the feed and discharge of the materials, means for admitting a regulated quantity of air into the casing in connection with the feed admission for the material, and means for withdrawing air and released moisture from the other end of the casing.

20. Apparatus for drying granular materials comprising a casing including a rotating cylinder, a feed inlet spout entering the casing at one end, a discharge spout at the other end of said casing, a battery of heated pipes within the casing, an air pipe having connection with the upper part of the casing and the discharge spout, and a blower connected with said air pipe.

21. Apparatus for drying granular materials comprising a casing including a rotating cylinder, a feed inlet spout entering the casing at one end, a discharge spout at the other end of said casing, a battery of heated pipes within the casing, an air pipe having connection with the upper part of the casing and the discharge spout, separate valves in the portions of said air pipe

going to the casing and to the discharge spout for regulating the relative flow through the respective branches of the pipe, and a blower connected with said air pipe between the valves.

22. Apparatus for drying granular materials comprising a casing including a rotating cylinder, a feed inlet spout entering the casing at one end, a discharge spout at the other end of said casing, a battery of heated pipes within the casing, an air pipe having connection with the upper part of the casing and the discharge spout, a blower connected with said air pipe, and a dust collector in the connection between the blower and the air pipe.

In testimony whereof I hereunto affix my signature.

ANTON HUHN.