Feb. 26, 1929. 1,703,290

L. BUCK

DRYING APPARATUS

Filed Feb. 2, 1927 2 Sheets-Sheet 1

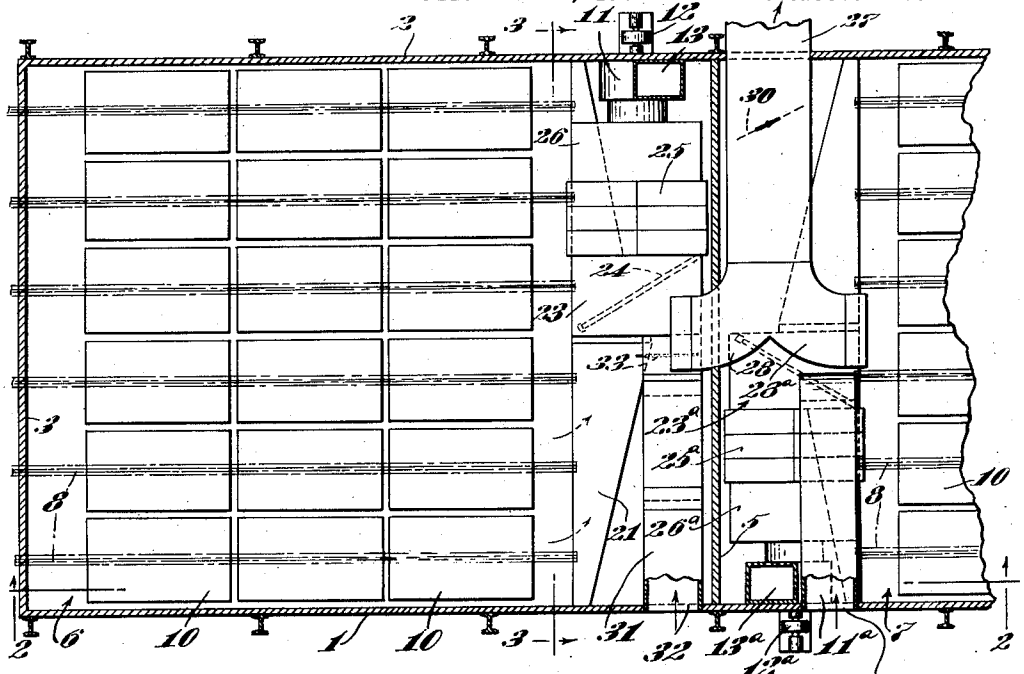


Fig. 1

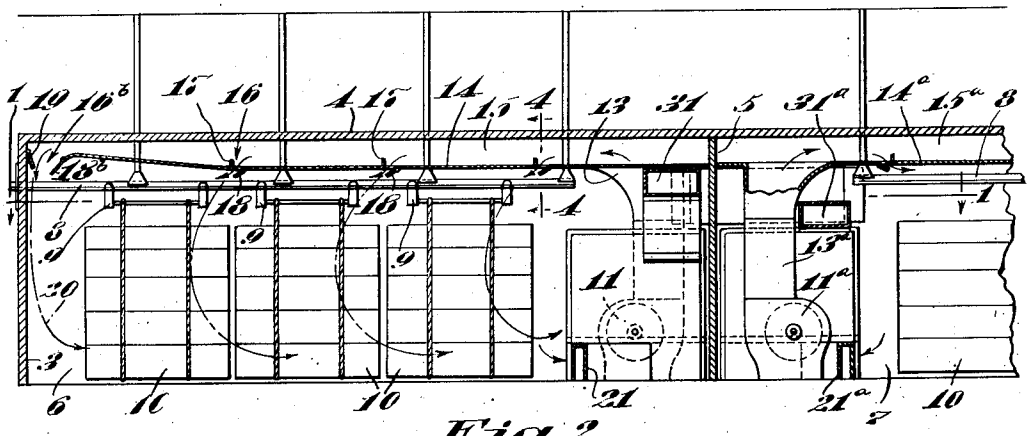


Fig. 2

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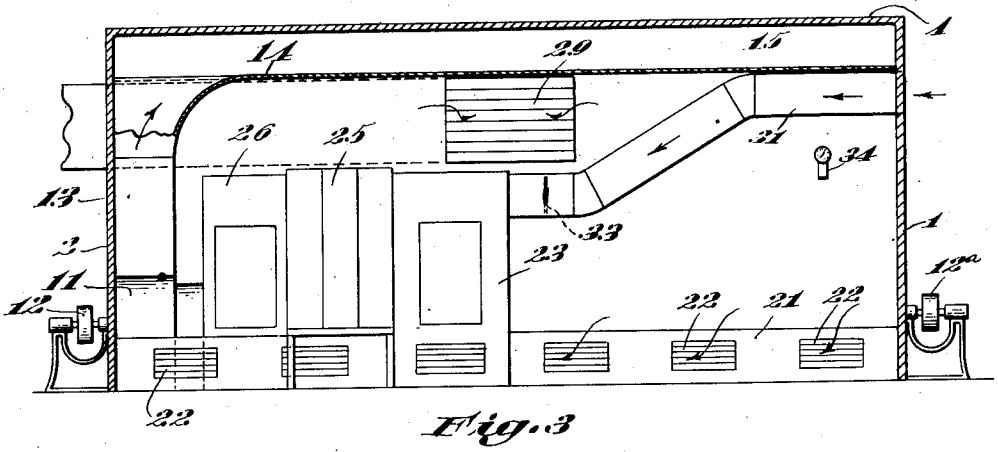


Fig. 3

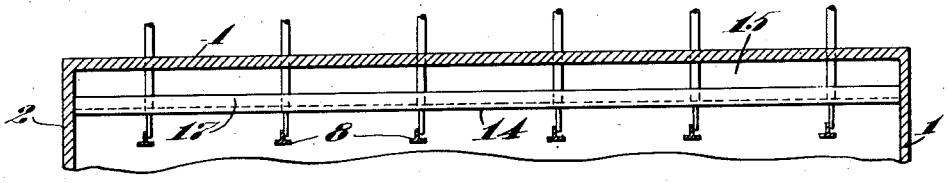


Fig. 4

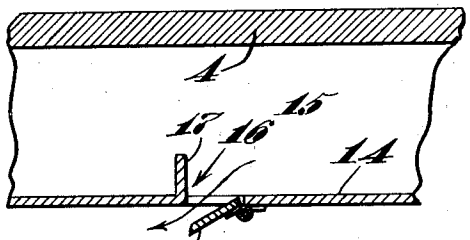


Fig. 5

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UNITED STATES PATENT OFFICE.

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DRYING APPARATUS.

Application filed February 2, 1927. Serial No. 165,323.

This invention pertains to a drying method and to drying and conditioning apparatus of that type in which the air having predetermined temperature and moisture characteristics is caused to circulate over and through material piled in stacks or loaded upon trucks or similar conveying means in a closed chamber or compartment, and relates particularly to means for so directing and controlling the pre-conditioned air in its circulation as most effectively to bring it into contact with the material to be dried.

In cerain prior apparatus known to me the material which is to be dried is stacked in spaced piles in the drying chamber and the entire supply of air is admitted at one side of the chamber near its ceiling and flows in a more or less horizontal stream across the entire width of the chamber until it impinges upon the opposite side wall of the chamber, whereupon it moves downwardly, forming an eddy or cyclonic stream which passes between and through the stacked material and then moves upwardly and is in part at least entrained with the entering stream of fresh air and thus recirculated.

In practice I find that the delivery of the entire volume of fresh air at one side of the room and without further control results in uneven distribution of the air and consequent non-uniform drying of the material. Probably this uneven distribution is due in part at least to the broken surface presented by the stacks of material to be dried, as the lower strata of air in the entering stream contacts with the upper parts of the stacks of material and is thereby caused to eddy, so that eventually the original stream is broken up into a series of swirls of indeterminate location and direction.

During the passage of the heated air current through the material its temperature drops rapidly so that it becomes progressively less efficient as a drying medium and as a consequence of this drop in temperature the volume of the air also decreases, thus gradually lessening its velocity and resulting in a further reduction in the rate of drying. The net result of this action is that the material at the one side of the chamber dries more rapidly than that at the other so that it is difficult to produce a uniformly dried product.

In accordance with my present invention I keep the circulating air current under positive control by enclosing it within a suitable duct, but at the same time provide for the cyclonic circulation of air above referred to. I also admit streams of air at such predetermined points in the chamber and in such quantities as substantially to maintain a uniform air velocity and temperature through the drying chamber, so directing these supplementary streams of air that they merge smoothly into the main current which is circulating through the chamber.

My improved apparatus also provides effective means for warming and conditioning the air, permitting the same air to be recirculated as many times as desired or permitting exhaustion of the previously circulated moistened air in whole or in part, and its replenishment by fresh air.

In the accompanying drawings I have illustrated my invention by way of example, and in the drawings:

Fig. 1 is a fragmentary horizontal section substantially on the line 1—1 of Fig. 2, showing the central portion of the apparatus and one of the drying chambers;

Fig. 2 is a fragmentary vertical section on the line 2—2 of Fig. 1;

Fig. 3 is a vertical section on the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary enlarged section substantially on the same plane as Fig. 2, showing more clearly details of the air directing means; and

Fig. 5 is a section at right angles to that of Fig. 4, and to larger scale, illustrating some of the parts shown in the latter figure.

Referring to the drawings, I provide a housing comprising the spaced side walls 1 and 2, the end walls 3, of which but one is shown, and the top or ceiling 4. These enclosing walls may be of any suitable material, although preferably of heat insulating character, such for example as asbestos wood or the like, and these walls may be constructed in accordance with any usual mode of erecting structures of this character, as for example by the use of sheets or slabs of the desired wall material supported upon channel bars or other usual structural steel shapes. As the exact details of construction of this housing are unimportant, it is unnecessary to describe them further herein.

I divide the housing as here shown by

means of a vertical partition 5 into two drying chambers 6 and 7, respectively. I may stack the material to be dried directly upon the floor of one or both of these chambers or I may place it upon trucks and wheel it into these chambers, and for introducing the material into the chambers I prefer to provide the end walls 3 with doors (not shown) which may be opened for admitting the material and closed after the material has been placed within the chamber.

As herein disclosed I provide suspended tram rails 8 within each chamber at a suitable point below the top or ceiling 4, such rails preferably extending parallel to the side walls 1 and 2 and being adapted to receive trolleys 9 from which the material 10 which is to be dried is suspended in any desired manner. These rails 8 may extend out through the end 3 of the housing to facilitate placing the material within the chamber.

Upon each side of the partition 5 I arrange suitable air conditioning and impelling means, the apparatus at each side of the partition 5 being substantially alike, except in so far as hereinafter described.

This apparatus comprises a fan 11 preferably disposed adjacent to the wall 2 and a similar fan 11^a disposed adjacent to the wall 1. The fan 11 is provided with a drive shaft having a pulley 12 outside of the housing and the fan 11^a is likewise provided with a drive pulley 12^a. The fan 11 is furnished with a delivery conduit 13 and the fan 11^a with a conduit 13^a. The conduits 13 and 13^a extend upwardly to a point near the wall or ceiling 4 and thence turn so as to deliver the air from the respective fans in substantially horizontal streams just beneath the ceiling 4.

In accordance with the present invention I control these streams of air as they travel outwardly toward the end walls of the housing by providing each drying chamber with a false ceiling 14 and 14^a, respectively, disposed a short distance beneath the true ceiling 4 and supported in any desired manner. The false ceilings may conveniently consist of sheet material, for example sheet metal, and provide the plenum space 15 and 15^a, respectively, between them and the ceiling proper. Preferably I provide each false ceiling, for example the ceiling 14, with a plurality of elongate slots 16 (Figs. 2, 4 and 5) spaced apart in the direction of flow of the air current and extending substantially at right angles to the direction of such flow. Preferably I provide an upright baffle member 17 at the remote edge of each of these slots 16, as referred to the direction of movement of air current, and I also prefer to provide a downwardly and outwardly inclined and preferably adjustable nozzle or deflecting plate 18 at the opposite edge of each slot. Preferably I arrange the false ceiling 14 so that it is somewhat nearer to the ceiling 4 at its outer end, that is to say, adjacent the wall 3 of the housing than its other end, thus causing the plenum space 15 to taper in vertical dimension toward its delivery end. By thus tapering this space I may provide a more or less constant pressure at all points within the plenum space, even though a portion of the air is diverted at successive slots 16. The false ceiling 14 terminates a short distance from the end wall 13 to provide the delivery slot 16^b, preferably having a downwardly inclined deflector member 18^b at its terminus, and to assist in the proper discharge of the air at this point and to cause the air to pass in a substantially vertical direction downwardly along the inner surface wall 3 I also furnish the baffle member 19, which, together with the endmost member 18, form an elongate converging nozzle from which the air passes down in a stream as indicated in broken lines at 20 in a substantially vertical direction until it nears the floor of the housing, when it turns more or less gradually and begins its movement back toward the partition 5. During this movement it passes through the material to be dried, taking up moisture from the latter. In the same way air from the several nozzle slots 16 passes downwardly in an inclined direction from the wall 3 and after passing down through the material to be dried is entrained by the air of the stream 20 and flows back with the latter toward the partition 5.

The combined area of the several delivery openings leading from the plenum space should be less than the area of the fan outlet so as to insure a positive discharge pressure at every delivery opening, and under most circumstances I find that the delivery slot 16^b should deliver approximately 85% of the total volume of air discharged by the fan, although different materials may require some variation in this proportion. Such variation may readily be accomplished by adjustment of the directing flanges or nozzle members 18 and 18^b.

At points at opposite sides of the partition 5 I provide exhaust conduits 21 and 21^a, respectively, which extend transversely across the housing near the bottom of the respective drying chambers. These exhaust conduits are furnished with openings 22 for the entry of air from the respective chambers and preferably the conduits gradually increase in transverse section as they approach the central part of the housing. These exhaust conduits deliver into moistening chambers 23 and 23^a, respectively, provided with sprinkling or vaporizing nozzles 24, and from the moistening chambers the air passes to heating chambers 25 and 25^a having suitable heating coils for raising the

temperature of the air. From the latter chambers the air passes through chambers or conduits 26 and 26ª, respectively, to the intake end of the corresponding fan.

At some suitable point, for example in the upper part of the chamber 7, I provide an exhaust conduit 27 passing out through the side wall 2 and provided with branches 28 and 28ª which open into the drying chambers 6 and 7, respectively. Preferably I may provide movable shutters or louvres to control the flow of air through the openings into the branches 28 or 28ª of this exhaust conduit, and I may also provide the conduit with a damper 30 to control the flow of air through it. Preferably I also provide the openings 22 leading to the exhaust conduits 21 and 21ª with suitable dampers or controlling devices.

Near the top of the chambers I provide fresh air inlet conduits 31 and 31ª, respectively, preferably opening through the side wall 1 of the housing, as indicated for example at 32 and 32ª and these fresh air conduits preferably lead to the moistening chambers 23 and 23ª. These conduits may also be furnished with controlling dampers, as shown for example at 33, and I prefer to provide within each chamber a suitable controlling element 34, for example a thermostat or hygrostat or both, adapted to respond to the condition of the air within the chamber and by its response setting the various shutters and dampers in accordance with previous determination, so as to obtain desired results in the drying chambers.

In the operation of the device, the material to be dried is placed in the chambers, as above described, and the doors in the wall 3 are closed. The fans are set into operation, drawing in air, either through the exhaust conduits 21 and 21ª or the fresh air conduits 32 and 32ª, or both, the proportion of fresh and exhaust air being determined by the relative setting of the dampers in the conduits, and after causing this air to flow through the moistening and heating chambers, it is delivered at high velocity into the plenum spaces from which, as above described, it is diverted at one or more points and caused to circulate through the material to be dried. After passing through the material, a portion of the air may again enter the conduits 21 and 21ª for recirculation, or it may pass out through the openings 29 into the exhaust conduit 27 through which it is discharged into the outside air. By suitable control of the various dampers the air condition in the drying chamber may be kept at such a point as to avoid too rapid drying with consequent surface hardening, while at the same time maintaining a sufficient degree of dryness and heat to produce the desired results.

By thus delivering the air in a predetermined manner and direction at a plurality of spaced points in the length of the chamber, I obtain a much more uniform drying action than though the air were merely admitted at one side of the chamber and permitted to follow its own course in circulating through the compartment. While thus controlling the air to a large extent, I, at the same time obtain the advantages of cyclonic action since the air forcibly expelled from each of the several nozzle slots tends to entrain air in the upper part of the chamber with it and thus to cause a circulation within the chamber of a much greater quantity of air than is passing through the fan at any one time. The device is thus exceedingly efficient in its operation and produces highly satisfactory results which I have not been able to obtain heretofore by the use of other apparatus known to me.

While I have illustrated one specific embodiment of my invention by way of example, I do not wish it to be limited to this particular embodiment, and I wish it to be understood that various changes in the number, size, shape, and relative arrangement of drying chambers and other parts, as well as in the materials employed may be made without departing from the spirit of the invention.

I claim:

1. Apparatus of the class described comprising a housing having a drying chamber therein, a false ceiling extending over the chamber, said false ceiling constituting the bottom wall of a plenum space, an outlet near one end of the chamber, means for delivering air at high velocity into the end of the plenum space which is above the outlet, a limited number of spaced, restricted openings in the false ceiling, spaced in the direction of air flow from each other to emit air in high velocity jets at certain predetermined points only into the top of the chamber, and a main air inlet into the chamber from the end of the plenum space opposite its inlet end, said main inlet having an area several times as great as the aggregate areas of the restricted openings, whereby the major portion of the air delivered from the plenum space passes through the chamber gradually toward the outlet at the opposite end of the same, acquiring moisture from the material being dried, while the drier air from the restricted openings serves to compensate for this increase in moisture, thus keeping drying conditions substantially uniform throughout the drying chamber.

2. Apparatus of the class described comprising a housing having a drying chamber therein, a false ceiling extending over the chamber, said false ceiling constituting the bottom wall of a plenum space, an outlet near the bottom of the chamber and adjacent one end thereof, means for delivering

air at high velocity into the end of the plenum space which is above the outlet, a plurality of spaced, restricted openings in the false ceiling, spaced in the direction of air flow from each other to emit air in high velocity jets at predetermined definite points only into the top of the chamber, said openings being in the form of narrow slots extending across the false ceiling substantially transversely to the direction of air flow, each of said openings having an inclined deflecting plate at its edge which is nearest the inlet to the plenum space, these plates being inclined downwardly in the general direction of air flow and projecting into the chamber, and a main air inlet into the chamber from the end of the plenum space opposite its inlet end, said main inlet having an area several times as great as the aggregate areas of the restricted openings, whereby the major portion of the air delivered from the plenum space passes gradually through the chamber toward the outlet at the opposite end of the same, acquiring moisture from the material being dried, while the drier air from the unrestricted openings serves to compensate for this increase in moisture, thus keeping drying conditions substantially uniform throughout the drying chamber.

3. Apparatus of the class described comprising a housing having a drying chamber therein, a false ceiling extending over the chamber, said false ceiling constituting the bottom wall of a plenum space, an outlet near the bottom of the chamber and adjacent one end thereof, means for delivering air at high velocity into the end of the plenum space which is above the outlet, a plurality of spaced, restricted openings in the false ceiling spaced in the direction of air flow from each other to emit air in high velocity jets at predetermined definite points only into the top of the same, each of said openings having an adjustable depending plate at its edge which is nearest the inlet to the plenum space, these plates being inclined downwardly in the general direction of air flow, and a main air inlet into the upper part of the chamber from the end of the plenum space opposite its inlet end, said main inlet having an area several times as great as the aggregate areas of the restricted openings, whereby the major portion of the air delivered from the plenum space passes gradually toward the outlet at the opposite end of the chamber, acquiring moisture from the material being dried while the dryer air from the unrestricted openings serves to compensate for this increase in moisture, thus keeping drying conditions substantially uniform throughout the drying chamber.

Signed by me at North Adams, Mass., this Twenty-fifth day of January, 1927.

LUCIEN BUCK.