

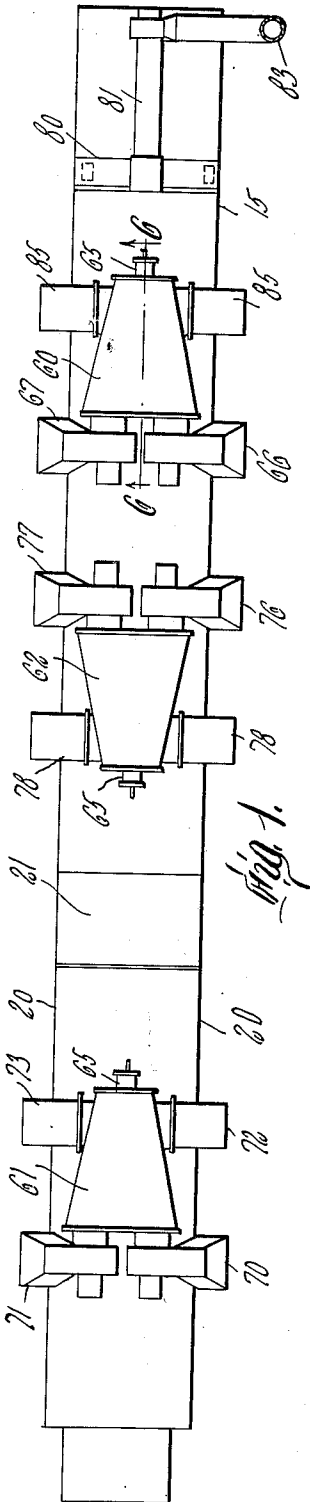
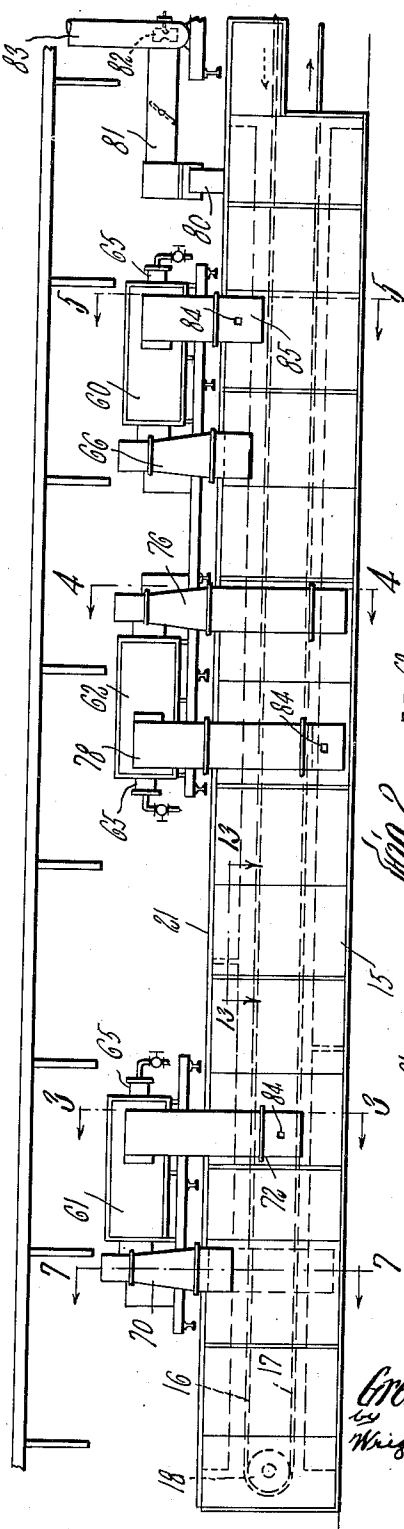
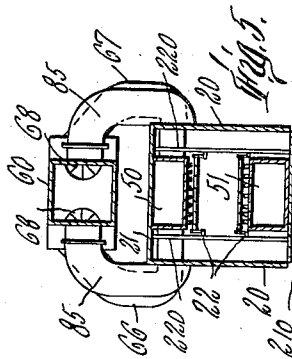
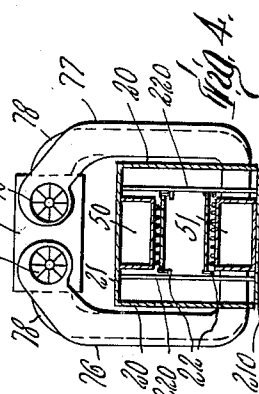
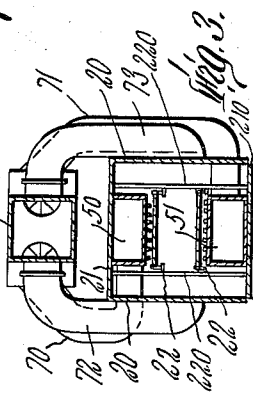
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DRYERS

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3 Sheets-Sheet 1



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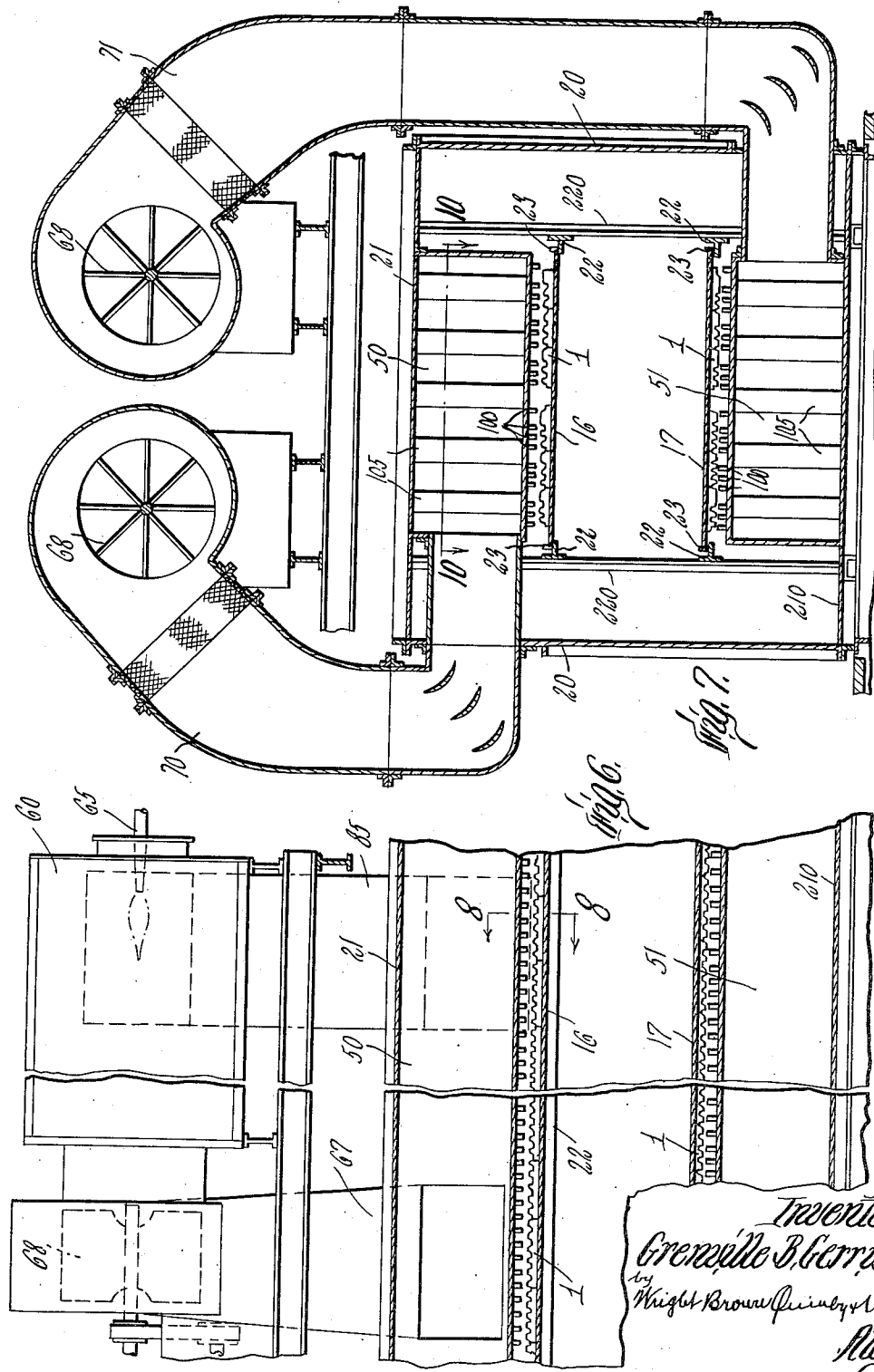
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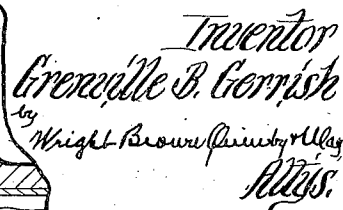
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DRYERS

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This invention relates to dryers, and has for an object to provide for uniform drying over the entire area of the articles to be dried. This is accomplished by utilizing a multiplicity of jets of high velocity of drying air or gas so arranged in pattern and numbers with reference to the particular articles to be dried, that substantially uniform drying of the entire article is produced even though the character of the article may differ markedly in different portions.

More particularly, the dryer hereinafter described has been designed to meet the requirements for drying paper pulp egg holder cartons of special design, but the principle illustrated may be applied to the drying of many different articles.

Another object of the invention is to divide the drying unit into a plurality of drying sections in which the temperature and other conditions most suitable for the articles in varying conditions of dryness are maintained. For example, the temperature may be relatively high when the articles when being treated are in wet condition, and may be lower when the moisture content of the articles has been substantially reduced in which condition scorching or other damage to the articles would be most likely to occur without close attention.

Further objects of the invention, together with detail mechanism particularly suitable for the particular use intended will be fully described, or will be evident, from a more complete description of an embodiment of the invention shown in the accompanying drawings in which

Figure 1 is a top plan view of a dryer particularly designed for drying of paper pulp egg cartons of the construction shown in Figure 9.

Figure 2 is a side elevation of the same.

Figures 3 to 5, inclusive, are detail sectional views on the correspondingly numbered section lines of Figure 2.

Figure 6 is a detail sectional view to a larger scale on line 6-6 of Figure 1.

Figure 7 is a detail sectional view on line 7-7 of Figure 2.

Figure 8 is a detail sectional view to a larger scale on line 8-8 of Figure 6.

Figure 9 is a perspective view of the egg carton to be dried.

Figure 10 is a detail sectional view on line 10-10 of Figure 7.

Figure 11 is a fragmentary plan view of a plenum chamber wall showing a different distribution pattern of jets some of which have been closed off by thimbles.

Figure 12 is a detail sectional view to a larger scale on line 12-12 of Figure 11.

Figure 13 is a detail sectional view on line 13-13 of Figure 2.

This dryer will be described more particularly in connection with the particular article to be dried shown in Figure 9, though it will be evident that the dryer is not limited to drying material of this configuration, and the arrangement and pattern of the drying nozzles can be varied as desired to produce the best functioning in connection with any particular type and shape of articles to be dried.

Referring to Figure 9, the article to be dried comprises a paper pulp molded member having a base portion 1 provided with a plurality of cups 2 extending therefrom,

2

each cup being designed to receive an egg therein, and a cover 3 which may be closed down over the eggs contained in the pockets 2 and be sealed in closed position if this should be desired. The cup portion may also be provided with a marginal flap 4 adapted to be brought up along in lapping relation to the adjacent side of the cover 3. This cover may be integral with the lower or receptacle portion of the container, such an arrangement being illustrated, for example, in Figure 8. The cartons after being molded are placed on forms, one of which is shown at 10 in Figure 8, and it is desired to remove the moisture content of these molded articles as uniformly as possible and without the possibility of overdrying any portion thereof.

The dryer itself comprises an elongated casing 15 housing upper and lower stretches 16 and 17 of a belt conveyor which passes over suitable end pulleys, one of these being shown at 18 and the other pulley being arranged outside of the casing where the outer face of the conveyor is accessible for placing the wet molded goods. This conveyor is driven by any suitable means (not shown) so that the wet molded goods pass into the casing at the right hand end as viewed in Figure 2, are reversed at the end of the casing where the conveyor passes around the pulley 18, and are then returned on the lower face of the stretch 17 and emerge from the casing where the fully dried articles may be removed from the forms. The casing is provided with opposite side walls 20 and a top wall 21 and bottom wall 210. The conveyor is provided with angle track members 22 secured to upright angle members 220 and is provided at suitable intervals with supporting rollers 23 which ride on these angle track members 22. The angle members 220 are spaced at suitable intervals. The walls of the casing may be provided with suitable heat insulation as at 24, retained in position as by sheet material such as canvas at 240.

As shown the dryer is divided into a plurality of lengthwise sections with suitable expansion joints located between adjacent sections. Such an expansion joint is shown, for example, in Figure 13 where the two adjacent sections are provided with end angle walls 25 (see Figure 13) having vertical flanges 26 which are joined together by bolts 27. Surrounding each bolt 27 is a coil spring 30 which bears at one end against the washer 28 and its other end against a washer 31 held in position by a lock nut 32. The other end portion of the bolt 27 passes through the opposed angle flange 26 and has a head 33 which bears against a washer 34 on the inner face of the adjacent flange 26. The spring 30 tends to hold the bolt in position when the flanges move together due to expansion of the casing when heated. A substantially vapor tight joint between the sections is provided by the use of a sealing plate 38 preferably of stainless steel and having a folded leaf portion 39 which allows the two sections to move relatively axially to a considerable extent without interference from outside sources.

The outer ends of the sealing plates 38 may be outwardly turned as at 40 and are enclosed by channel-shaped resilient plates 41 which are secured to the adjacent walls of the sections as by screws 42, the inner edges of these channel members 41 engaging outwardly of the out-turned extremities 40 of the sealing plates, thus to allow relative axial motion of the two sections but without opening up the interior of the dryer to outside atmosphere. Between the expansion joints the sections may be held together rigidly, adjacent angle end members 45 being secured together as by bolts and nuts as 46 and 47 (Figure 13) preferably with asbestos wicking 48 interposed between the members 45. The top flanges of the angle members 25 are welded to edges of the plates 35 which line the casing walls to form a vapor tight skin.

Arranged along the length of the casing and between the side walls 20 are upper and lower plenum chambers 50 and 51. The upper plenum chamber depends from the top casing wall 21, while the lower plenum chamber 51 rests upon the bottom casing wall 210.

Means are provided for supplying a gaseous drying medium to the two plenum chambers. As shown, the dryer is arranged in zones, three such zones being employed and each being provided with a heater 60, 61 or 62. Each of these heaters may be provided with a source of heat such as an oil burner 65 (see Figure 6) and air and the hot products of combustion may be taken from the discharge end of the heater and delivered to the desired plenum chamber by a suitable fan as 68.

As shown in Figures 1 and 5, the heater 60 for the first zone delivers hot products of combustion and air to a pair of ducts 66 and 67 which lead into the upper plenum chamber 50, and each of these ducts may have a suitable fan 68 therein by which the gaseous drying medium is delivered to the upper plenum chamber at the desired pressure. The air and gases after treating the material are returned from opposite sides of the casing above and beyond the margin of the top stretch of the conveyor to the heater 60 at relatively low velocity.

In the second zone the heater 61 delivers through a duct 70 at one side of the casing into the upper plenum chamber 50 and through a duct 71 on the other side of the casing into the lower plenum chamber 51, as shown best in Figures 3 and 7. It takes the heated air and gases from the casing between the upper and lower stretches and beyond the margins of the conveyor through the conduits 72 and 73, these leading from opposite sides of the casing.

In the third zone, as shown best in Figure 4, the hot gases are delivered from the heater 62 by the discharge fans 75 through conduits 76 and 77 into the lower plenum chamber 51, while the gases after use are delivered from below and beyond the margins of the lower conveyor belt stretch to the heater through the ducts 78 on opposite sides of the casing.

In the first zone means are provided for withdrawing some of the more highly moisture-laden drying medium from the enclosure, this being drawn from above the top stretch of the conveyor at its margins and through the double duct 80 leading to the central discharge duct 81 through the discharge fan 82 and to the stack 83 (see Figures 1 and 2). Additional gases supplied by the fuel combustion within the heaters make up the gases discharged from the casing through the stack 83 together with make-up air from the room drawn through suitable openings 84 in the return ducts.

From the foregoing it will be noted that the first section puts the heated gases into the upper plenum chamber, the second section into both the upper and lower plenum chambers, and the third into the lower plenum chamber alone. Since the articles being dried have their greatest moisture content where they enter the drier the medium delivered to the first section by the heater at 60 may be at a higher temperature, since with very wet materials there is little danger of burning or otherwise damaging the articles, but as the drying proceeds and the articles become more nearly dry, the temperatures are lowered, so that in the third section where the articles are about to emerge from the dryer, the temperature is at such a point that no danger of scorching or otherwise damaging the articles is to be feared.

Extending downwardly from the lower plate means wall of the upper plenum chamber and upwardly from the upper plate means wall of the lower plenum chamber are jets 100. As shown best in Figure 8, each of these jets comprises a pipe, one end of which is flanged over at 101, the pipes extending through the plenum chamber wall 102 with the flanges on the inner faces thereof where they are retained by plates 103 which overlie the flanges and are suitably secured as by spot welding to the plenum wall

member 102. These pipes 100 are preferably approximately in length eighth to ten times their diameters and their free ends project toward the articles carried by the stretchers of the conveyor, but are positioned at a sufficient distance therefrom to provide room for the air and hot gases to pass between them and the articles to be dried and around them where the gases may escape laterally at relatively low velocity and find their way to the discharge ducts for the various zones.

It will be noted from an inspection of Figure 8 that one portion of the article shown being dried is of irregular outline, this being where the egg-receiving cups are positioned while the adjacent portion which forms the cover of the carton is relatively flat.

The most difficult portion of such an article to dry is at the bases of the portions between the cups, but the hot drying gases coming from the plenum chamber through the nozzles strike these portions with sufficient velocity to break down the moist atmosphere at their surfaces and thus produce an efficient drying action, the jets being of sufficient force to penetrate into the spaces between the egg-receiving cups. Since this portion of the carton is of greater superficial area and mass than the cover, it holds more moisture and consequently a much greater contact of the drying gases thereon is necessary to produce an equal amount of drying to that required for the cover portion. Consequently the jets are arranged in pattern formation with the greater number of the jets being positioned where the drying gases coming therefrom will impinge upon the base portions of the carton cups, while a lesser number of jets impinge upon the cover portions. As shown also, the nozzles or jets terminate from 1 to 4 nozzle diameters from the adjacent surface of the material being dried. The jets also cause impingement of the gases on the surfaces to be dried at high velocity in the approximate magnitude of 5000 feet per minute. By breaking up the surface film of moisture and water vapor the rate of drying is thus substantially increased. This permits lowering the dryer operating temperatures while maintaining the desired rate of production. Therefore the thermal efficiency and fuel requirements are significantly improved due to reduction of heat losses from the dryer to the surrounding space.

A pattern arrangement of the jets suitable for drying this particular article has been illustrated in Figure 10, where it will be noted that the jets are positioned in rows opposite to the lines of depressions between the rows of cups and a lesser number are positioned to direct the drying gases against the flat cover portion. As shown in Figures 7 and 10, stationary baffles 105 may be used so arranged as to tend to distribute the air as it enters the plenum chamber for most uniform access to the various jets for proper and uniform drying action.

Where a different form of article is to be dried, the pattern arrangement may be varied as required for best results. One means for varying this pattern without requiring a separate set of plenum chamber walls with the jets projecting therefrom may be effected by closing off certain of the jets as desired to vary the pattern. This may be done as shown best in Figure 12 by inserting a sheet metal ferrule into the inner ends of selected jets, each of these ferrules having a body portion 110 which fits within the jet tube, a solid end portion 111, and a marginal flange 112 which may be engaged with the retaining plate 103. Suitable means of access to the plenum are provided as is well known in the art which provides for change of pattern after erection of the dryer. Such a change of pattern has been illustrated in Figure 11 where certain designated jets have been closed off by thimbles as shown.

It will be noted that the jets form between them spaces for the lateral passage of the drying gases so that they escape at low velocity to the rows of the articles to be dried which, if permitted might result in over drying of the outer rows of articles while the inner rows were in-

5

sufficiently dried, there being a multiplicity of rows as shown in Figure 7.

Thus, the use of tubes or nozzles terminating at points from 1-4 diameters from the product being dried having a total area of openings small, not more than 10%, of the effective face area of the plenum wall (see Figure 11) and having a minimum length eight times their diameter, and being arranged in repeating patterns capable of variation by plugging selected tubes or nozzles in each group after the oven is erected constitutes a valuable and significant improvement in the art of drying moulded pulp articles of irregular shape.

The molds which support the articles to be dried may be suitably secured to transverse bars which form portions of the conveyor as shown best in Figure 8. It will also be noted that at the lower stretch of this conveyor the articles to be dried are on the under face of the conveyor. However, the drying acts to shrink the articles onto the molds so that this drying results in the articles clinging to the molds even though the molds are inverted. Furthermore, the velocity pressure of the gases discharging from the tubes under the articles tend to hold them in place. After the articles are conveyed outside of the casing, they may be removed from the molds by any suitable means.

From the foregoing description of certain embodiments of this invention it will be understood by those skilled in the art that various changes and modifications may be made therein without departing from its spirit or scope.

I claim:

1. A dryer comprising means for advancing irregularly shaped sheet material to be dried and having indented portions, a plate means spaced above said advancing means, a plurality of nozzles extending outwardly from said plate means and having orifices in a plane parallel to the general path of advance of said sheet material for directing a gaseous drying medium against said material as it advances, said nozzles being arranged in spaced relation crosswise of said path to provide a nozzle positioned substantially directly over the path of each indented portion of said material and the paths of portions of said material intervening said indented portions passing between said nozzles, each of said nozzles being sufficiently long below said plate means to direct the flow of high velocity drying medium into the indented portions and to substantially confine this flow of high velocity gaseous medium within the indented portions, said nozzles being spaced apart to permit escape of said medium between said nozzles and laterally through the space defined between the plate means and said advancing means at a relatively low velocity, and means for supplying said medium to said nozzles.

2. A dryer comprising means for advancing irregularly shaped sheet material to be dried, having closely adjacent indented portions, a plurality of nozzles having orifices in a plane parallel to the general path of advance of said sheet material for directing a gaseous drying medium against said material as it advances, said nozzles being arranged in spaced relation crosswise of said path to provide a nozzle positioned substantially directly over the path of each indented portion of said material and the paths of portions of said material intervening said indented portions passing between said nozzles, each of said nozzles having a length of at least eight times its diameter and spacings between said nozzles in the direction of the material advance permitting escape of said medium between said nozzles laterally of said path of advance at a relatively low velocity, and means for supplying said medium to said nozzles.

3. A dryer comprising a conveyor, forms on said conveyor for repeatedly holding irregularly shaped articles, having both closely adjacent indented portions and flatter portions, to be dried on said conveyor in the same relative positions crosswise of said conveyor, a plurality of nozzles having orifices in a plane parallel to the path of

6

said conveyor and positioned to direct a gaseous drying medium against said articles as they advance on said conveyor, said nozzles being arranged in spaced relation and being more closely spaced crosswise of said conveyor path over the path of closely adjacent indented portions of said articles carried in said positions on said conveyor than over the path of flatter portions of such articles, whereby each of said nozzles serves a substantially equal overall crosswise surface area of said irregularly shaped articles as they pass through said dryer on said conveyor, each of said nozzles having a length at least eight times its diameter and spacings between said nozzles in the direction of conveyor advance permitting escape of said medium between said nozzles laterally of said conveyor path at a relatively low velocity, and means for supplying said medium to said nozzles.

4. A dryer as claimed in claim 3 wherein said forms on said conveyor conform to the shape of said irregularly shaped articles.

5. A dryer as claimed in claim 3 including means for plugging the orifices of selected nozzles to vary the crosswise spacing of nozzles through which said medium is directed and thereby conform the crosswise spacing of said nozzles with indentations in said irregularly shaped articles.

6. A dryer comprising an elongated casing, a conveyor having upper and lower stretches arranged within said casing, a plenum chamber arranged above said upper stretch and a plenum chamber arranged below said lower stretch, nozzles extending from the interiors of said chambers toward the respective stretches and terminating out of contact with articles to be dried carried by said conveyor and moved into said casing at said upper stretch and out of said casing at said lower stretch, air and gas heaters, means delivering highly heated air and gas from one of said heaters into said upper chamber and returning such air and gas from the sides of said casing above said upper stretch, means delivering less highly heated air and gas from another of said air and gas heaters into said upper and lower chambers and returning such less highly heated air and gas from between said stretches, and means for delivering to said lower chamber from another of said heaters less highly heated air and gas and returning the same from opposite sides of said casing below said lower stretch.

7. A dryer comprising an elongated casing, a conveyor having upper and lower stretches arranged within said casing, a plenum chamber arranged above said upper stretch and a plenum chamber arranged below said lower stretch, nozzles extending from the interiors of said chambers toward the respective stretches and terminating out of contact with articles to be dried carried by said conveyor and moved into said casing at said upper stretch and out of said casing at said lower stretch, air and gas heaters, means delivering highly heated air and gas from one of said heaters into said upper chamber and returning such air and gas from the sides of said casing above said upper stretch, means delivering less highly heated air and gas from another of said air and gas heaters into said upper and lower chambers and returning such less highly heated air and gas from between said stretches, means for delivering to said lower chamber from another of said heaters less highly heated air and gas and returning the same from opposite sides of said casing below said lower stretch, and means for removing air and gas carrying moisture from the sides of said casing in between said delivery of highly heated air and gas and the entrance of articles into said chamber.

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