July 27, 1965 W. FRIEDEL ETAL 3,196,555

DRYING APPARATUS

Filed Oct. 3, 1961 3 Sheets-Sheet 1

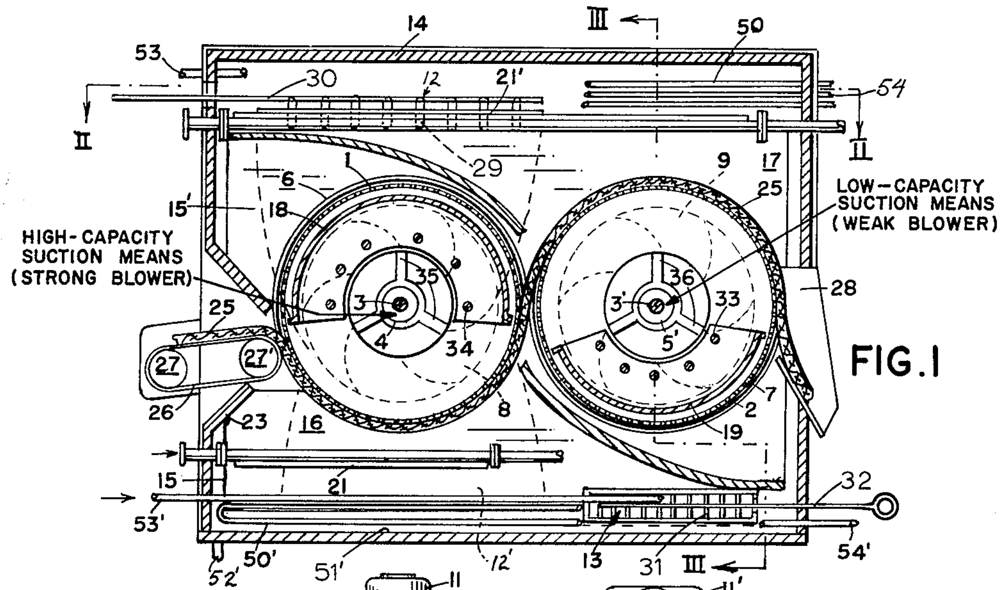

FIG.1

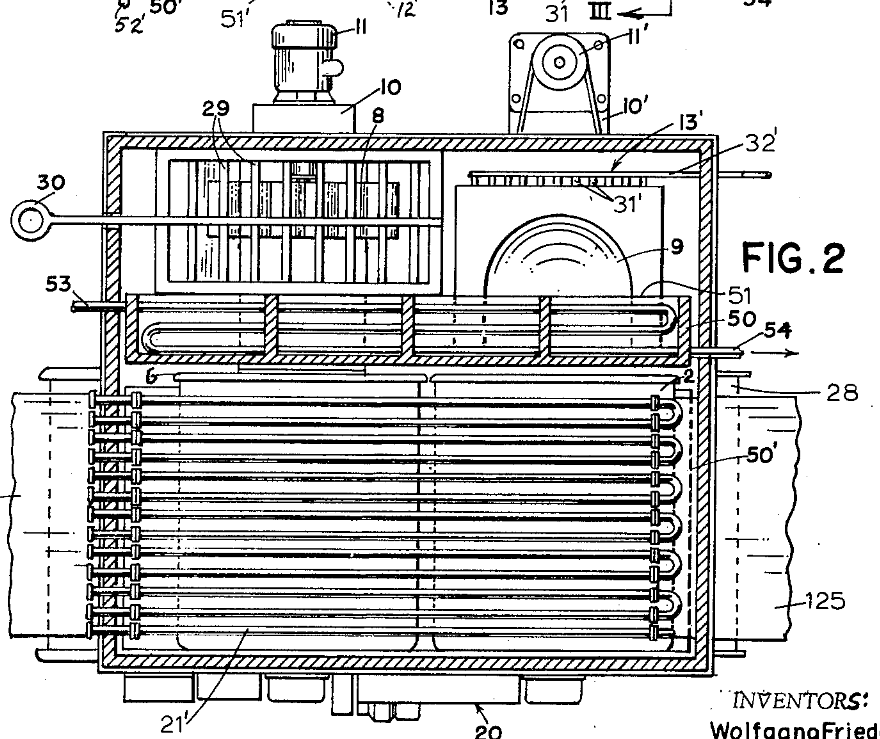

FIG.2

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DRYING APPARATUS

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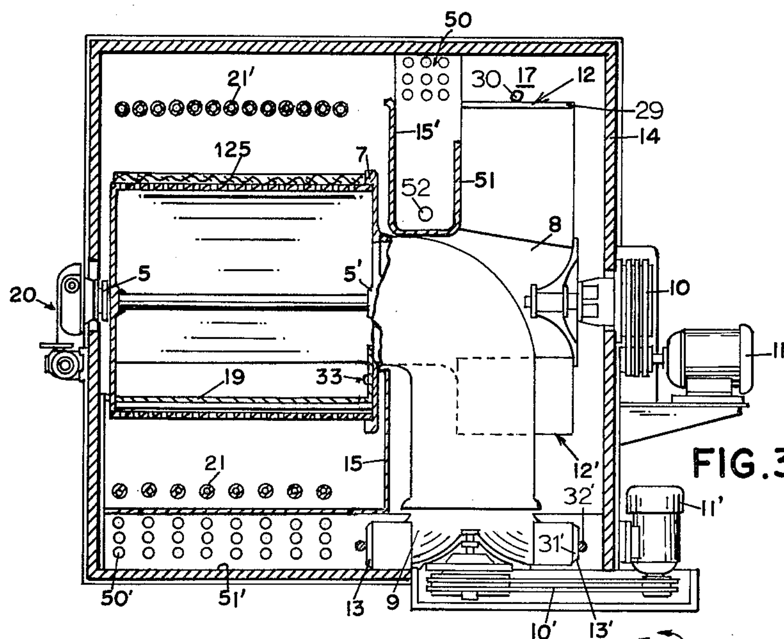

FIG.3

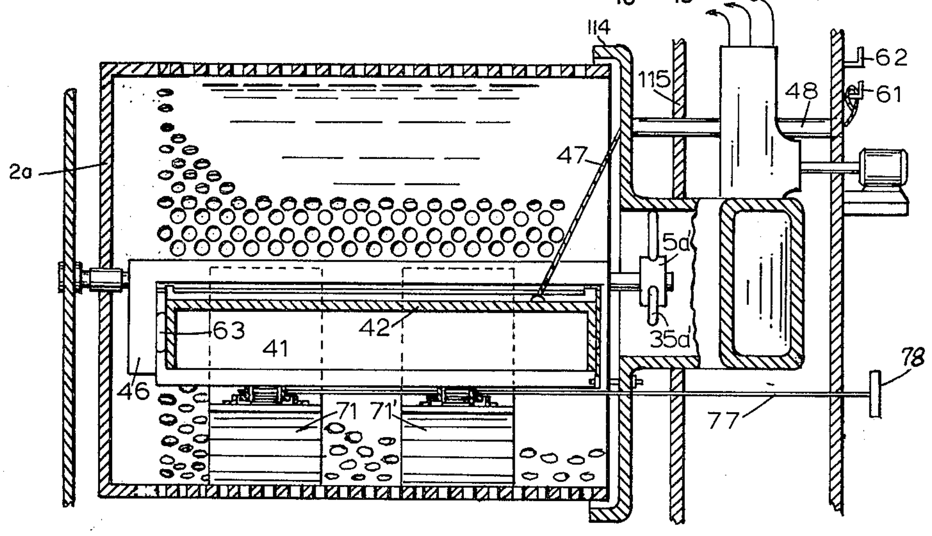

FIG. 5

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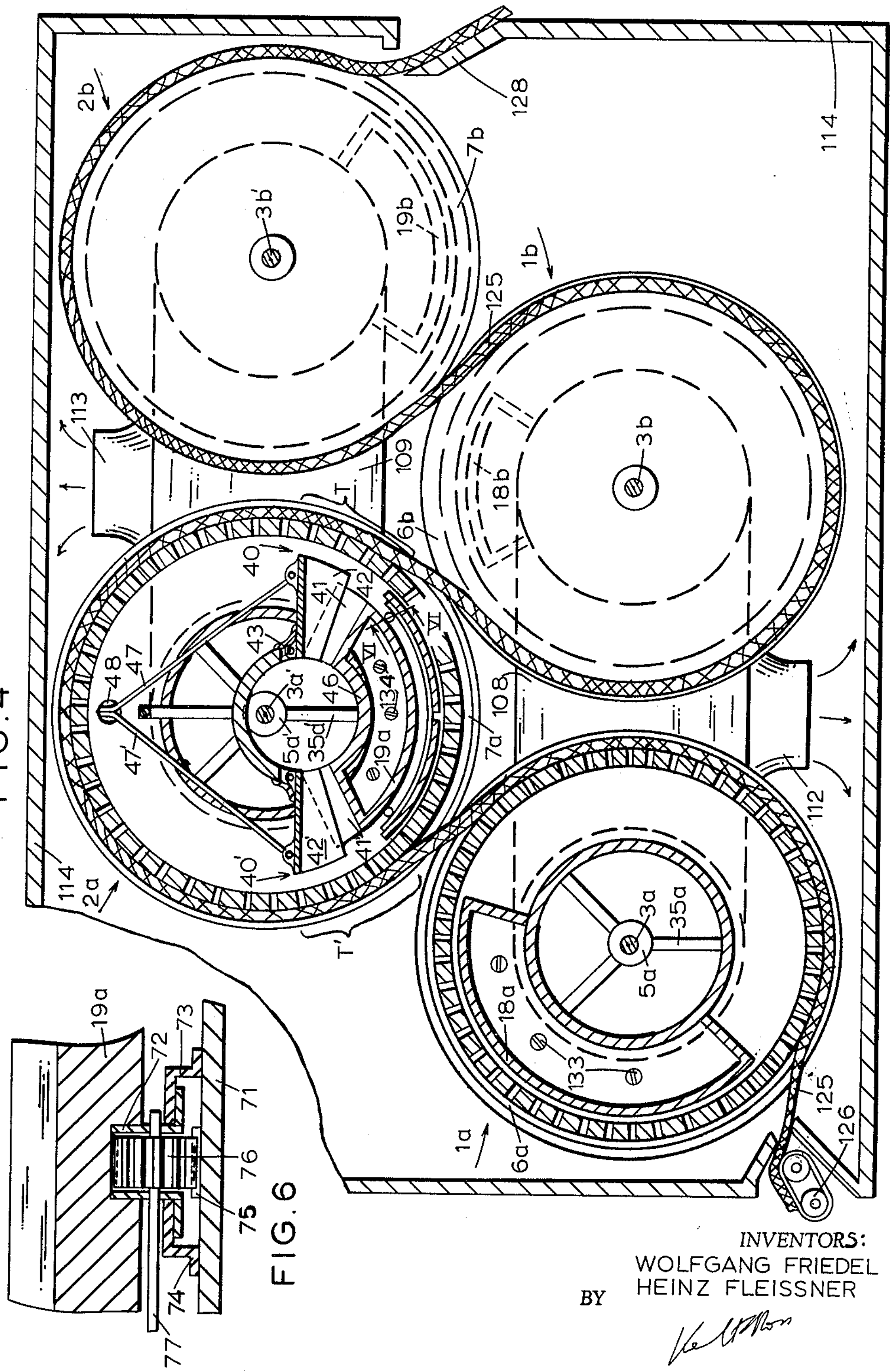

FIG. 4

FIG. 6

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United States Patent Office

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3,196,555
DRYING APPARATUS

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8 Claims. (Cl. 34—115)

Our present invention relates to a drum-type dryer for pervious or impervious materials such as veneer, textile sheets, fibrous or granular material, etc.

It is the general object of our invention to provide an improved drying mechanism of the type wherein the goods to be processed are carried by suction on alternately the upper and the lower surface of a plurality of drums rotating about substantially horizontal axes.

A more particular object of this invention is to utilize the action of gravity in alternate drums for minimizing the power requirements of the air blowers used as suction-creating means.

An important feature of our invention resides in the provision of circulation means adapted to deliver the treatment fluid (usually air) at a relative high pressure to a lower plenum chamber, communicating with the interior of one or more drums through a perforated lower portion of their respective peripheries, and at a relatively low pressure to an upper plenum chamber, communicating with the interior of the remaining drum or drums through a perforated upper portion of their peripheries. The difference in delivery pressures may be realized most conveniently with the aid of two blowers of different power. These blowers may respectively discharge into the two plenum chambers while aspirating the treatment fluid in a closed circuit from the interior of the drums communicating with these chambers; with an alternate mode of operation, however, we provide the stronger blower with two outlet ports of substantially equal cross-sectional area respectively serving the two plenum chambers while the weaker blower has but a single outlet which opens into the lower chamber to supplement the pressure created therein. In a system enabling a switchover from one mode of operation to the other, the ratio of the pressure differentials effective at the lower and upper drum surfaces may then be selectively established at $(p+q):p$ or at $p:q$, depending upon the ratio of the goods to be treated, where p and q are the output pressures of the two blowers.

A further object of our invention is to provide means for guiding the flow of treatment fluid through the drum surfaces in such manner as efficiently to maintain the load material in contact with these surfaces at all points where such contact is necessary or desired. To this end we prefer to provide some or all of the drums, especially the undershot ones or those which receive and/or transmit the treated material at locations substantially below their horizontal median plane, with special internal nozzles forming extensions of the suction ports of the associated circulation means and terminating close to the inner peripheries of the drums. These nozzles are preferably adjustable as to their effective cross-sectional area which may extend over the entire width of the drum or be confined to specific zones, e.g. at the center and near the ends. Since the most critical locations in need of augmented aspiration are the generatrices where the material to be dried meets and leaves the periphery of the drum, it will be advantageous to mount such nozzles directly on the edges of the shield plates internally obstructing a portion of its periphery to define the suction area. This will be particularly advantageous in the case of overshot drums

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embraced by the load layer over an arc greater than 180°, the nozzles then serving to supplement, at locations below the median horizontal plane of the drum, the relatively weak pressure differential prevailing along the greater part of the working surface.

The above and other objects, features and advantages of the present invention will become more fully apparent from the following detailed description, reference being made to the accompanying drawing in which:

FIG. 1 is a side elevation of a dryer embodying the invention, with the front wall of its housing omitted;

FIG. 2 is a cross-sectional view taken on line II—II of FIG. 1;

FIG. 3 is a cross-sectional view taken on line III—III of FIG. 1;

FIG. 4 is a view similar to FIG. 1 (parts broken away) illustrating an alternate embodiment of the invention with more than two drums;

FIG. 5 is an axial sectional view of one of the drums of the system of FIG. 4; and

FIG. 6 is a sectional detail view, drawn to a larger scale, on the line VI—VI of FIG. 4.

The embodiment shown in FIGS. 1 and 3 comprises two peripherally perforated drums 1 and 2 that rotate on horizontal shafts 3, 3′ in bearings 4, 5 and 4′, 5′ and are driven in synchronism by a suitable power source 20. The end of each drum facing power source 20 is solid and sealed to the shafts 3, 3′. The other ends of the drums are open and peripherally embraced by flanges 6 and 7 surrounding the intake ports of blowers 8 and 9 driven through belt-and-pulley transmissions 10 and 10′ by motors 11 and 11′. The blowers 8, 9 suck the air from the interior of the perforated drums and blow it out through exhaust ports 12, 12′ and 13, 13′. These exhaust ports, the surrounding machine housing 14 and partitions 15, 15′ therein constitute guidance means to direct the air flow to the plenum chambers 16 and 17 of drums 1 and 2, its ports 12, 13 and ports 12′, 13′ serving the lower chamber 16 and the upper chamber 17, respectively. The suction area of the undershot drum 1 is confined to its lower portion by a shield plate 18 while the suction area of the overshot drum 12 is confined to its upper portion by a shield plate 19. The shield plates 18 and 19 are mounted by bolts 33, 34 on the flange portions 6, 7 of the associated blowers along with the inner bearings 5, 5′ of the drum shafts 3, 3′, those bearings being supported on spiders 35, 36.

Air is drawn into drum 1 from chamber 16 around a coherent layer 25 of material to be treated and/or through the interstices thereof. It is then driven by blower 8 into outlet ducts 12 and 12′ which split the air stream delivered by this blower into two flows respectively issuing above and below the common axial plane of the drums. Outlet duct 12′ and partition 15 guide the airflow thereof over lower heating elements 21 and back into chamber 16 for recirculation through and/or around the layer 25. Air leaving outlet duct 12 passes around partition 15′ over upper heating elements 21′ into drum 2 whence it is extracted by blower 9 and returned via outlet 13 (outlet 13′ being considered closed) into chamber 16 for recirculation. Thus, the upper air flow passes through both drums in cascade whereas the lower air flow circulates only through the drum 1 which carries the layer 25 along tis underside and which in this manner is given the extra air-pressure differential needed to overcome the opposing force of gravity.

The drying system provided by this invention is essentially a closed-circuit system; in order to remove the moisture extracted from layer 25, conventional dehumidifiers 50 and 50′ are provided ahead of heaters 21, 21′ in the path of the air streams directed into plenum chambers 16 and 17, respectively. Dehumidifiers 50 and

50′ are equipped with integral catch pans 51, 51′, drains 52, 52′, coolant inlets 53, 53′ and coolant outlets 54, 54′, respectively.

The material 25 to be dried is delivered by a conveyor belt 26 to the underside of drum 1. The conveyor rides on rollers 27 and 27′, one or both of which are driven by conventional means not further illustrated. The material is forced against the bottom of drum 1 by the difference in pressure existing between the plenum chamber 16 and the interior of drum 1. By the rotation of the drum the material 25 is carried to drum 2 across the intervening gap, the pressure difference between the interior of drum 2 and its plenum chamber 17 causing the material to adhere to the upper surface of drum 2 which conveys it to a discharge chute 28.

In the embodiment of the invention thus far described, wherein two drums 1 and 2 are served by two blowers with three active exhaust ports 12, 12′ and 13, if blower 8 has a speed of *n* revolutions per minute, blower 9 (having the same characteristics) will preferably have a speed of $n/2$ revolutions per minute. The pressure delivered by blower 9, which discharges through only one port, will then be one fourth of that delivered by blower 8, the power requirement of blower 9 being thus only one eighth of that of blower 8 since the former circulates only half the air volume of the latter.

In order to enable different modes of operation of the system of FIGS. 1–3, the exhaust outlets 12, 13 and 13′ of blowers 8 and 9 are each provided with a set of louvers 29, 31, and 31′. Each set of louvers can be opened or closed independently by conventional manual controls 30, 32 and 32′, illustrated schematically. By closing louvers 29 and 31 while opening louvers 31′ it is possible to isolate each drum into a separate operating unit. This louver setting applies the full force of the more powerful blower 8 to the underside of drum 1 while directing the entire output of the other blower 9 onto the top surface of drum 2, thereby again establishing at the undershot drum a pressure differential greatly exceeding that prevailing at the overshot drum.

This invention is not restricted to the use of blowers with identical characteristics; the blowers may be of different diameters and operate at the same or different rotative speeds. Thus, low-, middle-, and high-pressure blowers can be used in various combinations. Changes in speed and/or adjustable baffles similar to louvers 12, 13, 13′ may, of course, be used to control the output pressure of each blower within specified limits.

In FIG. 4 a plurality of drums are illustrated with their axes of rotation vertically offset from one another, thus providing an arc of contact greater than 180° and affording an extension of the drying regime, optimum space utilization, and maximum drying area on each drum. This embodiment of my invention comprises four drums 1*a*, 2*a*, 1*b*, 2*b* which alternately transport the load layer 25 on their lower and upper surfaces. Shield plates 18*a*, 19*a*, 18*b* and 19*b* block off the inoperative portions of their respective drum surfaces.

Drums 1*a*, 2*a* have been shown in section whereas drums 1*b* and 2*b*, respectively identical therewith in their internal construction except for the extent and location of their shield plates, are seen in view. The respective drum shafts have been designated 3*a*, 3*a*′, 3*b* and 3*b*′; the rear bearings 5, 5*a*′ of the two first-mentioned shafts are visible, as are their spider supports 35*a*, 35*a*′ in the intake ports of blower flanges 6*a* and 7*a*, respectively. Flanges 6*a* and 6*b*, supporting by means of bolts 133 the shield plates 18*a* and 18*b* of undershot drums 1*a* and 1*b*, form the two intake ports of a single blower 108 whose sole outlet port 112 returns the stream of drying air via dehumidifiers and heaters, not illustrated but similar to those shown in FIGS. 1–3, to the underside of layer 125 of these drums; in like manner the shield plates 19*a* and 19*b* are mounted by bolts 134 on the in-take-forming flanges 7*a* and 7*b* of another blower 109 whose sole outlet port 113 delivers the dried and reheated air to the top surfaces of overshot drums 2*a*, 2*b* overlain by layer 125. This layer is introduced into the housing 114 by a conveyor 126 and discharged from it via a chute 128.

In the system of FIGS. 4–6 it is necessary to provide increased aspiration not only on the lower peripheral surfaces of drums 1*a*, 1*b* but also along part of the surfaces of drums 2*a*, 2*b*, i.e. at the locations where the layer 125 contacts these overshot drums below their median horizontal plane. For this purpose we prefer to provide, in accordance with a feature of our invention, special means designed to concentrate or reinforce the suction of blower 109 along these lower contact areas of drums 2*a*, 2*b* while correspondingly weakening the pressure differential at the upper peripheral halves of the drum. An effective arrangement for accomplishing this result comprises a nozzle for each of these contact areas, drum 2*a* being accordingly equipped with a pair of such nozzles 40′, 40, respectively facing the areas T′, T nearest the gaps bridged by the layer 125 in its transfer from drum 1*a* to drum 2*a* and from the latter to drum 1*b*. Similar nozzles, not shown, are present at the corresponding areas of drum 2*b*; they could, if desired, also be included in either or both of the remaining drums if increased suction were desired at certain peripheral locations thereof.

The nozzles 40, 40′ are carried along opposite axially extending edges of shield plate 19*a* and, as particularly illustrated for nozzle 40 in FIGS. 4 and 5, consist each of two relatively adjustable halves 41, 42 defining a nozzle mouth of variable intake area. Lower nozzle half 41 is integral with shield plate 19*a* and therefore fixedly positioned; upper nozzle half 42 is hinged at 43, 44 to a pair of pivot pins on opposite ends of a slot 45 formed in an exhaust duct 46 which extends axially within drum 2*a* from the intake port of blower flange 7*a* and partially registers with this port to communicate its suction to the two nozzles 40, 40′ served by it. Adjustment of the nozzle width is carried out with the aid of a pair of wires 47, 47′ which are anchored to the outer extremities of movable nozzle halves 42, 42′ and pass outwardly of housing 14 via a narrow tube 48 traversing the partition 115; their other ends are shown attached to a ring 49 adapted to be selectively slipped over hooks 61, 62 on the outside of housing 114, this arrangement being of course representative of any conventional mechanism for elevating the nozzle sections 42, 42′ (e.g. against the force of gravity) to a greater or less extent. It will also be apparent that lower nozzle halves 41, 41′ could, if desired, be divorced from shield plate 19*a* and hinged to the duct 46 in the same manner as nozzle halves 42, 42′ for controlled positioning jointly with the latter or independently therefrom. Packing strips 63, 64 are carried on the triangular end walls of nozzle halves 41, 41′ to contact the end walls of nozzle halves 42, 42′ so as to minimize the escape of air therebetween without interfering with the relative motion of these parts.

The effective length of each nozzle mouth, as will be apparent from FIG. 5, equals substantially the axial width of the perforated portion of the drum periphery and, accordingly, the corresponding dimension of layer 125 although the width of the latter may be somewhat reduced, particularly in the case of impervious material, to enable the suction air to flow around it. In some instances, especially with layers of good transverse coherency, a further selective increase in pressure differential may be realized by concentrating the effect of the blower on certain axially limited zones of the perforated drum surface. Such zones may be located, advantageously, along the longitudinal edges in the median region of the layer. For this purpose we have shown in FIGS. 4–6 a set of arcuate cover plates 71, 71′ disposed in the clearance between shield plate 19*a* and the peripheral wall of drum 2*a*, these covers being mounted on the shield plate with freedom of angular displacement into or beyond the positions illustrated in dot-dash lines in FIGS. 4 and 5. The covers 71, 71′ are provided in axially spaced pairs so as to register with two annular drum zones Z located between the extremities and the center of the perforated surface. As best seen in FIG. 6, sleeve 19*a* carries on its outer periphery an arcuate rail 72 slidably engaging a pair of mating brackets 73, 74 on the inner surface of each cover 71. Between these brackets the cover is formed with a rack 75 meshing with a pinion 76 whose shaft 77, common to both plates 71, is journaled in the rails 72 thereof and extends outwardly through partition 115′ and housing 114, its projecting end carrying a knob 78 whose manipulation enables angular displacement of the respective cover pair. Again, such cover plates may also be provided on the remaining drums, if desired, in order to control the advance of layer 125 as it meanders along an undulating path around the successive drums.

The selective intensification of suction at critical locations, by means of nozzles 40, 40′ and/or cover plates 71, 71′, enables the use of a relatively weak blower 109 in comparison with blower 108. Such intensification requires, in the case of nozzles, that the ratio of the intake area of duct 46 to the combined area of the nozzle mouths, i.e. the sum of the areas T, T′ registering therewith, be greater than the ratio of the remaining area of the blower port (unobstructed by duct 46) to the free perforated area of the drum, i.e. the surface area thereof not registering with either the shield 19*a* or the nozzles 40, 40′. It will be seen that, under these conditions, the pressure differential at the last-mentioned surface area of drums 2*a*, 2*b* will be weaker than that at the free areas of drums 1*a*, 1*b* even if the two blowers 108, 109 are of equal power or are, in fact, parts of the same circulation system.

The present improvement is, of course, not limited to the specific mechanical details described and illustrated as modifications and adaptations thereof, which will be readily apparent to persons skilled in the art, are intended to be embraced within the spirit and scope of our invention as defined in the appended claims.

We claim:

1. A system for drying a coherent layer of material, comprising a plurality of closely spaced drums including at least one undershot drum and at least one overshot drum rotatable about parallel horizontal axes, said drums being provided with perforated peripheral walls, first fluid-circulating means having an intake port communicating with the interior of said undershot drum for subjecting same to a relatively strong suction, second fluid circulating means having an intake port communicating with the interior of said overshot drum for subjecting same to a relatively weak suction, each of said circulating means having at least one outlet port, drive means for rotating said drums in unison and adapted for carrying a layer of a material to be dried on the underside of said undershot drum and on the topside of said overshot drum, shield means within said drums registering with portions of said walls not adapted to be covered by said layer, thereby rendering the respective circulating means ineffective at said portions, guide means for directing the outflow of said outlet ports onto the outer surfaces of said drums at locations adapted to be covered by said layer, said first circulating means comprising a relatively strong blower and said second circulating means comprising a relatively weak blower, said strong blower having two outlet ports and said weak blower having one outlet port, said guide means directing the outflow from said two outlet ports of said strong blower onto the surfaces of both of said drums adapted to be covered, respectively, and the outflow of said one outlet port of said weak blower onto the surface adapted to be covered of said undershot drum only, said strong blower having an output pressure substantially double that of said weak blower.

2. A system for drying a coherent layer of material, comprising a plurality of closely spaced drums including at least one undershot drum and at least one overshot drum rotatable about parallel horizontal axes, said drums being provided with perforated peripheral walls, first fluid-circulating means having an intake port communicating with the interior of said undershot drum for subjecting same to a relatively strong suction, second fluid circulating means having an intake port communicating with the interior of said overshot drum for subjecting same to a relatively weak suction, each of said circulating means having at least one outlet port, drive means for rotating said drums in unison and adapted for carrying a layer of a material to be dried on the underside of said undershot drum and on the topside of said overshot drum, shield means within said drums registering with portions of said walls not adapted to be covered by said layer, thereby rendering the respective circulating means ineffective at said portions, and guide means for directing the outflow of said outlet ports onto the outer surfaces of said drums at locations adapted to be covered by said layer, said overshot drum having a peripheral region below its median horizontal plane exposed to the suction of said second circulating means and adapted to be covered by said layer, further comprising suction-reinforcing means within said overshot drum registering with said peripheral region.

3. A system according to claim 2 wherein said suction-reinforcing means comprises a nozzle mounted on the shield means of said overshot drum and communicating with the intake port of said second circulating means.

4. A system according to claim 3 wherein said nozzle has a mouth of adjustable cross-sectional area positioned adjacent said peripheral region, further comprising mechanism positioned externally of said overshot drum and coupled with said mouth for adjusting same.

5. A system according to claim 4 wherein said mouth includes a pair of relatively movable sections, at least one of said sections being connected with said mechanism.

6. A system for drying a coherent layer of material, comprising a plurality of closely spaced drums including at least one undershot drum and at least one overshot drum rotatable about parallel horizontal axes, said drums being provided with perforated peripheral walls, first fluid-circulating means having an intake port communicating with the interior of said undershot drum for subjecting same to a relatively strong suction, second fluid circulating means having an intake port communicating with the interior of said overshot drum for subjecting same to a relatively weak suction, each of said circulating means having at least one outlet port, drive means for rotating said drums in unison and adapted for carrying a layer of a material to be dried on the underside of said undershot drum and on the topside of said overshot drum, shield means within said drums registering with portions of said walls not adapted to be covered by said layer, thereby rendering the respective circulating means ineffective at said portions, guide means for directing the outflow of said outlet ports onto the outer surfaces of said drums at locations adapted to be covered by said layer, and cover-plate means within at least one of said drums for obstructing an axially limited peripheral zone thereof at a location beyond said shield means, said overshot drum having a peripheral region below its median horizontal plane exposed to the suction of said second circulating means and adapted to be covered by said layer, further comprising suction-reinforcing means within said overshot drum registering with said peripheral region.

7. A system according to claim 6 wherein said cover means comprises an angularly displaceable member adjacent the inner peripheral drum surface and mechanism for selectively displacing said member.

8. In a system for drying a coherent layer of material,

the combination comprising a plurality of closely spaced drums adapted to be traversed by said layer including at least one undershot drum and at least one overshot drum rotatable about parallel horizontal axes, said drums being provided with perforated peripheral walls; first and second fluid-circulating means each having an intake port communicating with the interior of said undershot and said overshot drum, respectively, for subjecting same to suction, each of said fluid-circulating means having at least one outlet port; drive means for rotating said drums in unison and adapted for carrying a layer of a material to be dried on the underside of said undershot drum and on the topside of said overshot drum; shield means within each of said drums registering with portions of said walls not adapted to be covered by said layer, thereby rendering the respective circulating means ineffective at said portions; and guide means for directing the outflow of said outlet ports onto the outer surfaces of said drums at locations adapted to be covered by said layer, the suction force created by said first fluid-circulating means in said undershot drum being greater than the suction in said overshot drum, said guide means being positioned to direct the outflow of the outlet port of the second circulating means through both of said drums and to direct the outflow of the outlet port of said first circulating means through said undershot drum only.

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