Dec. 1, 1970 A. MEYER 3,543,415

DRUM DRYING APPARATUS

Filed Sept. 23, 1968 2 Sheets-Sheet 1

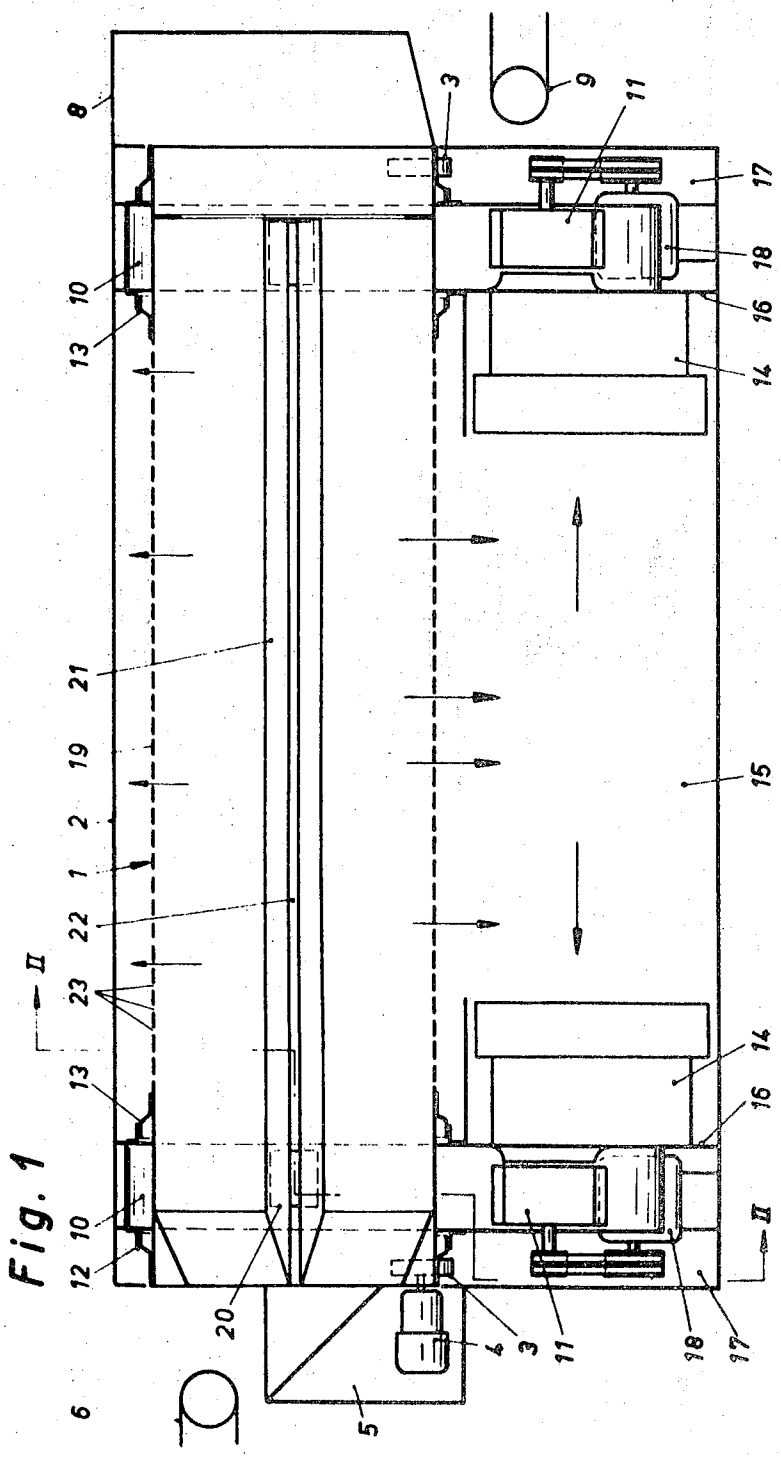

Fig. 1

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Fig. 2

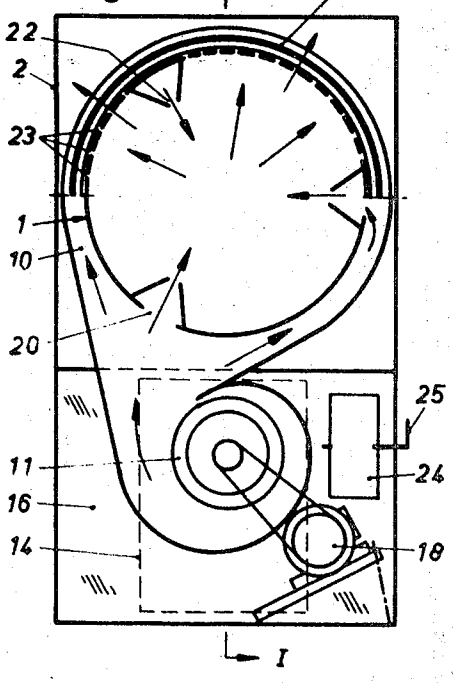


Fig. 3

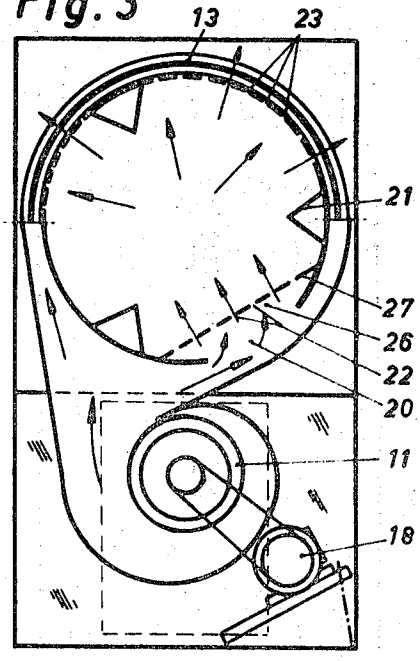


Fig. 4

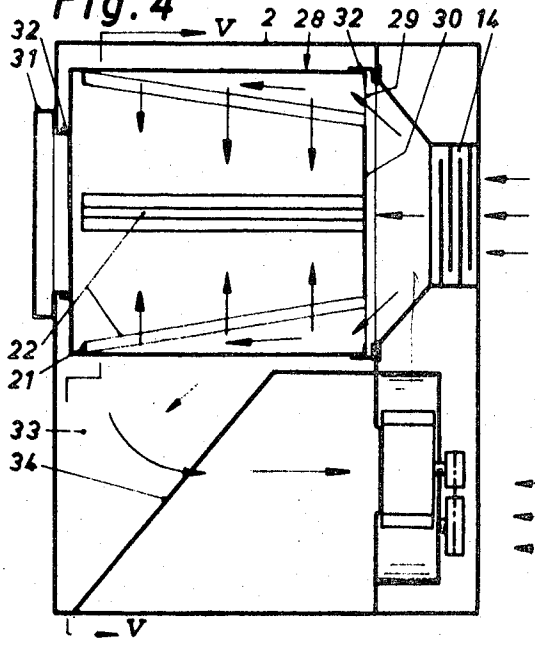
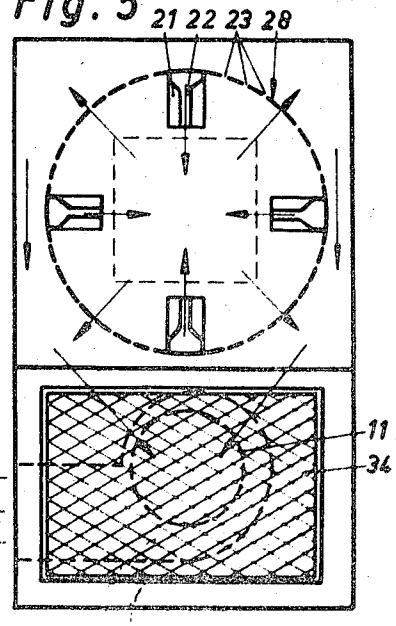


Fig. 5



United States Patent Office 3,543,415 Patented Dec. 1, 1970

3,543,415

DRUM DRYING APPARATUS

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Filed Sept. 23, 1968, Ser. No. 761,442
Claims priority, application Germany, Sept. 21, 1967, 1,585,888
Int. Cl. F26b 11/02
U.S. Cl. 34—130 10 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for drying laundry or the like, including a drum rotatably mounted in a stationary housing and having at least a portion of the peripheral surface thereof perforated, one or more axially-extending entrainment ribs within the interior of the drum, one or more fans for producing a fluid flow, one or more radiators for heating the fluid stream produced by the fans, one or more inlets for conducting the fluid stream into the interior of the drum, wherein the inlets are disposed, relative to the perforations serving as fluid outlets, so as to create fluid streams within the interior of the drum which are substantially radially-directed and wherein axially-directed fluid streams are minimized.

BACKGROUND OF THE INVENTION

Drum driers having perforated peripheral surfaces, of various constructions, have been used extensively for drying fabrics or the like. One basic characteristic of all of the conventional drum driers is that a substantial volume of air must flow through the perforated drying drum and be brought into contact with the material to be dried in order to maximize drying efficiency.

If, however, a relatively high velocity air stream is introduced into the drying drum and all or part of this air stream is axially-directed relative to the drum, the net effect on the drying process may be unfavorable. This unfavorable effect on drying efficiency is attributable in part to the fact that an axially-directed high velocity air stream necessarily increases the rate at which the material to be dried passes through the drying drum; the increase in the rate of travel through the drying drum may be considerable when the material being treated is substantially dry and therefore relatively lightweight. Thus, the existence of high velocity component air streams in a substantially axial direction has been found to create significant variation in the drying cycle time, thus precluding any certainty as to a uniform drying of the material being treated.

In an attempt to overcome the problems created by axially-directed air streams, continuous drum drying apparatus has been constructed wherein the inlet and outlet openings in the drum jacket are axially offset and longitudinally-directed air streams are introduced from both the inlet and outlet openings. Such apparatus, however, has failed to completely overcome the problems created by the existence of axially-directed air streams, but has merely complicated these problems by subjecting the material being treated to opposed component air streams. Thus, such apparatus has been found to produce varying cycle times and similarly-varying drying efficiencies, depending upon the nature of the material being treated, the degree of moisture content, etc.

Accordingly, it is an object of the present invention to produce continuous drum drying apparatus which eliminates entirely any axial influence on the material being dried, while maintaining a high volume flow of air.

Further, it is an object of the present invention to produce apparatus of the type described which ensures high-velocity air flow through the drying drum and thorough contact of the air streams with the material being treated, while minimizing axial influence on the material and, therefore, on the drying cycle time.

SUMMARY OF THE INVENTION

The problems inherent in the continuous drum drying apparatus known heretofore are solved, in accordance with the present invention, by arranging the inlet and outlet openings in the drying drum, relative to each other, such that a substantially-radial air flow through the material being treated is created. One particularly suitable construction of the drum drying apparatus to effect the desired radial air flow is obtained, in accordance with a further development of the present invention, by disposing the inlet and outlet openings within axially-extending zones, which may extend over the entire longitudinal extension of the drum, positioned alternately in the circumferential direction of the drum. Thus, a longitudinal zone of inlet openings alternates with a similar longitudinal zone with outlet openings.

BRIEF DESCRIPTION OF THE DRAWINGS

The aforementioned and further objects, features and advantages of the present invention will become more apparent from a consideration of the accompanying drawings which are described in detail hereinbelow and wherein:

FIG. 1 represents a longitudinal section through a continuous drum drier having two air cycles;

FIG. 2 represents a cross-section through the continuous drum drier, taken along line II—II of FIG. 1;

FIG. 3 represents a cross section, similar to that of FIG. 2, through an additional embodiment of a drum drier in accordance with the present invention;

FIG. 4 is a longitudinal sectional view through a drum drier representing a further embodiment of the present invention; and

FIG. 5 represents a cross section through the drier illustrated in FIG. 4, taken along the line V—V therein.

DETAILED DESCRIPTION OF THE DRAWINGS

FIGS. 1 and 2 illustrate a continuous drum drier wherein the drum **1** thereof is rotatably supported on rollers **3** within a stationary housing **2**. The rotary drive is effected by a motor **4**. The motor **4** is surrounded by the casing of the feed hopper **5** to which the material to be dried, for example, laundry, is supplied by means of a conveyor belt **6**. The dried material passes through a discharge housing **8** disposed at the opposite end of the housing **2** and onto a second conveyor belt **9**, which effects the further conveyance of the material.

In the region of both ends of the drum **1**, annular chambers **10**, surrounding the drum, are formed. Drying fluid, such as air, is supplied to the chambers **10** by fans **11**. Chambers **10** are sealed, with respect to the remainder of the space within the housing **2**, by means of seals **12** and **13**.

Fan **11** is in communication, on the intake side thereof, with a vacuum chamber **15**, through radiator **14**. Vacuum chamber **15** is appropriately defined directly by the air tight housing **2** and is sealed off, by means of wall **16**, from a chamber **17** which houses the drive mechanism **18** for fan **11**. In the region of annular chambers **10**, the drum jacket or sheath **19** of the drum **1** is provided with perforations **20** which provide communication into the interior of hollow entrainment ribs or projections **21**, which serve as feeding channels. The ribs **21**, which are illustrated as having a substantially triangular cross-section, are provided, preferably along the apex thereof, with

one or more openings which may be slot-shaped and serve effectively as inlet openings **22** for the air flow into the interior of the drum. As illustrated, openings **22** extend substantially over the entire longitudinal extension of the entrainment ribs **21**. In the regions outside the entrainment ribs **21** and between the internally-disposed seals **13**, the drum jacket **19** is provided with outlet apertures **23**.

From the foregoing comments it can be seen that air drawn by fan **11** from the vacuum chamber **15** and heated by radiator **14** is supplied to annular chambers **10** and then into the entrainment ribs **21** through the perforations **20**. Thence, the air flows through ribs **21** and into the drying chamber through inlet openings **22** in an approximately radial direction. Due to the creation of the radial streams of air impinging on one another at high velocities from various directions, an intense turbulence is effected within the drying chamber of the drum. Thus, the material to be dried enters the inner chamber of the drum during the rotation thereof, or during the reversal of the direction of rotation, and comes into intimate contact with the radially-directed air streams. In this manner, it can be seen that the material being dried is simultaneously loosened and agitated.

The air streams, after absorbing moisture from the material within the drum chamber, exit therefrom through the outlet apertures **23** in the drum sheath or jacket **19**. Thereafter, the air re-enters the vacuum chamber **15** from whence the cycle is repeated.

It should be noted that the arrangement illustrated in FIGS. 1 and 2, wherein fan and radiator units are disposed in the regions of both ends of the drum, creates two identical air cycles. Further, the particular arrangement of the air inlets and outlets within the drum enables only a relatively small portion of the air present within the drum chamber to escape, albeit that the ends of the drum are open. Nevertheless, the open ends of the drum, in combination with the turbulence created therewithin, causes a relatively large amount of fresh air to be drawn into the drum, the fresh air entering in this manner being normally sufficient for providing the requisite degree of moisture-absorbing capability. This capability is attributable to the repeated heating of the air in radiators **14**.

If necessary, the regulation of fresh air intake may be provided for by means of an aperture which can be selectively closed by means of a flap **24** or the like provided in a wall of the suction chamber **15**, preferably in wall **16**. Flap **24** can be operated, for example, from the outside by a handle **25**, beneath which a graduated scale may be suitably arranged. Fresh air may then flow into vacuum chamber **15** depending upon the extent to which flap **24** is opened. The fresh air, after passing through the motor chamber **17**, is thereby slightly preheated.

Alternatively, suction chamber **15** can also be provided with a separate blower which can supply fresh air thereto or withdraw moist air exiting from the drum **1**. The amount of air corresponding to the air supplied or withdrawn from the cycle escapes through the open ends of the drum or enters therethrough, respectively.

In the embodiment of FIG. 3, air is fed into the drum **1** through a channel **26** formed by a plate **27**, which partially covers drum jacket **19** on the inner surface thereof in the circumferential direction. This plate is provided with inlet openings **22**. The channel **26** extends approximately over the entire length of the drum **1** and is, in the manner described above, in communication, by way of perforations **20**, with an annular chamber **10** at some point, for example, in the middle or at one end of the drum, or in the alternative, with several annular chambers **10**. The portion of the drum jacket **19** lying outside of the channel **26** is suitably provided with outlet apertures **23**. Of course, it is also possible to provide several channels **26** spaced circumferentially about the inner surface of the drum jacket **19**. In this manner, separate longitudinal zones are created, extending approximately over the entire length of the drum, and having inlet openings **22** and outlet openings **23** disposed in alternating relationship in the circumferential direction of the drum.

The same concept of effecting air flow through the drum without creating axial flow can also be effected in drying drums having a drum **28** closed at one end, as illustrated in FIGS. 4 and 5. In this embodiment, the drum **28**, rotatably mounted and driven, is provided with several hollow entrainment ribs **21** each provided with inlet openings **22**. The ribs **21** are in communication, at the closed end of the drum **28**, with radiator **14**, by means of perforations **29** in front wall **30**. Outlet apertures **23** of the drum **28** are positioned, in the manner set forth above, between the entrainment ribs **21** in drum jacket **19**. Therefore, as in the case of the embodiment illustrated in FIGS. 1 and 2, inlet and outlet openings **22** and **23** extend axially, preferably over the entire longitudinal extension of the drum, and are disposed in alternating relationship over the circumference thereof.

The feeding opening in housing **2**, associated with the open end of drum **28**, can be selectively closed by door **31**, such that an air stream is formed by fan **11**, passes through radiator **14**, and enters the drum chamber through inlet openings **22**, finally exiting by way of the perforations in the drum jacket **19**. Thus, it is practically impossible for an axial air flow to be established within drum **28**.

After the air has left drum **28**, it is contained within a suction chamber **33** sealed off by seals **32** in the vicinity of the drum ends. The fan **11** draws moist air from suction chamber **33** through a screen **34** and conveys the air to the outside atmosphere. Of course, the air can also be conducted in the form of a closed cycle as described above in connection with the embodiment illustrated in FIGS. 1 and 2.

Primarily, the advantages realized by the apparatus in accordance with the present invention are attributable to the absence of axially-directed air streams within the drying drum chamber. The absence of such air streams provides for a uniform passage through the drying chamber of all of the materials to be dried, regardless of the particular weight, shape or moisture content of the materials to be treated. Further, the arrangement of the air inlets and outlets in the drying drum and the radially-directed air streams created thereby minimize the possibility of one or more pieces of material being treated adhering to a point on the periphery of the drum, such as intermediate walls, and being retained there by the pressure of the air stream. The elimination of such occurrences is extremely significant since such instances tend to seriously impair the drying efficiency of the apparatus, not only for those pieces of material involved, but also for other materials within the drum. The apparatus contemplated by the present invention, however, creates intense turbulence within the drum, while minimizing the possibility of a single piece being retained under pressure against the wall of the drum. The intense turbulence created in the apparatus according to the present invention provides for initimate contact of the air stream with the material to be dried and also for a concomitant loosening of the material. Thus, a high volume of moisture can be withdrawn from the material being treated with a correspondingly low energy input to the radiator.

With the air inlet channel rotating together with the drum, particularly in the form of the hollow entrainment ribs, the apparatus contemplated by the present invention affords low resistance to the entering air stream passing into the drying chamber. Therefore, the radially-directed air streams further the rotary motion of the drum.

While I have shown and described certain embodiments of the present invention, it should be understood that

the same is not limited thereto, but is susceptible of numerous changes and modifications as known to a person skilled in the art, and I therefore do not wish to be limited to the details shown and described herein, but intend to cover such modifications and changes as would be within the scope of one normally skilled in the art.

I claim:

1. Apparatus for drying materials, comprising drum means perforated over at least a portion of the peripheral surface thereof,

stationary housing means including means for rotatably supporting said drum means therein,

said drum means including entrainment rib means on the interior surface thereof, said rib means including channel-shaped means arranged for rotation with said drum means, inlet means disposed in said channel-shaped means and providing for passage of a treatment fluid into said drum means and outlet means providing for passage of a treatment fluid out of said drum means,

wherein said inlet means and said outlet means are disposed relative to each other such that a substantially radially-directed flow of treatment fluid through the interior space of said drum means is created.

2. Apparatus according to claim 1, wherein said inlet means and said outlet means are disposed in axially-extending zones alternately in the circumferential direction of said drum means.

3. Apparatus according to claim 2, wherein said axially-extending zones extend substantially over the entire axial extension of said drum means.

4. Apparatus according to claim 1 wherein said inlet means are disposed in said entrainment rib means and said outlet means are disposed in the regions of said peripheral surface of said drum means between said entrainment rib means.

5. Apparatus according to claim 4, wherein said channel-shaped entrainment rib means are substantially triangular in cross section, with the apex of the triangle extending radially inward toward the rotary axis of said drum means, and said inlet means comprise one or more slots extending along the apices of said entrainment rib means.

6. Apparatus according to claim 4, further comprising at least one annularly-shaped chamber means surrounding said drum means, said chamber means communicating with said fan means, said peripheral surface of said drum means including perforations in the region surrounded by said chamber means and providing communication between said chamber means and said channel-shaped entrainment rib means.

7. Apparatus according to claim 6, wherein said drum means is open at both ends thereof, and one chamber means is disposed in the region of each end of said drum means, said outlet means being disposed in the region between said two chamber means.

8. Apparatus according to claim 7, further comprising drive means for causing rotation of said drum means, vacuum chamber means, partition means separating said drive means from said vacuum chamber means, said partition means including an opening therein for intake of fresh air into said vacuum chamber means, and closure means for adjustably restricting said opening.

9. Apparatus according to claim 8, further comprising separately-operable blower means communicating with said vacuum chamber means.

10. Apparatus according to claim 4, further comprising wall means covering one lateral end of said drum means, said wall means being provided with apertures permitting passage of treatment fluid medium therethrough and into said channel-shaped entrainment rib means and wherein the cross-section of said rib means decreases in the direction of the open end of said drum means.

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