United States Patent [19]

Chaikin et al.

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[11] **3,913,241**

[45] **Oct. 21, 1975**

[54] **APPARATUS FOR DRYING TEXTILE MATERIALS**

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[22] Filed: **May 29, 1974**

[21] Appl. No.: **474,172**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 50,527, June 29, 1970, abandoned.

[30] **Foreign Application Priority Data**

June 25, 1969 Australia 56985/69

[52] **U.S. Cl.** **34/122;** 34/155; 34/242

[51] **Int. Cl.²** **F26B 11/02;** F26B 13/00

[58] **Field of Search** 34/23, 115, 122, 155, 162

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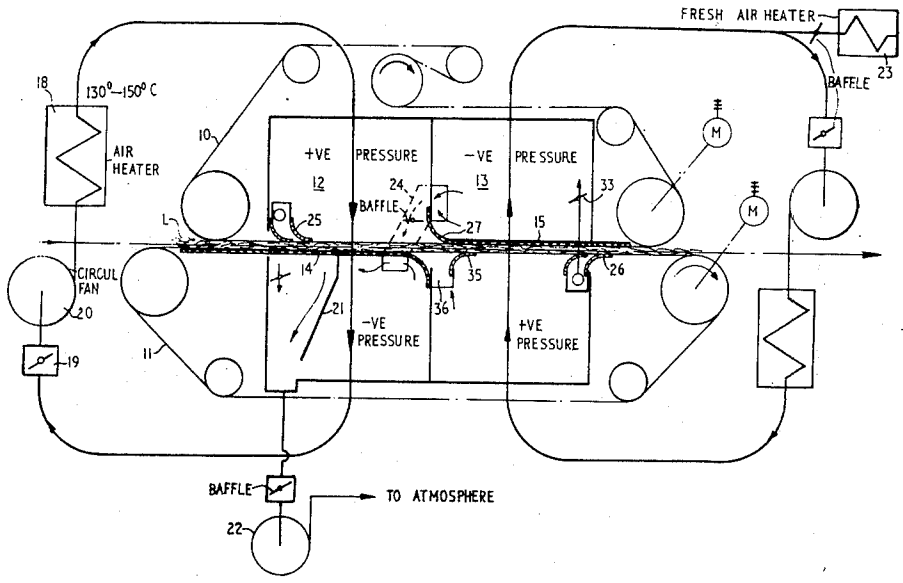
[57] **ABSTRACT**

Apparatus for drying loose fibres and other textile materials in which the material to be dried is supported on a porous member which itself is supported on a perforated backing member having in it a plurality of holes, the material to be dried being subjected to a high velocity flow of drying air. The distinguishing feature of the invention is the deliberate restriction of the number and size of the holes in the perforated member so that they constitute between 5 and 20% of the total area of the backing member, it having been found that this leads to quicker and more uniform drying.

10 Claims, 8 Drawing Figures



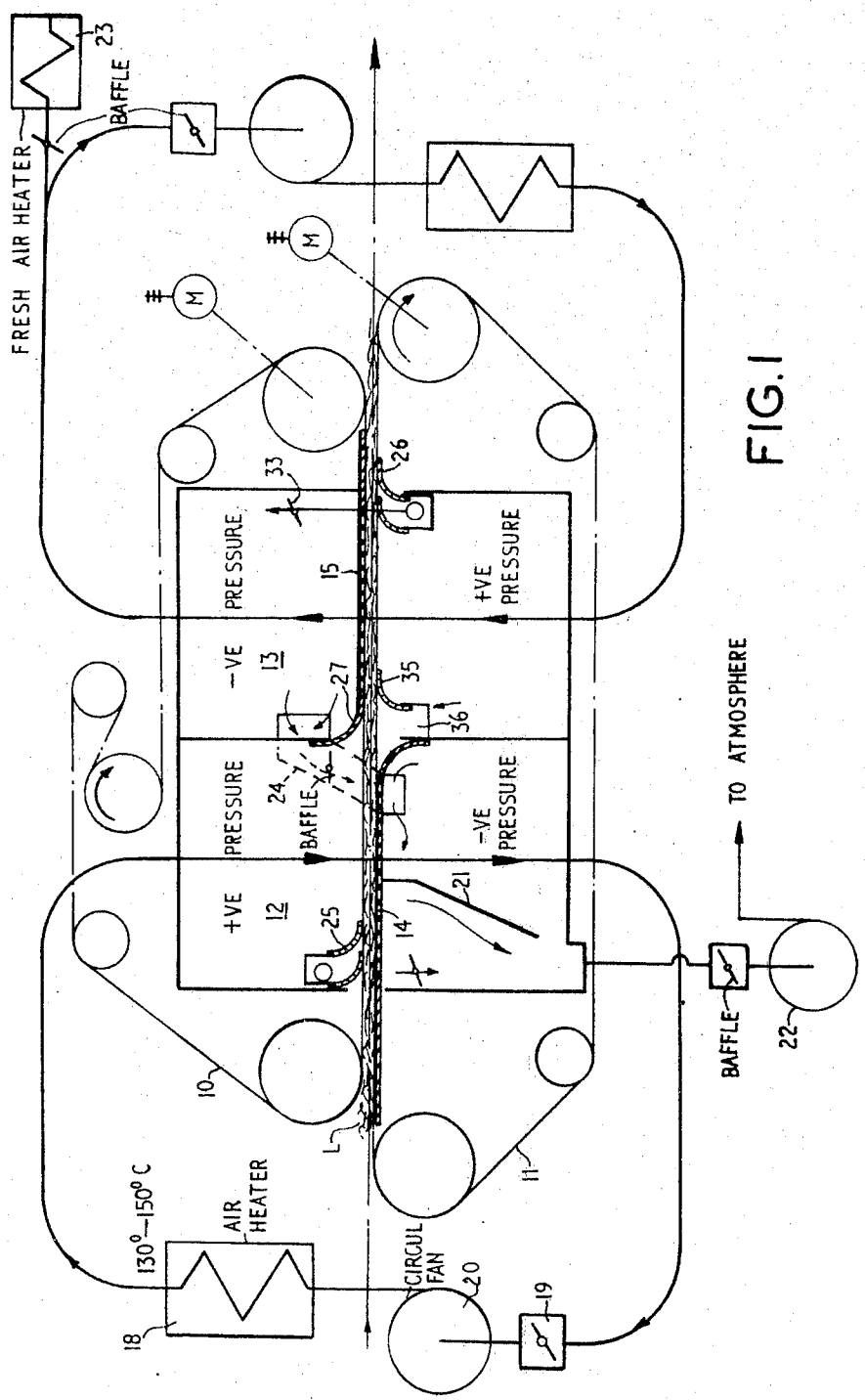


FIG. 1

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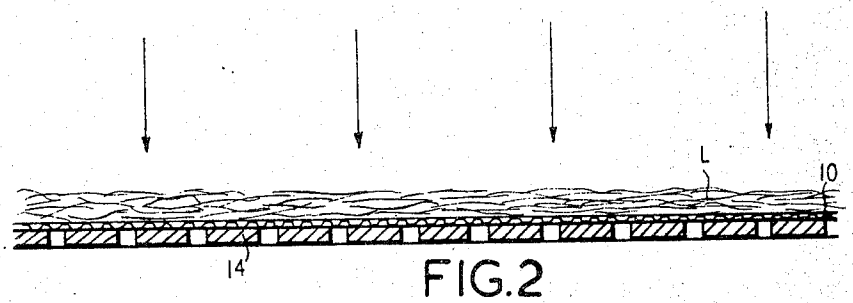

FIG.2

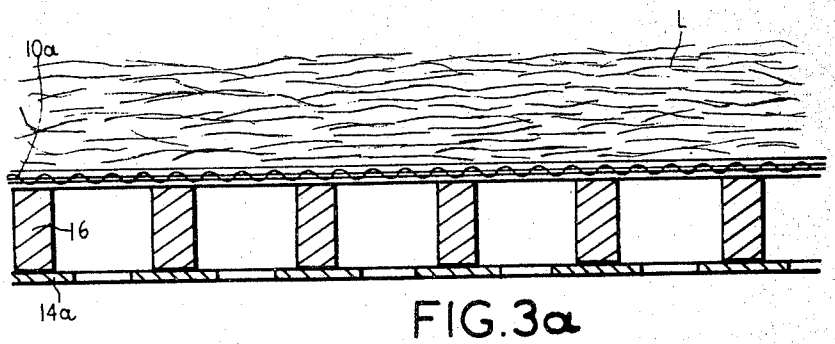

FIG.3a

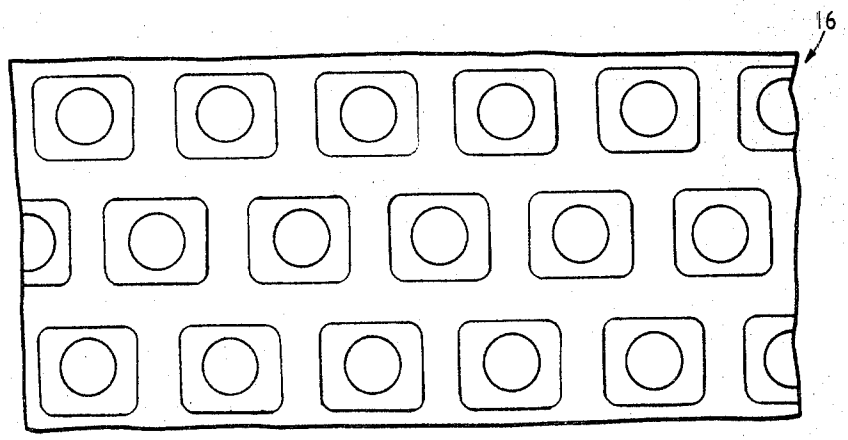

FIG.3b

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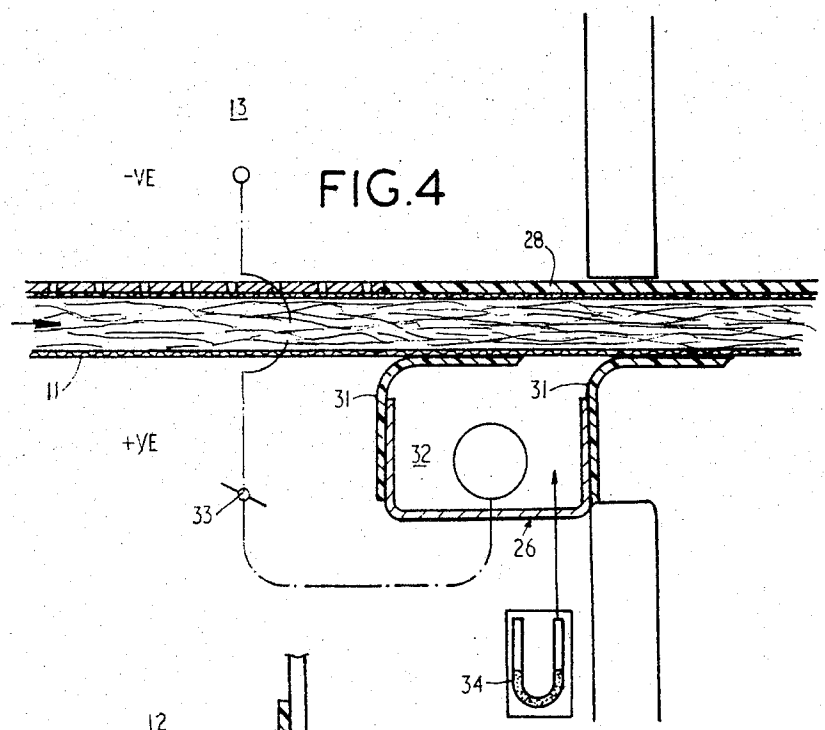

FIG.4

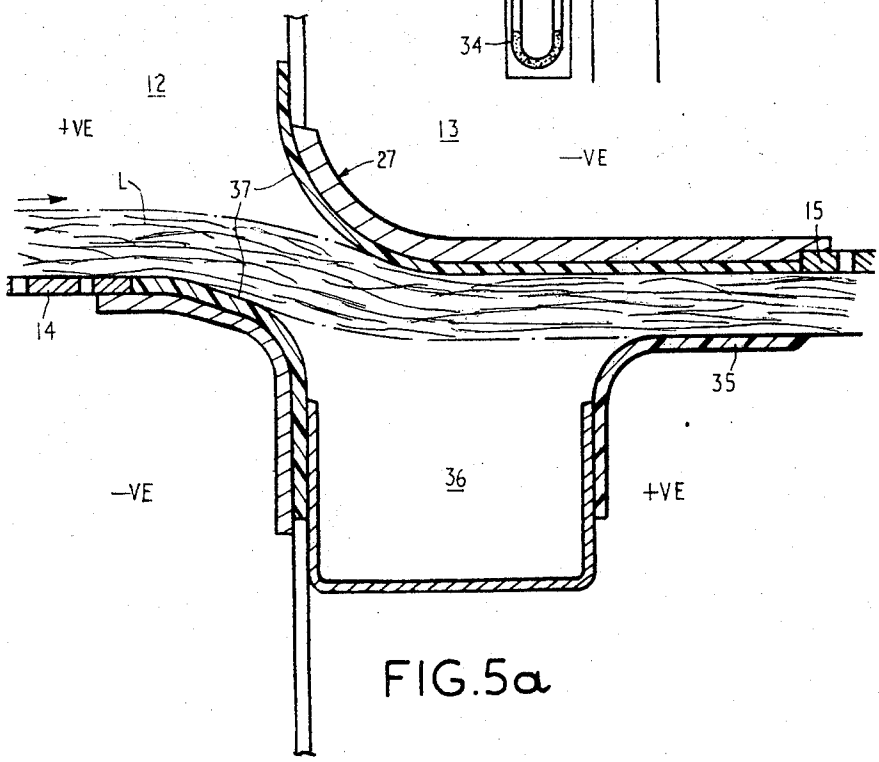

FIG.5a

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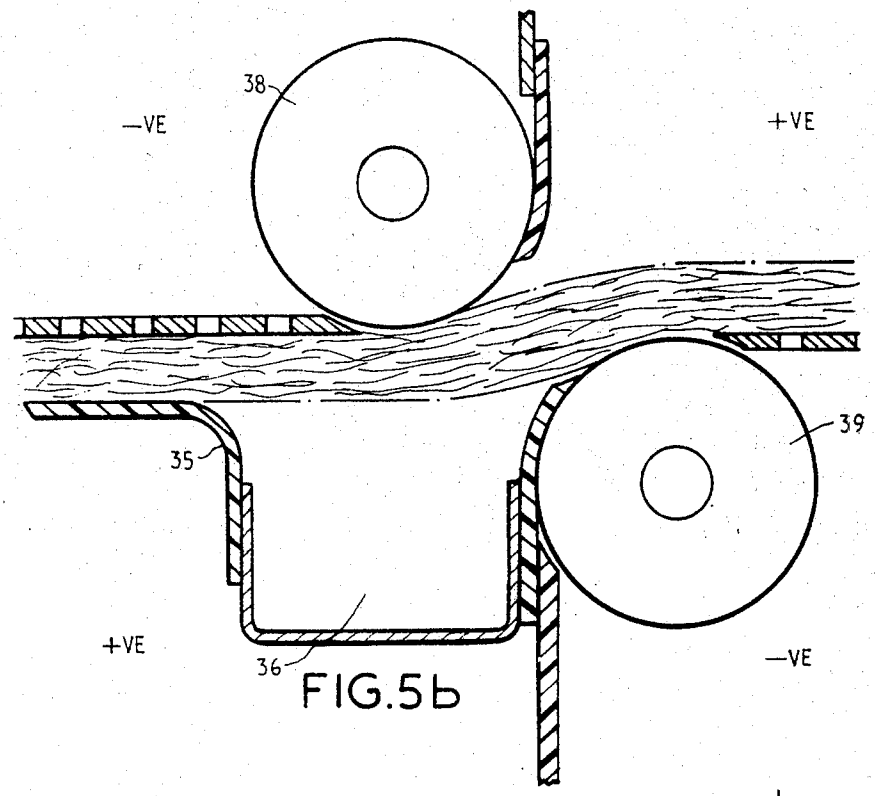

FIG.5b

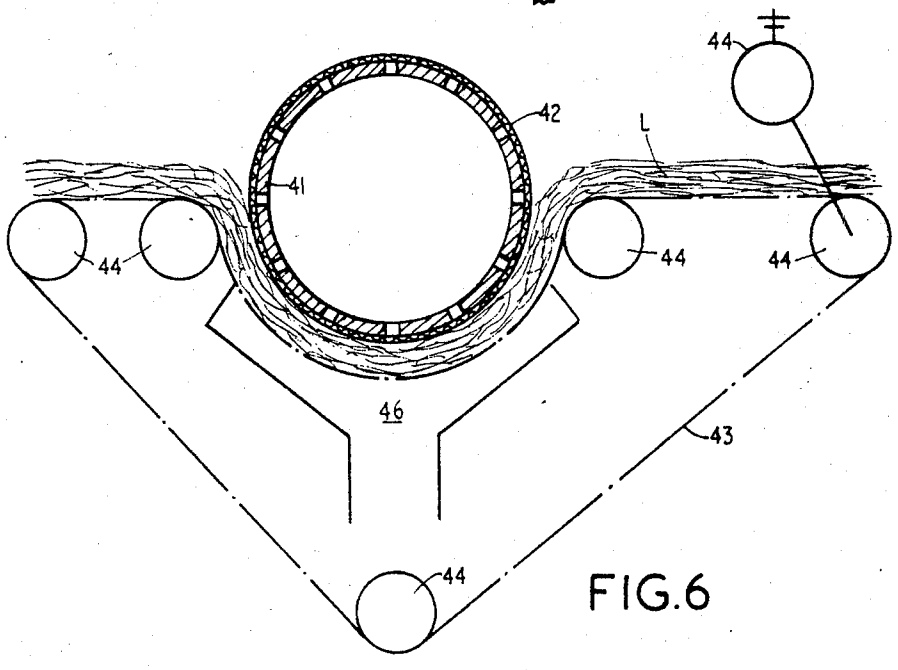

FIG.6

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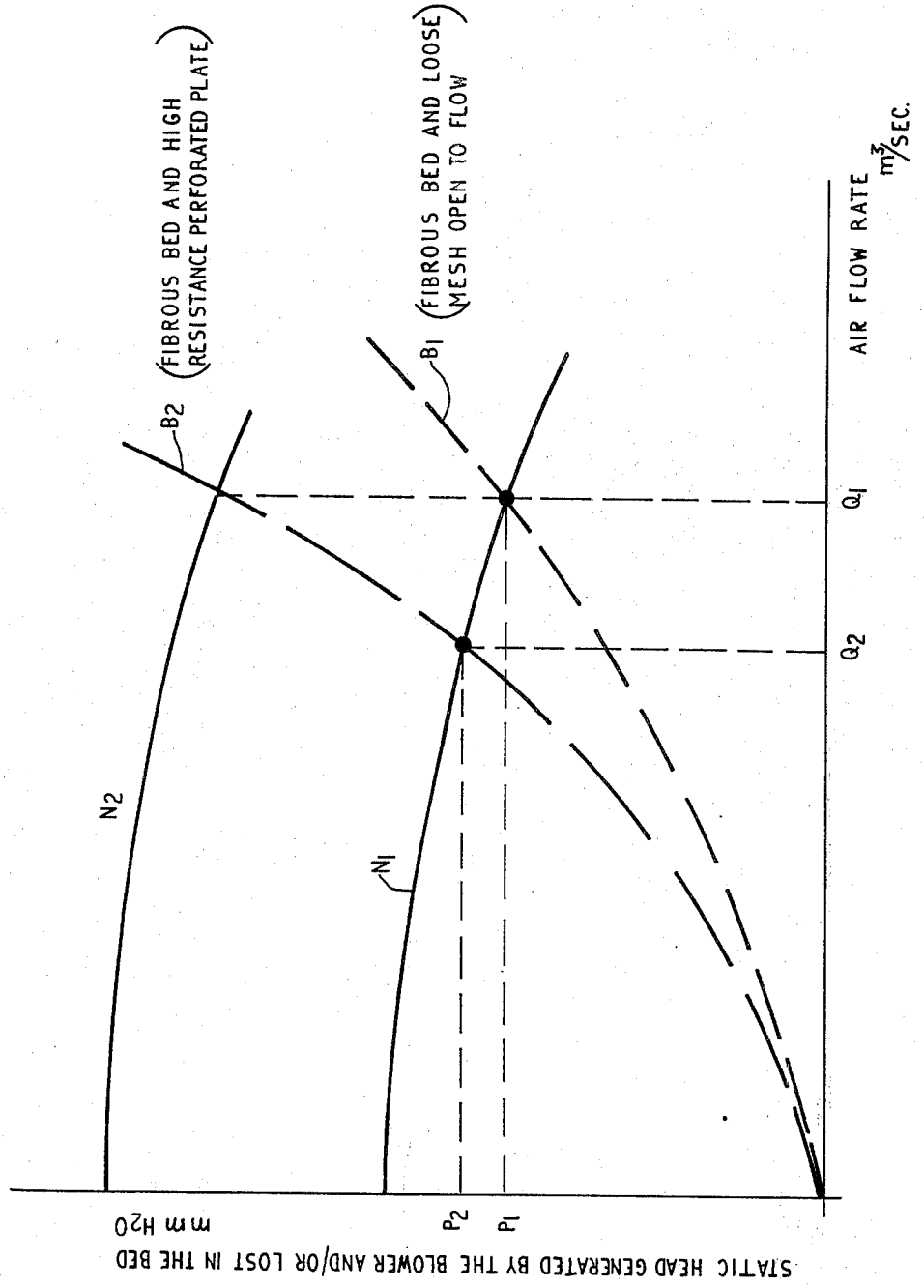
(FIBROUS BED AND HIGH RESISTANCE PERFORATED PLATE)
(FIBROUS BED AND LOOSE MESH OPEN TO FLOW)
B2
B1
AIR FLOW RATE m³/SEC.
Q1
Q2
N2
N1
P2
P1
m m H2O
STATIC HEAD GENERATED BY THE BLOWER AND/OR LOST IN THE BED

FIG 7

APPARATUS FOR DRYING TEXTILE MATERIALS

This is a continuation-in-part of application Ser. No. **50,527,** filed June **29, 1970** and now abandoned.

The present invention relates to apparatus for drying loose fibres, cloth, hanks and other textile materials.

The principal object of the invention is to provide a drying apparatus in which a layer of fibrous material may be dried in a particularly uniform, efficient and economic manner and in which the effect of lack of uniformity in the layer on evenness of drying is mitigated.

In the drying of loose fibres it is a common practice to support the fibres on a porous or perforated sheet or other member while subjecting the fibres to a flow of air. In doing this it has hitherto been the practice to

a. endeavour to make the layer of fibres being dried as uniform as possible in order to promote uniform drying, and

b. to make the area occupied by the apertures or perforations in the supporting material as large as possible in proportion to the total area, with a view to avoiding what was regarded as a non-productive pressure drop.

It has now been found that, contrary to the normal practice improved results may be obtained by deliberately restricting the free area of the supporting member, that is to say, the area through which air is free to pass. It has been found that by this means, although the pressure drop is increased, it leads to substantially more uniform and thus quicker drying and considerably reduces the effect of non-uniformity in the layer of fibres. It has also been shown experimentally that the flow of drying air is preferentially diverted through wetter areas of the layer of fibres due to increased resistance to flow of hotter air emerging from drier hotter portions of the layer.

The invention consists in drying apparatus for drying a layer of fibres consisting in means for producing a high velocity flow of drying air, a porous member for supporting a layer of fibres to be dried in said flow and a perforated backing member arranged to support said porous member and having in it a plurality of holes distributed over it, the total area of said holes constituting between **5** and **20%** of the total area of the backing member.

It is to be noted that an essential feature of the invention is that the perforated backing member should be located only on the downstream side of the layer of fibres, leaving the upstream side fully exposed to free and undisturbed airflow. The location of a corresponding perforated member on the upstream side of the layer would tend to defeat the object of the invention by localizing the flow to jets of air issuing from the holes in the perforated plate.

The effectiveness of the present invention arises from the fact that the area of the holes in the backing member is restricted to such an extent that the resistance to flow caused by the plate becomes significant in comparison with differences in resistance to flow between the loosely and densely packed areas of the layer of fibres.

This results in a much more uniform flow of air through the drying bed and to the preferential diversion of air to wetter areas of fibres and increases the effectiveness of drying in some cases by **40%**, although the rate of flow of drying air is reduced by the limitation of the area occupied by the holes in the perforated backing member. The preferential diversion of drying air

stream to the wetter areas in the bed arises from the fact that in the wetter areas, the evaporation of moisture lowers the temperature of the drying air and this leads to a contraction in its volume, which facilitates increased mass flow. By contrast, in the drier parts of the layer of fibres the air is hotter and its volume remains large thus preventing excessive mass flow. This effect is greatly enhanced by the presence of the perforated member which offers high resistance to flow.

It might be considered that a reduction in the area of holes in the perforated backing member, would give rise to a situation in which, with a constant volume of air being delivered by, for example, a centrifugal blower or fan, there was an increase in the velocity of the air passing through the perforations in the backing plate and that this increase in velocity could enhance drying. However, since this increased velocity occurs after the air stream has left the fibrous bed this explanation is most unlikely.

Prior to this invention a person skilled in the art on examining the situation could have inferred that the likely increase in the velocity of flow through the restricted areas of the perforations could be utilized if the perforated plate were installed on the upstream side of the fibrous bed and that this could enhance drying in the areas of the fibres which offered more resistance to air flow.

While this is to some extent true any person skilled in the art of drying would come to a conclusion that this effect would be greatly offset by the reduction in the total volume of air flowing through the system when such a perforated plate was inserted into the air stream. This stems from the characteristics of the centrifugal blower as illustrated in FIG. **7,** in which the ordinate represents pressure generated by the fan and/or pressure drop occurring in the system and the abscissa represents the rate of air flow.

Curve **N1** represents the operating characteristics of a blower operating at a given speed **N1** r.p.m. and curve **B1** the combined resistance to flow of a fibrous bed such as a layer of fibres, and low resistance supporting surface. A higher resistance to flow created, for instance, by introducing a perforated plate with a limited number of holes results in curve **B2** which intersects the blower characteristics at a point corresponding to a lower rate of flow **Q2** than the original flow **Q1.** Thus it is obvious that a substantial reduction in the rate of flow is related to a relatively small increase (from $p1$ to $p2$) in the pressure drop through the bed system.

Prior to the present invention it would have been considered necessary to maintain the original rate of air flow **Q1** by increasing the speed of rotation of the centrifugal blower to **N2** r.p.m., corresponding to curve **N2.** Such a change would of course involve the expenditure of considerably greater power thus making the whole procedure uneconomical.

The present invention is based on a surprising discovery that if the perforated supporting member is placed on the downstream side of the bed, the resulting reduction in the rate of air flow does not affect the effectiveness of drying which is in fact increased quite unexpectedly and without the use of additional power.

If a perforated member similar to the perforated backing member were placed on the upstream side of the layer of the fibres, each hole in that member would tend to form a jet of air which would act to convert the

stream of air attempting to penetrate the layer into a large number of individual jets affecting areas in line with the position of the holes while leaving areas of the layer between the holes unexposed to the flow of air. In the application of the present invention, however, the distribution of velocity in the layer of fibres is not affected by the position of the holes as they are on the downstream side and act only after the stream of air has passed through the layer of fibres.

An upper limit of **20%** for the total area of holes in the backing member has been chosen because if the area is increased above this figure the total pressure drop becomes relatively insignificant in comparison with the overall differences in pressure drop within the bed, making the perforated backing member ineffective for the purposes of the invention.

In order that the invention may be better understood and put into practice preferred forms thereof are hereinafter described, by way of example, with reference to the accompanying drawings, in which:

FIG. **1** shows the layout of a complete drying apparatus incorporating the invention,

FIG. **2** shows in section details of the perforated plate supporting material being dried.

FIG. **3***a* shows a view similar to FIG. **2** but in which a bearing grid is interposed between the porous conveyor and the supporting plate;

FIG. **3***b* is a plan view of a portion of the bearing grid and the perforated plate of FIG. **3***a;*

FIG. **4** shows to an enlarged scale the sealing arrangement used at the entry and exit of the dryer shown in FIG. **1**;

FIG. **5***a* shows to an enlarged scale the sealing arrangement between the two sections of the dryer;

FIG. **5***b* shows a modified form of the sealing arrangement shown in FIG. **5***a*,

FIG. **6** shows a second form of dryer incorporating the invention, and

FIG. **7** is a graph representing the characteristics of air flow from a blower in the present invention with pressure being plotted against the air flow rate.

The drying apparatus shown in FIG. **1** is a flat bed dryer in which a layer L of fibrous material to be dried by means of a high velocity air stream is fed between two porous conveyors **10** and **11** passing through two chambers **12** and **13,** each having air circulating in opposite directions through the layer L of fibrous material passing through them, to improve uniformity of drying.

The layer L of material to be dried is supported in each section by a perforated plate **14** or **15** located at the downstream side of the flow. The perforated plate which is shown to a larger scale in FIG. **2** consists of a metal sheet having small holes uniformly distributed over it, the free area for air flow through the plate consisting of between **5** and **20%** of the total area of the plate which corresponds to the surface area of the layer supported by the perforated plate. Holes in the plate are prevented from blocking with wool or other material being dried by a wire mesh or other porous material separating the perforated plate from the material being dried. In the present case the mesh is constituted by one of the conveyor belts but in other applications this need not necessarily be the case.

The principle of utilising a backing plate or other member having a plurality of air holes in it, the total area of the holes constituting between **5** and **20%** of the total area and the holes being covered by a wire mesh and/or other porous material separating the plate from the material being dried has particular virtues arising from the fact that the arrangement ensures an even distribution of air through a generally uneven layer of loose fibrous material which greatly increases rates of drying in that the drying effect is applied throughout the whole of the fibrous material instead of being concentrated in places where resistance to flow is least, as is the tendency in known drying apparatus.

The optimum size and number of holes in the backing member within the range of holes of **5** and **20%** of the total area will depend to some extent on the nature of the material being dried and in practice this is obtained by simple experiment. In an experimental flat bed apparatus for drying wool fibres, satisfactory results have been obtained using holes of a diameter of the order of one-eighth inch to one-fourth inch, the total area of which was **13%** of the area of the backing member. Reduction of the area of the holes tends to increase the power required and if decreased to below about **5%** this factor negates the advantages of the invention.

The holes are distributed over the whole surface of the backing member and while, in practice, uniform distribution is convenient, strict uniformity is not necessary.

In some constructions it may be found desirable to protect the perforated plate or other backing member against wear occasioned by a porous member, such as a porous conveyor belt, sliding over it. This may be done as illustrated in FIGS. **3***a* and **3***b* by inserting between the conveyor **10***a* and the plate **14***a* a grid **16** of relatively soft or lubricating material, for example, cast iron. The grid **16** may either be stationary and fixed in relation to the plate **14***a* or it may be made in sections and be attached to and move with the conveyor. As is shown in the plan view of FIG. **3***b* the grid is provided with relatively large apertures so as not to affect the air flow.

In the apparatus of FIG. **1,** as the layer L of fibrous material to be dried passes through the compartment **12,** air passes through the compartment from top to bottom in a circulation indicated by the left hand arrow bearing line which extends from the air heater **18** through the apparatus to the baffle **19** and circulating fan **20.** As indicated a positive pressure exists in the upper half of the compartment **12** and a negative pressure in the lower part. A baffle plate **21** and an exhaust fan **22** act to draw air out of the lower parts of compartment **12** and, as will be seen, the exhaust air before being drawn out of the compartment passes through the layer of fibres L entering the compartment that is to say, the part of the fibres which is coldest and wettest and this arrangement results in an overall heat economy, in that the heat from incoming air is given up to the layer of fibres and not exhausted from the system. The evaporation of moisture lowers the temperature of the drying air causing a reduction in its volume and increasing the mass flow through the part of the fibres which is coldest and wettest.

As the layer L of fibres being dried passes to the compartment **13** a reversal of air flow through the layer takes place as indicated by the right hand arrow bearing line, utilising a circuit similar to that described for compartment **12.** Air lost from the system due to the exhaust fan **22** is made up by the fresh air heater **23** and a duct **24** allows air to pass from the upper part of compartment **13** to the lower part of compartment **12.**

Seals 25 and 26 are provided at the inlet and outlet of the apparatus. The latter of these is shown to a larger scale in FIG. 4 in which a blanked-off section 28 of perforated plate 15 coupled with intense suction behind the perforated plate constitutes one part of the seal. The other part is formed by flexible flaps 31 which bear on the surface of the conveyor belt 11. The space 32 is connected through an adjacent baffle 33 to the suction side of the compartment 13 and baffle 33 is adjusted to assure near atmospheric conditions in space 32, this being done by observing a water manometer 34 (not shown in FIG. 1). It will be seen that the pressure differential between the sides of the layer of fibres being dried is utilised to maintain the compartment 32 at atmospheric pressure, thus avoiding leakage of air either into or out of the drying apparatus.

A seal 27 is arranged between the two compartments 12 and 13 of the drier and this is shown in greater detail in FIG. 5*a*. While there will be a very small difference of pressure between the two compartments of the drier, it is desirable to prevent the circulation of air between them and to this end the layer of fibres being dried is utilised as a seal, the construction shown automatically accommodating variations in the thickness of the layer. The lip 35 and space 36 are included to provide sealing when the dryer is operated empty. Under these conditions the flexible lip 35 will make contact with the surface immediately above it, under the influence of the positive pressure in that part of the dryer. Wear pads 37 made of wear resistant reinforced polytetrafluorethylene or other similar material are provided to reduce frictional resistance and to accommodate any variations in the thickness of the layer of material.

An alternative form of construction is shown in FIG. 5*b* in which rollers 38 and 39 are used to replace the wear pads 37.

FIG. 6 shows a somewhat different application of the invention in the form of a rotating drum dryer in which a perforated plate drum 41 has in it holes distributed over it and a free area of between 5 and 20% and is covered with a mesh or other porous material 42 to prevent clogging of the holes. A layer L of fibres to be dried is held closely against the cylindrical surface of the drum by a continuous porous conveyor belt 43 passing over rollers 44. The conveyor is driven by the motor 45 and carries the layer of fibres L around the drum, which rotates. Air is applied to the porous conveyor 43 through the chamber 46 and passes through the layer L into the interior of the drum from which it is withdrawn. The perforated plate structure promotes even drying of the fibrous material.

We claim:

1. Drying apparatus for drying a layer of loose fibres using a high velocity flow of drying air comprising mesh-like porous support means for conveying a layer of fibres to be dried along an elongated path of travel which mesh-like porous support means does not significantly interfere with the flow of drying air, means for producing the high velocity flow of drying air and for directing the flow of drying air against one surface of the layer of fibres so that it passes through the layer from the surface against which the drying air is directed to the opposite surface of the layer with the drying air passing through the layer transversely of the path of travel of the layer, and a perforated backing member arranged to support at least a portion of said porous support means and spaced from the layer fibres by said porous support means, said perforated backing member located only on the downstream side of the layer of fibres relative to the direction of flow of the drying air through the layer of fibres so that the flow of drying air to the upstream side of the layer is substantially unobstructed, and said perforated backing member having a plurality of holes therethrough distributed over its surface opposite the surface of the layer from which the drying air exists with the total area of the holes in its surface opposite the surface of the layer constituting 5 to 20% of the total area of said backing member.

2. Drying apparatus, as set forth in claim 1, wherein said mesh-like porous support means comprises a continuous support member located on the downstream side of the layer of fibres to be dried.

3. Drying apparatus, as set forth in claim 1, wherein said mesh-like perforated backing member is a rotatable cylinder having a perforated circumferential periphery, said porous support means comprises a porous member disposed about and in close contact with the circumferential periphery of said cylinder, said porous support means also comprises a continuous porous conveyor belt for supporting the layer of fibres against said porous member on the periphery of said cylinder, and said means for producing a high-velocity flow of drying air being arranged to direct the flow of drying air through the layer of fibres into said cylinder.

4. Drying apparatus, as set forth in claim 1, wherein said mesh-like porous support means includes a pair of porous support members, said porous support members each comprise a continuous porous conveyor belt arranged to contain between them a layer of the fibres to be dried, and means being provided to move said conveyor belt so that said conveyor belt on the downstream side of the layer of fibres moves over said perforated backing member.

5. Drying apparatus, as set forth in claim 4, wherein a grid constructed and arranged to reduce wear is positioned between said perforated backing member and said conveyor with which it is associated.

6. Drying apparatus, as set forth in claim 5, wherein said grid is fixed in relation to said perforated backing member.

7. Drying apparatus, as set forth in claim 5, wherein said grid is attached to and moves with said conveyor belt associated with said perforated backing member.

8. Drying apparatus, as set forth in claim 4, wherein said means for producing a high-velocity flow of drying air consists of an enclosure through which said conveyor belts pass and means for circulating air through said enclosure to pass through the layer of fibres.

9. Apparatus, as set forth in claim 8, wherein said enclosure includes a partition dividing said enclosure into two compartments, said partition having an aperture therethrough through which said conveyor belts pass, and means for circulating air in each of said compartments in said enclosure so that in each said compartment the air circulates in an opposite direction.

10. Drying apparatus, as set forth in claim 9, wherein a seal is provided in said aperture to prevent the interchange of air between said compartments, said seal comprising antifriction devices affixed to said partition at the edges of said aperture in such a manner that they bear against the conveyor belts to form a seal therewith, and resilient flap means being provided to close said aperture in the absence of a layer of fibres between said conveyor belts.

* * * * *