United States Patent [19]
Houben et al.

[11] **3,823,488**
[45] **July 16, 1974**

[54] **APPARATUS FOR FULL-WIDTH SUSPENSION GUIDANCE OF WEBS OF MATERIAL**

[75] Inventors: **Heinz Houben,** Monchengladbach; **Carl Kramer,** Aachen; **Heinrich Stein,** Laurensberg near Aachen, all of Germany

[73] Assignee: **A. Monforts,** Monchengladbach, Germany

[22] Filed: **Apr. 28, 1972**

[21] Appl. No.: **248,382**

[30] **Foreign Application Priority Data**

Apr. 28, 1971 Germany 2120805

[52] **U.S. Cl.** **34/156,** 34/23, 226/97
[51] **Int. Cl.** **F26b 13/20**
[58] **Field of Search** 34/156, 158, 155, 10, 23; 226/97; 239/590.5; 302/29, 31, 32

[56] **References Cited**

UNITED STATES PATENTS

2,038,457	4/1936	Venturini	34/155
3,384,282	5/1968	Vits	34/156
3,509,638	5/1970	MacLeod	34/155
3,622,058	11/1971	Vits	302/31
3,680,223	8/1972	Vits	226/97

FOREIGN PATENTS OR APPLICATIONS

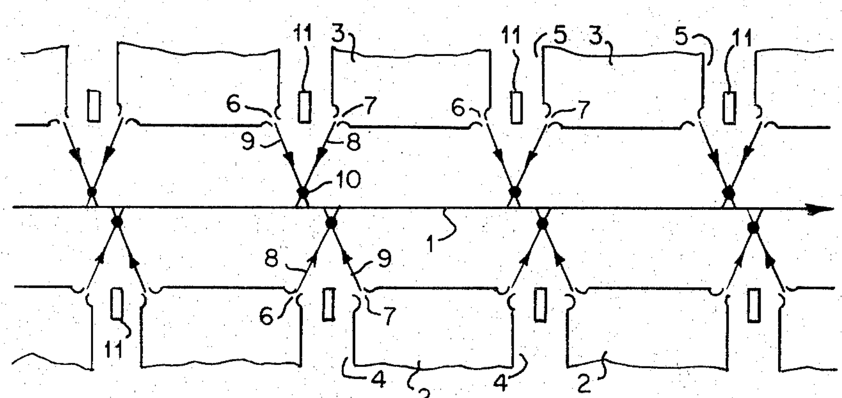
1,410,879	8/1968	Germany	34/155
1,149,169	12/1957	France	34/156
1,097,943	1/1961	Germany	34/156
1,097,942	1/1961	Germany	34/156
11,615	9/1955	Germany	34/156
835,251	5/1960	Great Britain	34/156

Primary Examiner—William F. O'Dea
Assistant Examiner—Paul Devinsky
Attorney, Agent, or Firm—Herbert L. Lerner

[57] **ABSTRACT**

Apparatus for full-width suspension guidance of a web of material on a fluid cushion includes a plurality of nozzle boxes located adjacent one another in a direction parallel to a plane, in which a web of material is disposed, the nozzle boxes being formed with respective jet nozzles inclined transversely to direction of travel of the web, and return flow channels for removing fluid blown onto the web from the jet nozzles, the return flow channels being disposed alternately with the nozzle boxes in travel direction of the web, the return flow channels being open gaps defined by respective adjacent nozzle boxes, the inclined jet nozzles being disposed respectively at both sides of each of the return flow channels and being inclined with respect to one another as to direct into regions between the respective return flow channel and the plane of the web inclined jets of fluid from the nozzle boxes at opposite sides of the respective return flow channels which penetrate one another pairwise, interfere one with the other and flow out through the respective return flow channels after being deflected at the web.

18 Claims, 8 Drawing Figures



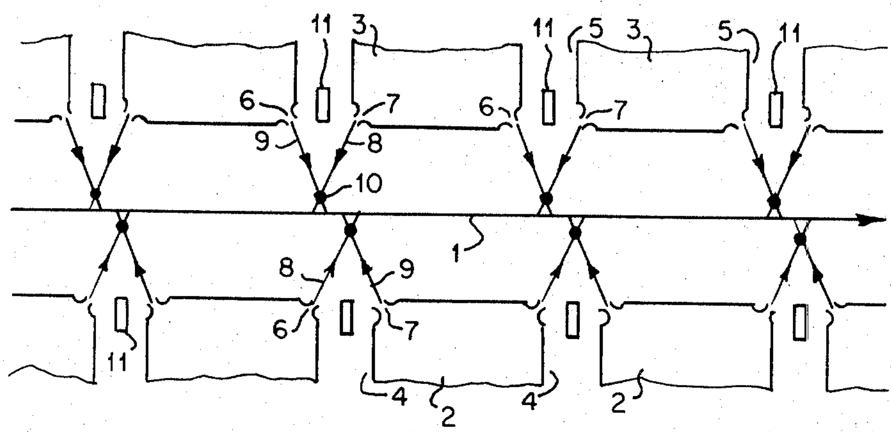


Fig. 1

Fig. 2

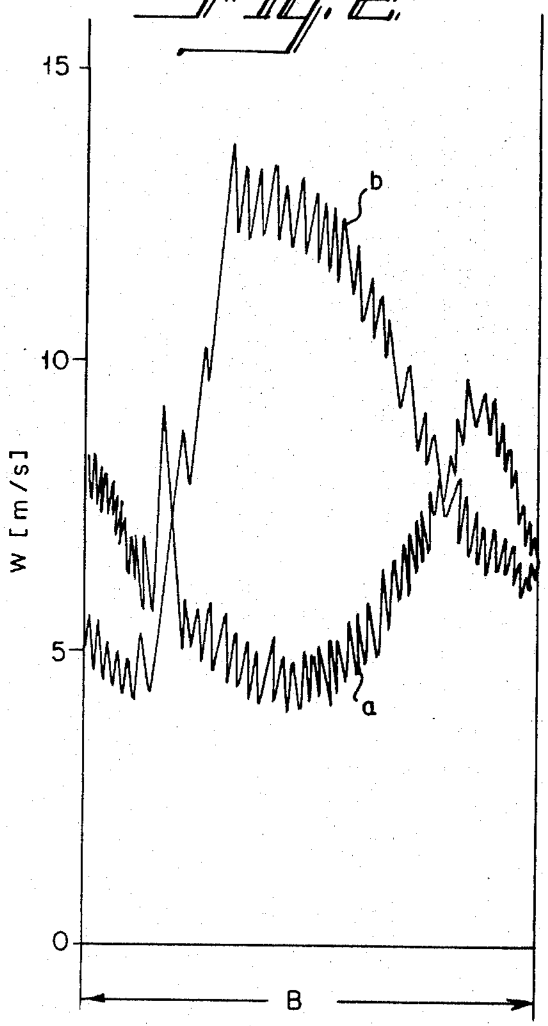
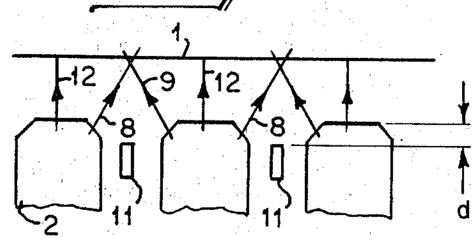


Fig. 3b



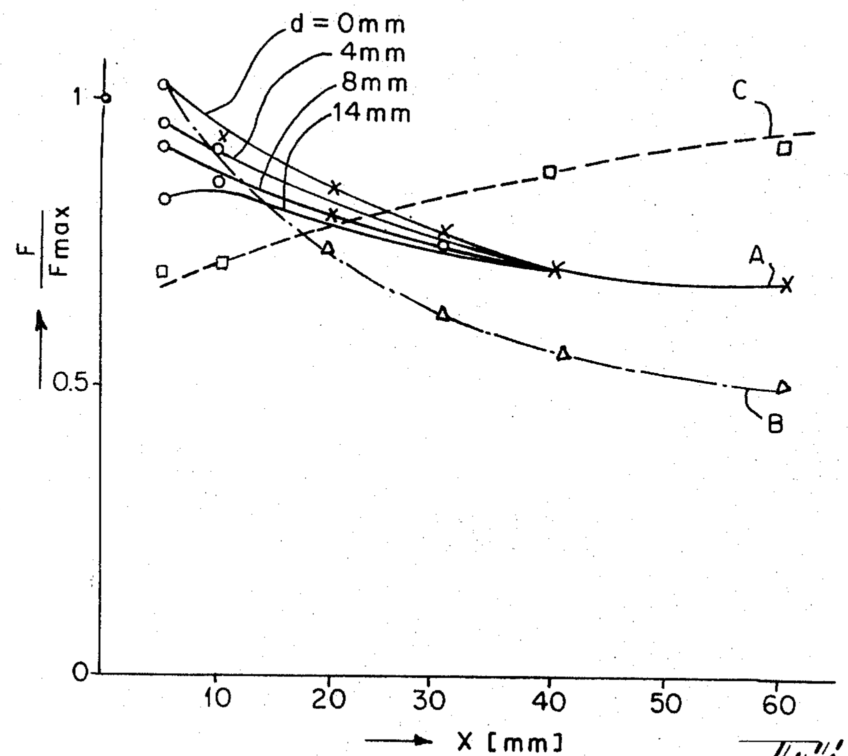

d = 0mm
4mm
8mm
14mm
C
A
B
1
0.5
0
F / Fmax
10
20
30
40
50
60
X [mm]

Fig. 3a

Fig. 5

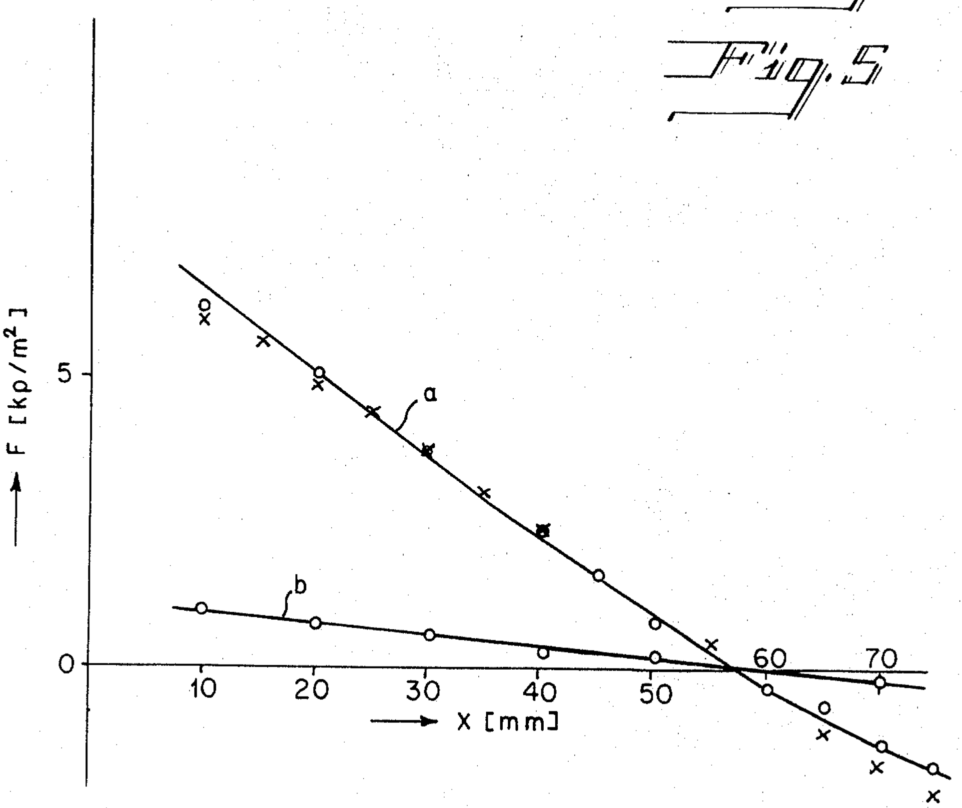

a
b
5
0
F [kp/m²]
10
20
30
40
50
60
70
X [mm]

Fig. 7

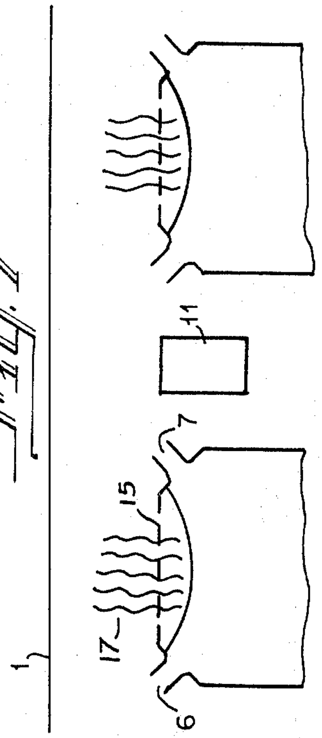


Fig. 6

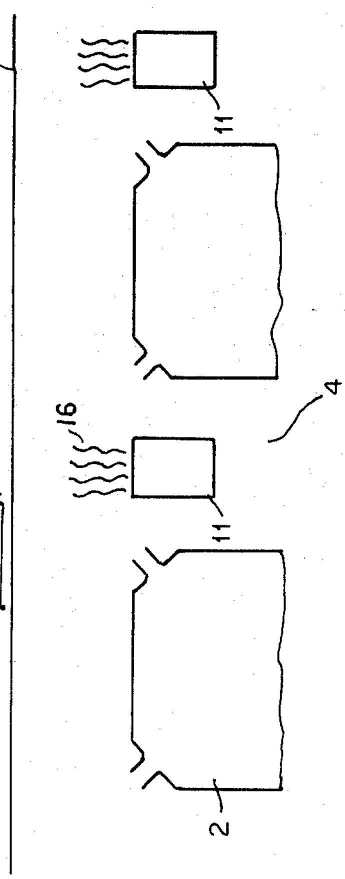
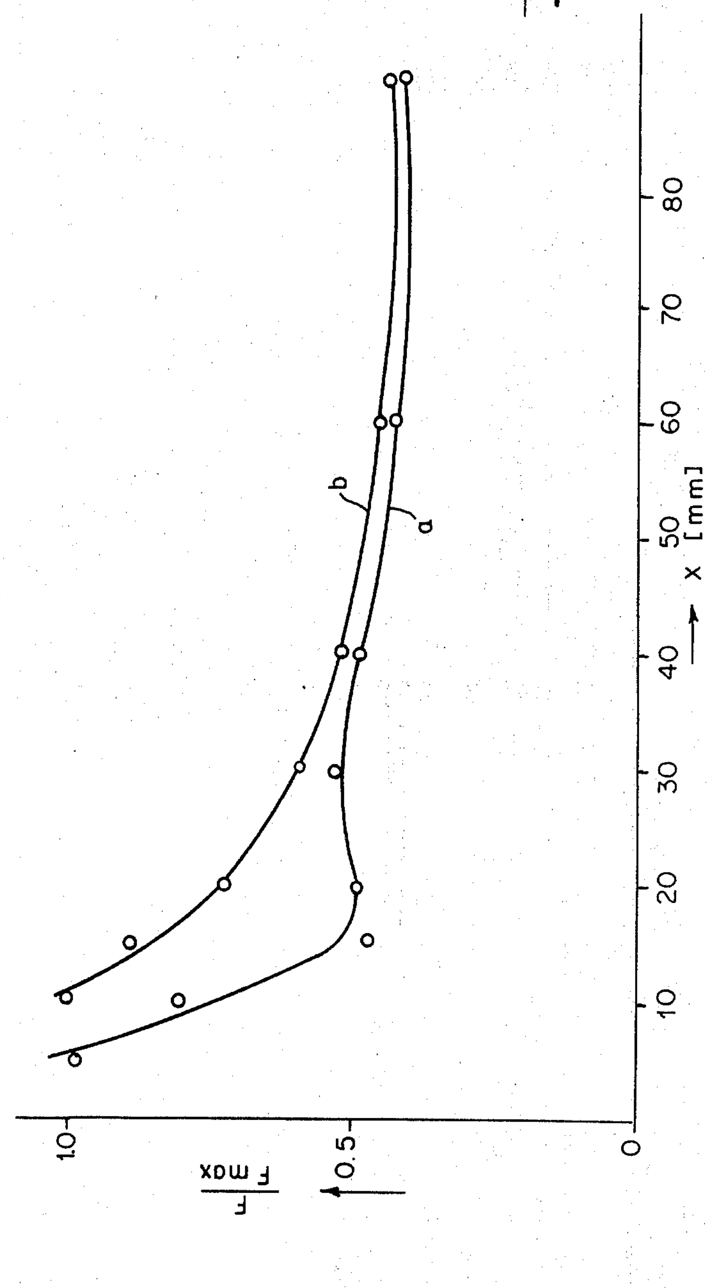


Fig. 4



APPARATUS FOR FULL-WIDTH SUSPENSION GUIDANCE OF WEBS OF MATERIAL

The invention relates to apparatus for full-width suspension guidance of webs of material on a fluid cushion, such as air, which is produced by nozzle boxes disposed parallel to the plane of the material web and extending transversely to the direction of travel of the web, through boxes being formed with inclined jet nozzles, the nozzle boxes and return flow channels for removing the air blown onto the web being disposed alternately in the travel direction of the web.

Such apparatus serves for treating or processing the most varied kinds of materials such as webs of textile, plastic or paper materials, for example. These apparatuses are employed particularly for drying (as so-called suspension or floating dryers) but also for shrinking, fixing, thermosoling, and the like. The term "fluid" or "air cushion" mentioned above, includes any kind of gaseous or vaporous medium which is required for the respective treatment or process, inclusive of hot or cold, dry or moist normal air, but also including inert, reactive, catalytically effective and similar gases or vapors. The term "fluid" or "air cushion" is furthermore to be understood generally to be applicable in apparatuses or devices wherein the web of material is exposed to the air blast from below and from above, the rests suspended between so-called "air springs."

Apparatuses for full-width suspension guidance of webs of material are employed particularly where it is not possible or advisable for any reason to pass the web material on the entire surface, for example on a conveyor belt or solely by stretching it between needles or clamping or tentering chains through the apparatuses which provide the aforedescribed type of treatment.

Starting from the last-mentioned, conventional hole or slot nozzle dryers, fixing devices and the like having fluid jets impinging upon the web of material perpendicularly and wherein stabilization of the position of the web material is effected solely by clamping or tentering the edges thereof in tentering or needle chains and by longitudinal stressing or tensioning the web of material, wherein an underpressure or negative pressure is produced due to the increased air velocity between the nozzle boxes and the web of material, as the web of material comes close to the nozzle boxes, so that the web of material tends to stick to the nozzle box, pressure spaces have been provided ahead or upstream of the nozzle boxes in order to build up static pressure (note German Prosecuted Published Applications 1,059,872 and 1,179,178 as well as German Non-prosecuted Published Application 1,629,029). Such dual slot nozzles (air cushion nozzles) possibly with converging jets, however, supply either a force-spacing characteristic having too low a progression and therefore, not having a sufficiently stable position of the material or, due to the fact that air flows off transversely into the pressure spaces between interrelated slot nozzles, they cause edge flutter as well as differences in the surface treatment, such as for instance, over-drying of the edges.

Basically, a web of material can be suspended and guided stably if the so-called Coanda principle (the so-called air-foil effect) is adhered to (note German Non-prosecuted Published Application 2,008,804 and U.S. Pat. Nos. 2,052,869 and 3,316,657). The effect of the air-cushion is then, however, limited primarily to the

support of the web of material, while the intended task, namely the desired treatment of the web of material (such as drying, for example) is inadequately fulfilled. However, combinations of the above-mentioned support systems with slot nozzles are known (note German Non-prosecuted Published Application 1,938,529). The drying air is accordingly drawn off by suction perpendicularly to the plane of the web of material, and the web of material travels past the nozzle boxes in slight arcs.

In order to attain a stable suspension, a relatively strong longitudinal tension or stress in the web of material is necessary, however, so that the web of material cannot be led tension-free in the longitudinal direction, and the heretofore known apparatus for treating or processing stretchable webs of material is not suitable. Furthermore, the spacing of the web of material from the respective nozzle is so small that these devices cannot be equipped, due to space requirements, with needle or clamp chains for maintaining the width of the material web, and can therefore frequently not be used, for example, in connection with most textiles.

Suspension dryers with inclined jets directed against one another but not intersecting, have also been developed heretofore (note German Patent 1,097,942 and German Prosecuted Published Application 1,097,943). The supporting action is ascribed to supporting vortices which, however, produce a much too limited drying effect. For the intended treatment purpose, in this case drying, additional nozzles have therefore been provided heretofore. Furthermore, the return flow of the treatment gas is supposed to take place, accordingly, substantially tangentially to the material web (perpendicularly to the direction of travel thereof), so that a stable position of the material web is not readily obtainable, and danger of overdrying the edges exists. Moreover, this apparatus cannot be operated without considerable longitudinal tension in the web of material.

Furthermore, a device is known (note German Prosecuted Published Application 1,156,749) wherein nozzle boxes disposed transversely to the direction of travel of the web of material and having a respective slot nozzle, are each spaced relative to one another so that a (partially) open return flow channel is formed between respective pairs of nozzle boxes. Into these return flow channels, in order to produce a useful supporting effect, baffles are inserted which completely close off, in sections, the return flow cross sections transversely to the direction of travel of the web material. In this manner, a pressure cushion causing the supporting action is supposed to be formed between the web of material and the nozzle boxes. Outflow of treatment gas perpendicularly to the web material is, however, only partially assured, and a superimposition of tangential and perpendicular outflow is produced, with the afore-mentioned disadvantages of the tangential outflow.

To heretofore known apparatuses for full-width suspension guidance of webs of material therefore have, among other things, either the disadvantage that the suspension position of the web of material is not stable or is insufficiently stable, or the disadvantage that the gas cushion has an efficiency which is too low for the originally intended treatment, such as drying, fixing, chemical exposure, etc.

It is accordingly an object of the invention to provide apparatus of the foregoing type which, however, avoids the hereinbefore noted disadvantages of the conventional apparatus of this general type, and moreover, to provide such apparatus with inclined jet nozzles, by which the web of material to be treated is guided floatingly and in suspension and free of tension with or without needles or clamping chains. More specifically, it is an object of the invention to provide such apparatus so that the flow resistance in the return flow channels thereof for the spent or outflowing treatment medium increases as the spacing of the web material from the respective nozzle box decreases.

With the foregoing and other objects in view, there is provided in accordance with the invention apparatus for full-width suspension guidance of a web of material on a fluid cushion comprising a plurality of nozzle boxes located adjacent one another in a direction parallel to a plane in which a web of material is disposed, the nozzle boxes being formed with respective jet nozzles inclined transversely to direction of travel of the web, and return flow channels for removing fluid blown onto the web from the jet nozzles, the return flow channels being disposed alternately with the nozzle boxes in travel direction of the web, the return flow channels being open gaps defined by responsive adjacent nozzle boxes, the inclined jet nozzles being disposed respectively at both sides of each of the return flow channels and being inclined with respect to one another as to direct into regions between the respective return flow channel and the plane of the web inclined jets of fluid from the nozzle boxes at opposite sides of the respective return flow channels which penetrate one another pairwise, interfere one with the other and flow out through the respective return flow channels after being deflected at the web.

In the novel system or apparatus of the invention, the discharge or outflow of the treatment medium for the "air-cushion" into the return flow channels is throttled all the more, the smaller the spacing of the web of material is from the respective nozzle boxes. This throttling effect is optimized in practice if the inclined jet nozzles are suitably disposed with respect to the web of material, the return flow channel and the nozzle bar.

In accordance with other features of the invention, the apparatus has inclined jet nozzles, which are slot nozzles extending transversely to the direction of travel of the web material and may as well be nozzles which are constructed as hole nozzles. By employing slot jet nozzles in accordance with the invention, very good transverse stabilization of the web of material can furthermore be attained. By transverse stability, there is meant the tendency of the material web to assume, always, a position parallel to the nozzle boxes in a section transverse to the direction of travel of the web of the material. Due to the return flow behavior at the material web which differs from that with slot jet nozzles, it is usually impossible to obtain with hole nozzle jets sufficient transverse stability, without additional measures. The material sags, with wide latitude, in an S-shaped manner, between the nozzle boxes on opposite sides of the material and if needle or pin chains are used for lateral guidance, the danger of tearing exists.

With hole nozzles, transverse stability could be achieved, heretofore, only by partially covering up the return flow channels (not the previously cited German Prosecuted Published Application 1,156,749). However, the aforedescribed disadvantages of lateral outflow must then be taken into consideration. It is therefore already an important advantage of the present invention that transverse stability of the material position is readily assured when slot jet nozzles are used.

In accordance with another feature of the invention and to enhance the desired treatment proper, additional rectilinear jets are directed (perpendicularly) onto the web of material.

In accordance with a further feature of the invention and in order that the flow resistance in the return flow channels for the discharging air should increase, as the spacing of the material from the nozzle decreases, there are provided thrust members or displacing bodies at the respective inlets to the return flow channels extending lengthwise thereof so that each return flow channel at its inlet, i.e. on the side facing the web of material, is divided into two sub-channels. These thrust members, such as throttle rods, for example, are preferably employed when the inclined jet nozzles are constructed as hole nozzles, however, the thrust members can also provide very considerable advantages for inclined jet nozzles constructed as slot nozzles, particularly if the nozzle boxes are relatively wide, for example, wider than 5 to 10 cm, depending on the construction of the nozzle and upon the pressure of the treatment gas.

An effect similarly advantageous as that provided by the thrust members can be achieved with inclined jet nozzles and wide nozzle boxes through the selection of a suitable spacing of the inclined jet nozzles from the edge of the nozzle box. In particular, it is possible thereby to make the boxes wider at the expense of the return ducts, retaining the pitch in the direction of travel of the web of the material (i.e. without otherwise changing the geometry) which, for relatively large operating widths is very advantageous for the feeding of the treatment medium.

For example, when the cross section of the parts of the nozzle box which face towards the web of material is constructed in the form of a trapezoid, it means that in the case at hand, the nozzles are disposed on the inclined edges of the trapezoid, above the centers thereof. According to another feature of the invention, generally and irrespective of the shape of the nozzle box, the ratio of the return flow channel width to the spacing of the nozzles from the return flow channel is within the range of 1/5 to 5. The numerical ratio 1/5 accordingly means that the spacing of the nozzles from the return flow channel is relatively large. The permissible range of variation of the afore-mentioned numerical ratio depends, however, on the width of the nozzle boxes. With normally employed nozzle boxes, the range of variation is therefore frequently only ¼ to 4.

The inventive effect of the thrust members according to the invention, is increased if the thrust members are advanced out of the return flow channel toward the web of material just so far that the side thereof facing the web of material is in the same plane as the boundary or limit of the nozzle boxes facing the web of material.

If particularly good support properties in an apparatus constructed in accordance with the invention, with nozzle boxes located below and above the web of material, are desired, for example, for very heavy or very moist material, it is advantageous to make the thrust members located between the lower nozzle boxes (with otherwise unchanged nozzle box geometry) wider than those between the upper nozzle boxes. In this manner, a stable suspended position near the upper nozzle boxes can generally be achieved. If it is desired, however, to adjust a stable suspension position near the lower nozzle boxes, this position can advantageously be obtained if the thrust members between the upper nozzle boxes are made wider than those between the lower nozzle boxes.

The nozzle boxes constructed in accordance with the invention are located, as a rule, below and above the web of material. The web then actually rests between two air cushions (in the narrower sense), thus between two air springs; with hereinbefore initially introduced general definition of the term "air cushion" one may also say in this case that the material rests on an air cushion. Thus, a treatment of the material web on both sides thereof is simultaneously received. However, it is also possible to provide, especially in the inlet field of the novel apparatus of the invention, nozzle boxes that are located only below the web of material. The support capacity of the nozzle boxes is then selected so that it corresponds to the weight of the material. From the relationship upon which the solution provided by the invention is based, namely between the support effect and the width of the nozzle box, the width of the return flow channel, the inclination of the nozzles, the spacing of the nozzles from the edges of the nozzle box, the width of the thrust members or displacing bodies in relation to the return flow channel width, as well as the nozzle pressure, the configuration, according to the invention, of the nozzles, the nozzle box and the return flow channel can be given for each spacing of the material web that may be of interest, so that the material web is stably supported at the desired spacing. Of course, it is also possible to provide in the outlet field, just as in the inlet field, nozzle boxes that are located only below the web of material.

Depending upon the desired method of treatment, it may further be advisable and in accordance with the invention, to provide at least part of the nozzle boxes with means for cooling, spraying or steaming the web of material. It is advantageous and in accordance with the invention, in that case, for the nozzle boxes and, for example, dampeners to be in the form of a common structural unit. However, it may also be advantageous and in accordance with an alternate feature of the invention to use at least part of the thrust members as the feeding device for the afore-mentioned treatment media.

Since the web of the material in the apparatus according to the invention is generally guided in one plane, and the spacing between the nozzle boxes, on the one hand, and the web of material, on the other hand, is always several centimeters, it is readily possible spatially to provide needle or clamping chains for maintaining the width of the web of material.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described herein as embodied in apparatus for full-width suspension guidance of webs of material, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages thereof, will be best understood from the following description of the specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a schematic view of an embodiment of the invention;

FIG. 2 is a plot diagram of air velocity to the width of the return flow channels;

FIG. 3*a* is a plot diagram of the force ratio as a function of the spacing of the web from the nozzle box when rectilinear jets are included in the apparatus of the invention;

FIG. 3*b* is a diagrammatic view of the apparatus of the invention which includes rectilinear jets;

FIG. 4 is a plot diagram, similar to FIG. 3*a* of a specific embodiment of the invention;

FIG. 5 is a plot diagram of the resultant force as a function of the spacing between the web and the lower nozzle box; and

FIGS. 6 and 7 are diagrammatic views of two embodiments of the apparatus in which dampeners are integrated.

Referring now to the drawings, and first particularly to FIG. 1 thereof, there is shown schematically apparatus embodying the principle of the invention. Above and below a web of material **1** moving in the direction of the arrow, are disposed nozzle boxes **2** (below) and **3** (above). Return flow channels **4** and **5** are located between the nozzle boxes **2** and **3**, respectively. The nozzle boxes **2** and **3** are provided with jet nozzles **6** and **7**, respectively, at the edges of the boxes adjoining the return flow channels **4** and **5.** The jet nozzles **6** and **7** are inclined with respect to the travel direction of the web **1**, the similarly inclined jets **8** and **9** issuing from these nozzles crossing and penetrating each other at their intersection point **10** just in front of/or approximately in the plane in which the web **1** of material is disposed, i.e. substantially in the middle between the nozzles boxes **2**, on the one hand, and the nozzle boxes **3**, on the other hand. As described more fully hereinafter, thruster members **11** are inserted in the return flow channels **4** and **5.**

In FIG. 2 there is plotted the distribution of the air velocity w in meters per second (m/s) against the width B of the return flow channels, i.e. the spacing between respective adjacent nozzle boxes. The measured curves a and b relatively irregular due to the jet turbulence. Curves *a* and *b* in FIG. 2 apply to the case wherein the inclined jet nozzles **6** and **7** in the apparatus constructed in accordance with the invention are hole nozzles. Curve *a* appertains to the case wherein the web **1** of material extends substantially in a desired middle position between the nozzle boxes. The plot diagram of FIG. 2 shows that at the edges of the return flow channels, velocity maxima develop corresponding to the convergent flow into the channel. The flow velocity is thus lowest in the middle of the return flow channel. When the web **1** of the material is spaced a relatively short distance from the nozzle box, however, a velocity maximum distinctly forms in the middle of the return flow channel, as shown by the curve *b* in FIG. **2.**

This maximum is explained by the jet fountain, which is located above the middle of the return flow channel and is formed by the coincidence or confluence of the inclined jets **8** and **9** which have been exactly deflected toward one another by the material web 1 and have not yet been subjected to turbulence by jet interference.

If the aforementioned thruster member 11 is thus placed in the middle of the return flow channel, it becomes immediately clear that it will impede the return flow more if the web material is spaced a shorter distance from the nozzle box than if it were spaced a greater distance therefrom, consequently, as the distance of the web material from the nozzle decreases, the force applied to the web material increases even further than would be the case if no thruster member were located in the return flow channel.

FIG. 3a shows that the spatial disposition of the thruster member 11 in the return flow channel 4 or 5, respectively (FIG. 1) also influences the effect on the web material. In FIG. 3*a*, the force ratio F/F_{max} is plotted as a function of the distance x in millimeters (mm) of the material web 1 from the nozzle box for the case wherein (with the family of curves A) rectilinear jets **12**, as shown in FIG. 3*b*, are additionally directed toward the material web 1 in addition to the inclined jets **8** and **9.** These rectilinear jets **12** influence the carrying capacity of the novel apparatus of the invention per se, but not unfavorably. This is shown by a comparison of the family of curves A with the curves B and C in FIG. 3*a*. In the case of curve B, the plotted values were derived from the use of inclined jet nozzles exclusively, and in the case of curve C, only rectilinear jet nozzles were used. Rectilinear jet nozzles thus have no supporting effect, but, when used in addition to inclined jets, they may nevertheless be advantageous if an enhancement or reinforcement of the originally desired treatment appears to be necessary.

The family of curves A in FIG. 3*a* shows that the progression of the force on the material with decreasing spacing between the material web and the nozzle is comparatively greatest when the end face of the thruster member is disposed in a common plane with the nozzle boxes. This case is indicated in FIG. 3*a* by the curve $d=0$mm (family of curves A). If the end face of the thruster member is located below the end face of the nozzle boxes, a distance d = 4mm, 8mm or 14mm, the progression of the force applied to the material web (note the family of curves A) becomes even smaller as the distance x decreases.

The description hereinbefore with respect to the drawing, relates essentially to the use of the hole nozzles. If slot jet nozzles are used instead of hole nozzles, nothing essential changes in the geometry of the apparatus according to FIG. 1. However, slot jet provide the desired force pattern according to the invention even without thruster members. If the material web is situated substantially in the desired middle position between the nozzle boxes, there results a velocity distribution in the return flow channels which is substantially uniform over the width of the return flow channels. If, on the other hand, the goods are located very closely to the nozzle boxes, an increasingly more intensive jet fountain is formed which, due to constriction, utilizes only part of the return flow channel and therefore, the desired progression of the force as the distance between the material web and the nozzle decreases, is produced naturally. The increase of the pressure in the space between the nozzle ribs and the material web caused by the decrease in the distance located between the material and the nozzle, already results, as a rule, in an adequate suspension or floating effect, without any further measures, when slot jet nozzles are used. With relatively wide nozzle boxes (for example more than 5 to 10 cm), the progression can be adjusted to the desired value by suitably selecting the nozzle angle, the distance of the nozzles from the edges of the nozzle box and/or the use of thruster members. By the term "nozzle angle" there is meant the angle with respect to the normal at which the nozzle jet impinges on the web of material.

The nozzles are of such construction that, in the vertical projection on the material web, the direction of flow of the treatment gas is preferably substantially parallel to the material travel direction. In this sense, the nozzle angle is advantageously between 15° and 50°, and especially between 20° and 40°. The above-mentioned wider nozzle boxes are required, for example, in very wide machines because of the large quantity of air that is necessary.

In FIG. **4**, there are plotted values attained for a nozzle box width of 120 millimeters and a return flow channel width of 40 millimeters; the force ratio F/F_{max} is plotted as a function of the distance x (in mm) of the web of material from the nozzle box (as in FIG. 3*a*). The curve *a* in FIG. **4** pertains to apparatus with slot jet nozzles and without thruster members. A characteristic force curve thus results having a relative maximum for the spacing x between the material web and the nozzle box of 30 to 40 mm. This undesired force curve, which results in an unstable equilibrium of the material over a wide range, can be completely eliminated if a thruster member is used in the return flow channel (or by the other hereinbefore-described means). This is demonstrated by the curve *b* in FIG. **4,** which is based on data derived from apparatus wherein a bar with a cross section of 15 × 30 mm was placed in the return flow channel without otherwise changing the layout of the apparatus.

When slot jet nozzles are used, the progressing of the force on the web of material can be further increased with decreasing distance between the web of material and the nozzle box if the air discharge openings at the nozzle boxes do not have the form of simple slot or hole diaphragms or orifices, but are constructed as nozzles in the proper sense, which do not constrict the jet but rather allow it to discharge in full width.

In the preceding description, the forces which have been discussed are only those which one nozzle box exerts on the web of material. However, if nozzle boxes are disposed both above and bleow the web of material being processed, the forces directed gainst one another from the nozzle boxes must be added. In order to attain a suspension or floating effect, the resultant of the air forces should then have a slope that is as steep as possible.

Applicable measurement results are plotted in FIG. **5.** The resultant force F (Kp/m^2) is shown in FIG. **5** as a function of the distance x (mm) between the web of material and the lower nozzle box. The data of the curves are plotted for a nozzle pressure of **50** mm of water column. The curve a refers to a woven fabric having a weight per unit area of 164 p/m^2.

The curve *b* was derived for curtain fabric that is very permeable to air and has a weight per unit area of 32 p/m^2. In both cases, the resultant of the air forces F is sufficiently large and many times greater than the weight of the material, so that the desired suspension or floating effect is achieved in an excellent manner. As the curves in FIG. 5 show, both types of goods that are represented will float about 50 to 60 mm. above the lower nozzle box.

The curve a in FIG. 5 is shown along a line, which is indicated by crosses and circles. The circles appertain to the case wherein the nozzle boxes are located exactly opposite one another above and below the web of material. The crosses, on the other hand, are related to the case wherein the nozzle boxes are offset 25 mm (i.e. by about one-fourth of a nozzle box width as in FIG. 1) in the direction of travel of the web of material.

It is seen from curve a in FIG. 5 that this offset of the nozzle box has virtually no influence on the force which is exerted on the web of material.

The apparatus constructed in accordance with the invention may, for example, be used as a suspension dryer, as mentioned hereinbefore. Unexpectedly, the drying performance deviates here only little from the performance which is achieved with conventional dryers without suspension effect. The drying performance can be further increased in the system according to the invention of the instant application if, in addition to the inclined jets, other jets would also be directed perpendicularly to the web of material and/or the opposing nozzle boxes were offset with respect to one another in the direction of travel of the material. As mentioned in the preceding paragraph, this displacement of the nozzle boxes with respect to one another has no effect upon the supporting characteristics of the apparatus according to the invention.

In order to support a web of material floatingly also in the inlet or outlet field of a stretching or tentering machine between the pin or clamping chains (regardless of a leading condition and excessive width), the nozzle apparatus according to the invention can advantageously also be constructed as a onesided support nozzle apparatus. Thus, in that case, nozzles are located only underneath the web of material, while the opposing nozzles are omitted. The air force of the nozzles can then be adjusted without difficulty so that equilibrium prevails between it and the weight of the material web.

With the apparatus according to the invention, other types of treatment of webs of material besides drying, can also be carried out, as mentioned hereinbefore. For example, textured polyester fibers must be subjected to a steam treatment because of the required relaxation shrinkage.

For shrinking and fixing such articles, conveyor belt structures have already been used heretofore. In order to achieve the shrinking, the conveyor belt must be accordingly vibrated at a very exactly adjusted frequency (depending on the kind of material and the type of treatment). Moreover, the conveyor belts which are formed in most cases of steel, absorb large quantities of energy, often leave markings on the material, hardly permit treatment of the material from below, and must be cleaned frequently, particularly when finished fabrics are used. The expensive measures are unnecessary in the apparatus according to the invention is used, because the web of material is guided, as noted hereinbefore, in the nozzle system and in the inlet field, without contact and free of tension.

The aforementioned relaxation shrinkage can advantageously be introduced into the inlet field by dampeners integrated into the nozzle system.

In FIGS. 6 and 7, two embodiments of such integrated dampeners are shown schematically. In the embodiment of FIG. 6, the thruster members 11, which are inserted into the return flow channels 4 between the nozzle boxes 2, are constructed as dampeners radiating moisture or coolant. In the embodiment of FIG. 7, the nozzle boxes 2 form an integrated structural unit with the dampeners in that the surface of the nozzle boxes 2 facing the web of material 1 between the nozzles 6 and 7, has the construction of a dampener 15 radiating moisture on coolant.

In case it should be necessary to attain better shrinkage values, one or more of such dampeners can be provided additionally in the nozzle system within the main part or in the outlet field of the apparatus according to the invention (for example a stretching or tenter frame chamber).

We claim:

1. Apparatus for full-width suspension guidance of a web of material on a fluid cushion comprising a plurlaity of nozzle boxes located adjacent one another in a direction parallel to a plane, in which a web of material is disposed, said nozzle boxes being formed with respective jet nozzles inclined transversely to direction of travel of the web, and return flow channels for removing fluid blown onto the web from said jet nozzles, said return flow channels being disposed alternately with said nozzle boxes in travel direction of the web, said return flow channels being open gaps defined by respective adjacent nozzle boxes, said inclined jet nozzles being disposed respectively at both sides of each of said return flow channels and being inclined with respect to one another as to direct into regions between the respective return flow channels and the plane of the web inclined intersecting jets of fluid from the nozzle boxes at opposite sides of the respective return flow channels, said intersecting jets interfering one with the other and then flowing out through the respective return flow channels after being deflected at the web.

2. Apparatus according to claim 1 wherein said inclined jet nozzles are slot nozzles extending transversely to the travel direction of the web.

3. Apparatus according to claim 1 wherein thrust members are disposed respectively lengthwise of said return flow channels substantially along the center lines thereof and divide the respective return flow channels into two sub-channels at the inlet thereof.

4. Apparatus according to claim 3 wherein said thrust members are disposed in said return flow channels so that a limiting surface thereof facing toward the web is disposed in the same plane as parts of said nozzle box facing toward the web.

5. Apparatus according to claim 1 wherein said inclined jet nozzles are hole nozzles.

6. Apparatus according to claim 1 wherein the width of said return flow channel is to the spacing of said nozzles from said return flow channel in a ratio within the range of 1/5 to 5.

7. Apparatus according to claim 1 wherein the angle of inclination of said inclined jet nozzles with respect to a normal to the plane of the web is between 15° and 50°.

8. Apparatus according to claim 1 wherein said nozzle boxes are located underneath the plane of the web.

9. Apparatus according to claim 1 wherein said nozzle boxes are located both underneath and above the plane of the web.

10. Apparatus according to claim 3 wherein said nozzle boxes are located both underneath and above the plane of the web, and the thrust members located between the lower nozzle boxes have a different width than those between the upper nozzle boxes, with the geometry of all the nozzle boxes being the same.

11. Apparatus according to claim 10 wherein the lower thrust members are wider than the upper thrust members.

12. Apparatus according to claim 3 wherein said thrust members are provided at least in part with means for moistening the web.

13. Apparatus according to claim 3 wherein said thrust members are provided at least in part with means for cooling the web.

14. Apparatus according to claim 1 wherein said nozzle boxes are provided at least in part with means for moistening the web.

15. Apparatus according to claim 1 wherein said nozzle boxes are provided at least in part with means for cooling the web.

16. Apparatus according to claim 1 wherein at least part of said nozzle boxes have nozzles for delivering a jet perpendicularly to the plane of the web in addition to said inclined jet nozzles.

17. Apparatus according to claim 9 wherein the nozzle boxes opposite one another on both sides of the plane of the web are offset from one another in the direction of travel of the web.

18. Apparatus according to claim 1 wherein said nozzles are constructed so as to deliver a jet of fluid in a direction substantially parallel in vertical projection of the plane of the web, to the direction of travel of the web.

* * * * *