Aug. 27, 1963 S. COHN ET AL 3,102,006

METHOD AND APPARATUS FOR TREATING WEB MATERIALS

Filed Nov. 14, 1958 4 Sheets-Sheet 1

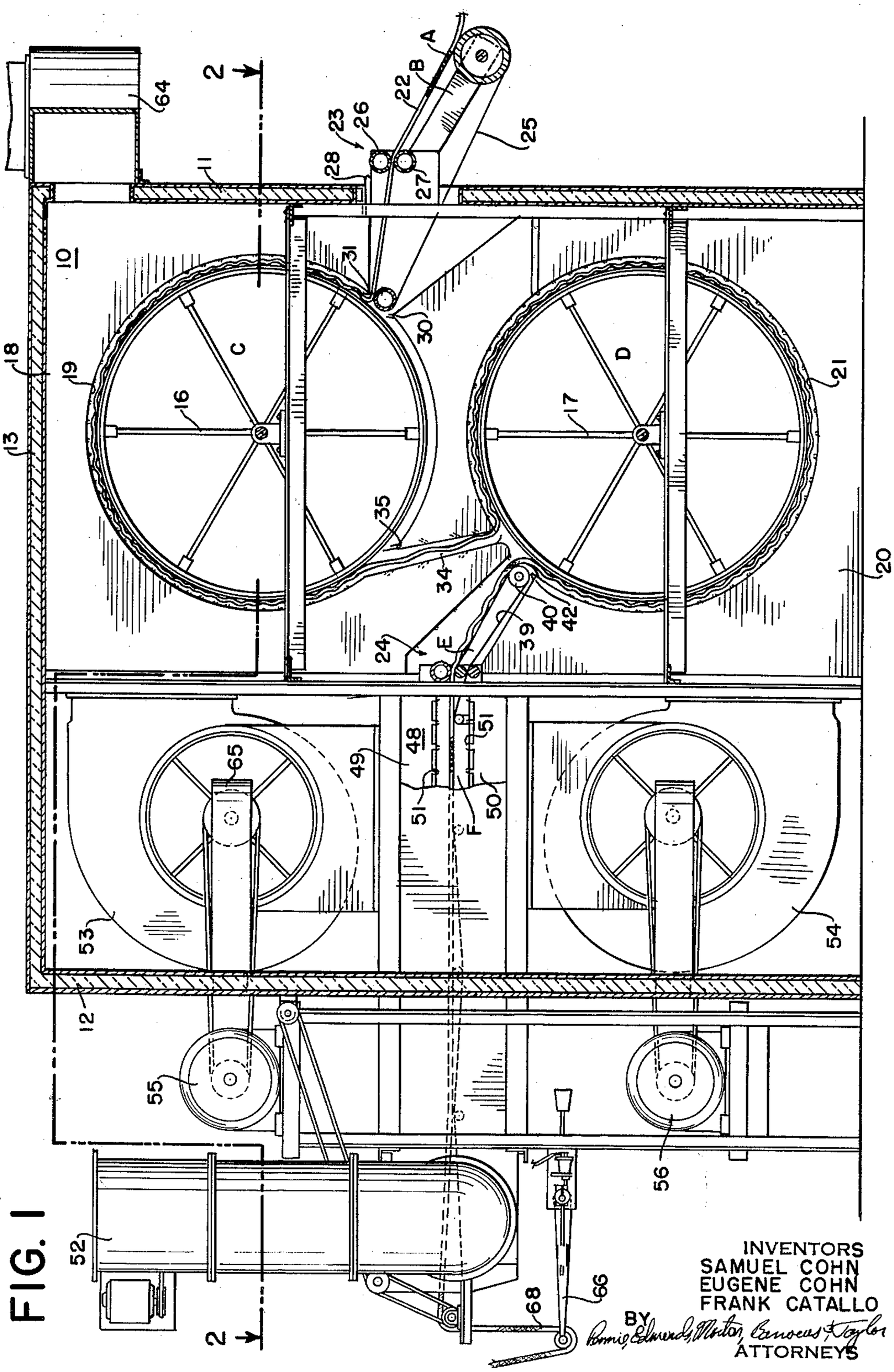

FIG. 1

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Filed Nov. 14, 1958 4 Sheets-Sheet 2

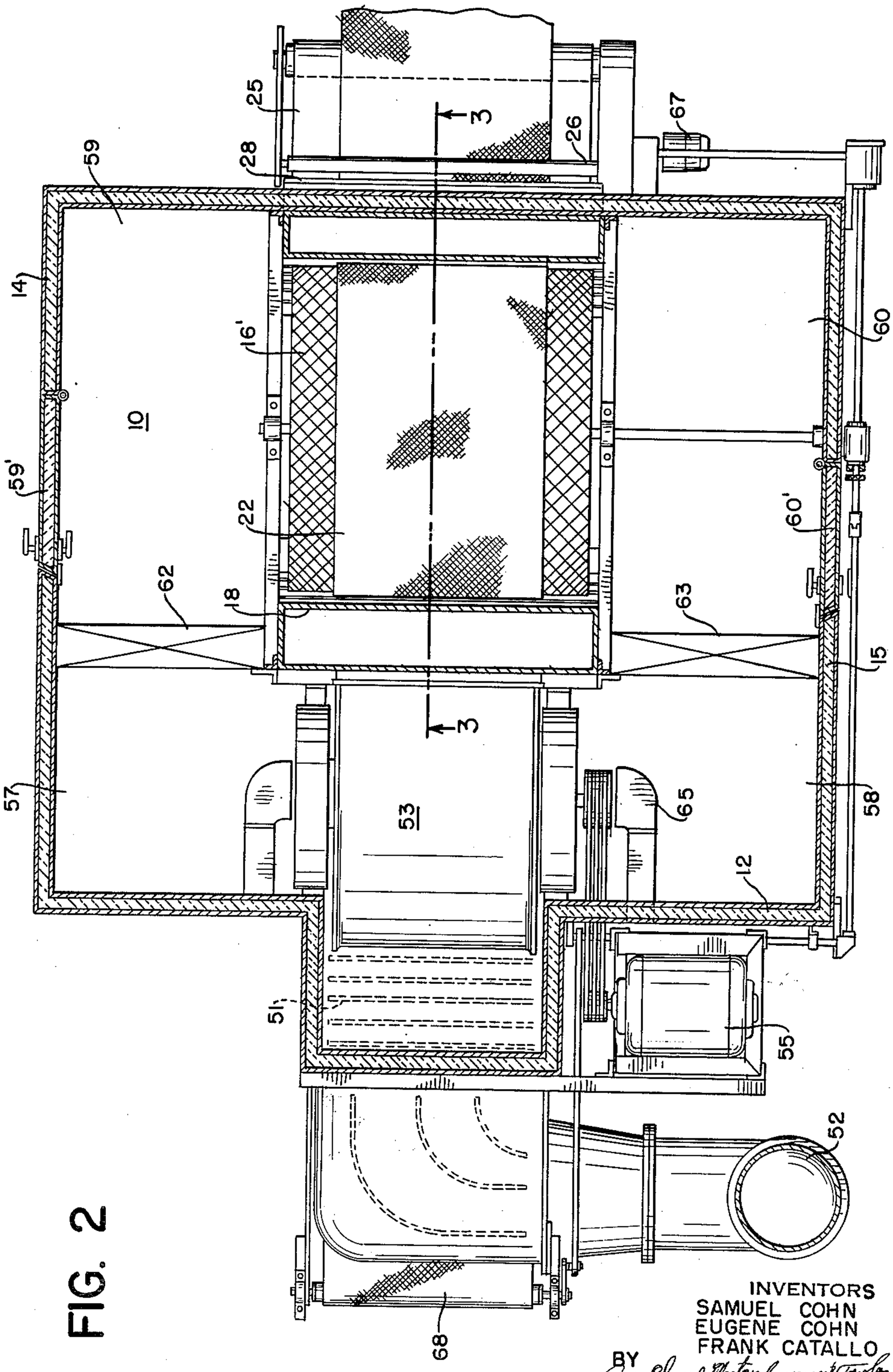

FIG. 2

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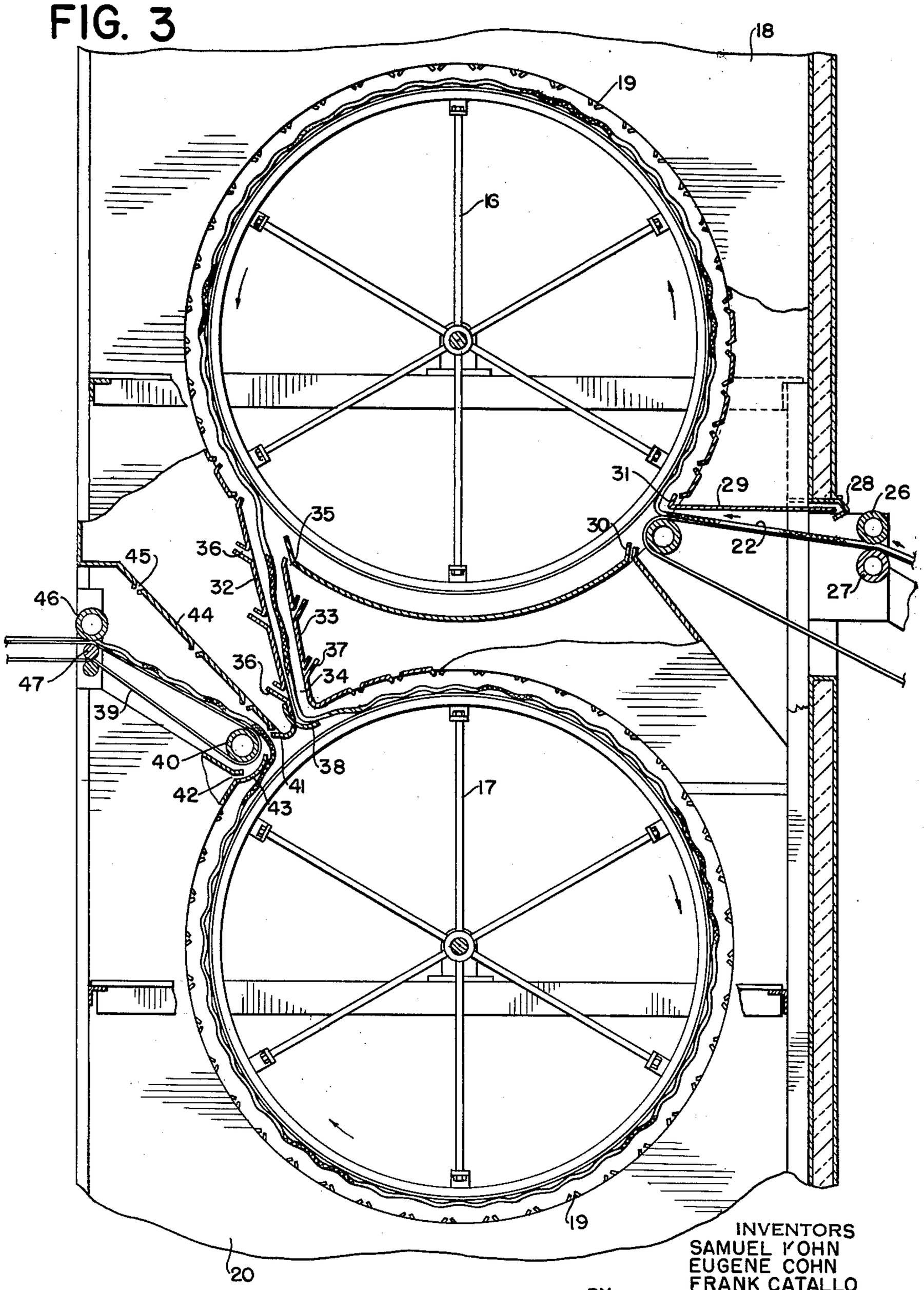
METHOD AND APPARATUS FOR TREATING WEB MATERIALS

Filed Nov. 14, 1958 4 Sheets-Sheet 3

FIG. 3



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Filed Nov. 14, 1958 4 Sheets-Sheet 4

FIG. 4

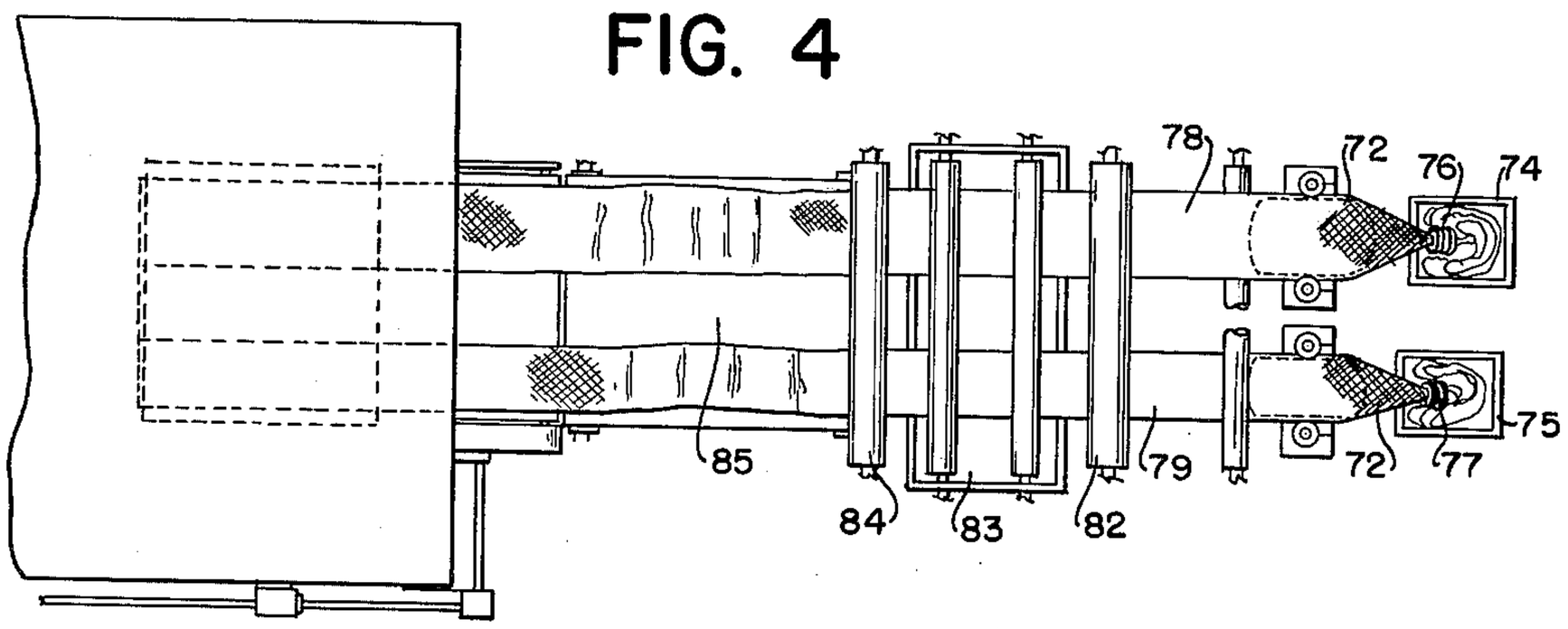


FIG. 5

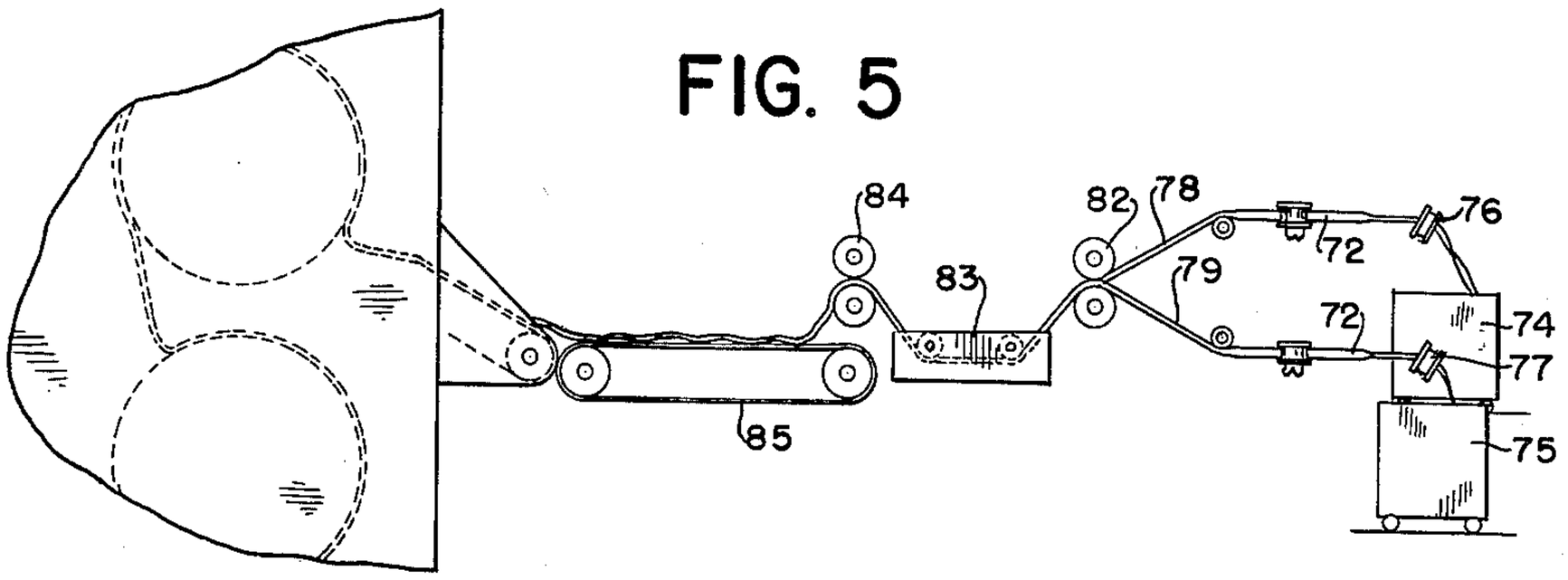
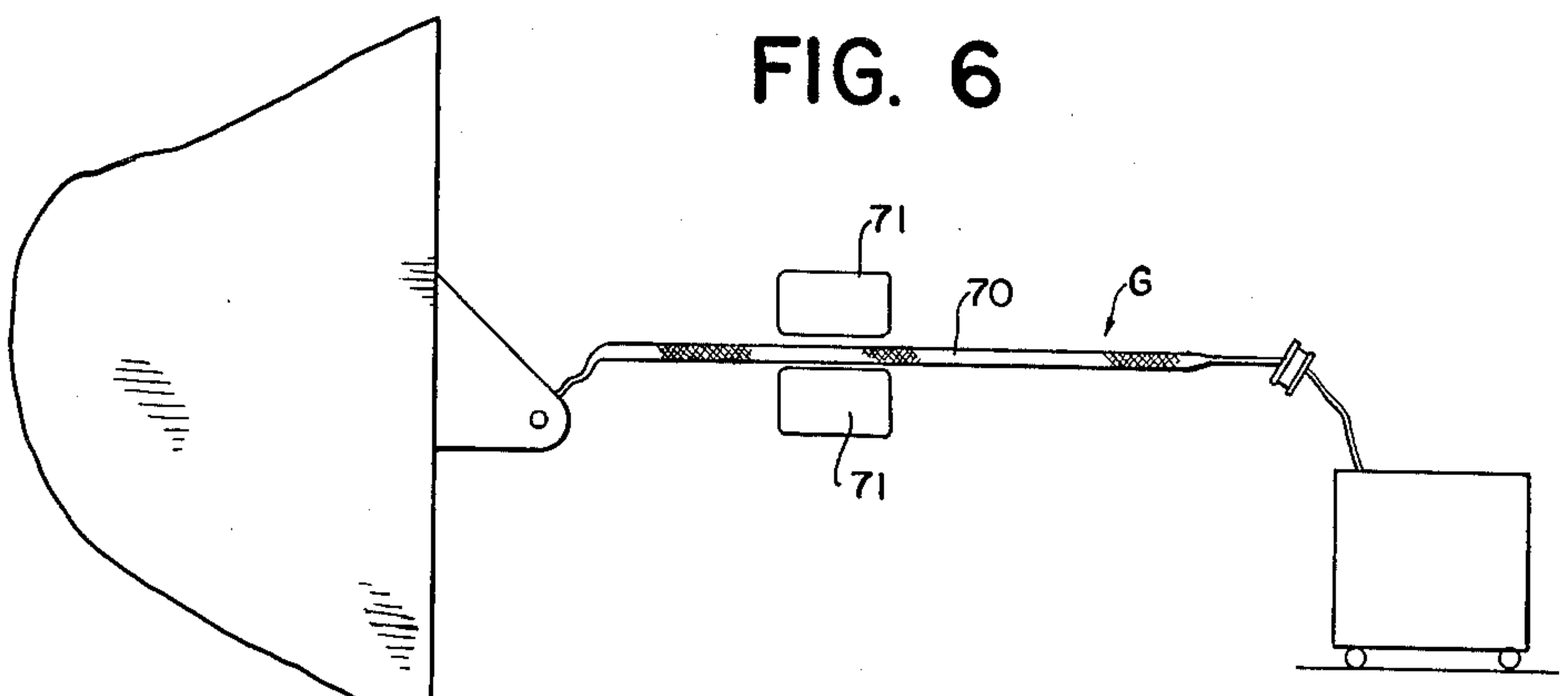


FIG. 6



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United States Patent Office

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3,102,006
METHOD AND APPARATUS FOR TREATING WEB MATERIALS

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Filed Nov. 14, 1953, Ser. No. 773,864
4 Claims. (Cl. 34—23)

The present invention relates to the treatment of web materials, such as tubular knit fabrics, and is concerned more specifically with novel and improved arrangements for drying and treating such materials.

In connection with the processing of web materials and particularly tubular knit fabrics, it is frequently necessary or desirable to treat the fabric by passing it through a drier, wherein the fabric is exposed to a medium such as heated air, so that moisture is removed from the fibers or elements of the material. Advantageous arrangements for drying knit fabric, for example, include a plurality of reels about which the material is passed and means for flowing heated air through and about the material as it traverses the reels. In addition, suitable means are provided for delivering the material to the reels and for removing the material therefrom. An improved form of such apparatus is described and claimed in the co-pending application of Samuel Cohn et al., Ser. No. 673,474, filed July 22, 1957, owned by the assignee of the present invention and application.

During the drying of certain web materials, and particularly knit fabrics, considerable shrinkage may occur lengthwise of the web. Accordingly, where fabric is carried by a plurality of moving surfaces, such as rotating reels, it has been thought necessary, in many instances, to provide relatively complicated arrangements for regulating the relative speeds of the moving surfaces, as well as the speed of the fabric removing means, in relation to the speed at which the fabric is delivered to the treating zone.

In accordance with one aspect of the present invention, web material is delivered to a drying and treating zone at a predetermined speed and is caused to travel over rotating reels in the zone while being maintained in a relaxed condition substantially completely free of external tensions. While in the zone, and supported by the reels, the relaxed material is acted upon by more or less discrete streams of air which pass through and about the material to remove moisture therefrom. The streams of air are directed toward the material in such a way that the material is acted upon intermittently and is agitated or caused to flutter in a manner such that highly efficient drying of the material is realized, while at the same time the material is conditioned and treated by reason of the substantial agitation thereof.

Advantageously, a plurality of rotating reels are provided in the treating zone. These reels are rotated so that their surfaces are caused to move at a predetermined speed, which is somewhat slower than the speed at which the material is delivered thereto, enabling the material moving over the surfaces to be completely relaxed lengthwise and accommodating substantial shrinkage of the material. Streams of air, moving at relatively high velocity, are directed toward the rotating reels at spaced intervals, as the fabric moves over the reel surfaces, to effect a desirable agitation or fluttering of the material.

An important, advantageous feature of the invention resides in the provision of transfer means for causing the material to move throughout at least a portion of its path through the drying and treating zone and from one rotating reel to another by the action on the material of streams of air. Thus, the material is not transferred directly from the delivering means to the drier reels, but

is passed through a transition zone, in which the material is agitated and urged along its path by appropriately directed air streams. Likewise, the material is advantageously transferred from one reel to another within the treating zone and from the last of such moving surfaces to a removing carrier or conveyor by the action on said material of properly directed streams of air. As the material is transferred, within the treating zone, from one surface or reel to another, the material is rearranged, assuring that all portions of the material are properly exposed during the traverse of the treating zone. One of the advantages of the feature just described is that material may be threaded through a rather complex treating path and around drier reels in an entirely automatic manner, so that short pieces of material, such as individual garments, for example, may be delivered individually to the treating zone and will pass therethrough without difficulty. Moreover, separate pieces or webs may be passed through the treating zone side by side without difficulty, notwithstanding that the different pieces may be subject to different amounts of shrinkage.

Another aspect of the invention resides in the provision of an improved method and means for treating tubular knitted material comprising the spreading and steaming of the material to shorten the fabric and set its width, followed by the drying of the material, in a completely relaxed and tension-free state, in the manner described. The combination treatment results in a superior conditioning of the material, provides a finished material having a practical minimum of residual shrinkage, and permits of accurate presetting of the fabric width at the spreader, since little, if any, change in width takes place in the treating zone of the drier. The invention also contemplates the advantageous combination treatment of knit materials, which includes the steps of spreading the material, impregnating it with a resin, and drying and curing the material in the manner before described to provide a superior finished material having substantial dimensional stability.

In connection with any of the various treatments contemplated it is frequently advantageous to treat simultaneously two or more parallel strings of material. In accordance with the invention, this may be accomplished effectively by the overfeeding of material from prior treating stations onto the rotating reels of the drier and accommodating shrinkage from the excess material so fed. Parallel strings of material having different shrinkage characteristics may even be fed at the same rate of speed and passed over the same drier reels, although it may be desirable in some cases to provide for feeding of separate strings at different speeds.

For a better understanding of the above and other advantageous features of the invention, reference should be made to the accompanying drawings, in which:

FIG. 1 is an elevational view, in cross section, of a web treating apparatus incorporating features of the invention;

FIG. 2 is a cross-sectional view taken generally along line 2—2 of FIG. 1;

FIG. 3 is an enlarged, fragmentary, cross-sectional view taken generally along line 3—3 of FIG. 2;

FIGS. 4 and 5 are simplified, schematic representations of a combination treating system, including means for impregnating and drying a plurality of parallel strings of material, which may have different characteristics; and

FIG. 6 is a simplified, schematic representation of a typical treating system according to the invention, incorporating means for spreading and steaming the material and then drying it.

Drying and treating according to the invention is accomplished by delivering web material, such as a fabric A,

either as one or more parallel webs or as a plurality of separate pieces, such as garments, onto a conveyor B, which carries the material into a treating zone. In the zone, the material is picked up by streams of air and by that means transferred to a rotating reel C. As the material moves around the reel C, it is subjected to the action of discrete, high velocity air streams, which flutter the material and remove moisture therefrom. The material is then picked up again by air streams, fluttered and rearranged, and transferred to a subsequent rotating reel D, where the opposite side of the fabric is subjected to the action of discrete, high velocity air streams. After travelling around the last reel, the material is again picked up by air streams and transferred to a conveyor E, for conveyance through a cooling zone F and to a folder, for example.

In accordance with one aspect of the invention, the material is overfed onto the first reel C, and the entire drying operation is characterized by a complete lack of tension on the material. Advantageous treatment of the material is realized by the fluttering of the material on the reels and the transfer of material onto, between and from the reels by air streams, which permits rearrangement and readjustment of the material to accommodate any shrinkage.

The invention contemplates that, at least in most cases, treatment in the drier will follow a prior specific treatment which, in combination with the improved drying treatment, results in a superior conditioning of the material. One such prior treatment used particularly in the processing of tubular knit material, comprises spreading and steaming of the material and delivering the thus treated material to the new drier means. Another advantageous prior treatment involves directing wet material successively through a spreader, to set the width of the material, a first pair of rolls, to remove excess moisture, a resin dip, to impregnate the material, and a second pair of rolls, to remove excess resin, after which the material is delivered to the new drying means.

Subject, perhaps, to limitations arising from the nature of the equipment used in the prior treatment, the combined treatment, including the drying, may be carried out simultaneously with a plurality of parallel strings of material, each passing over the same drier reels, substantially regardless of the individual shrinkage characteristics of the individual strings. This is made possible by the fact that the air transfer and fluttering of the material provides for the accommodation of shrinkage independently of the rotational speed or speeds of the drier reels.

The improved drying and treating apparatus of FIGS. 1–3 comprises a housing **10** of generally cubic form including front and back walls **11**, **12**, top wall **13** and side walls **14**, **15**. Mounted within the housing **10** are reels **16**, **17**, which are advantageously of relatively large diameter and may be mounted one above the other. The reels **16**, **17** may be of substantial width, as indicated in FIG. 2 and, in the illustrated arrangement, are provided with outer walls or surfaces (as indicated at **16'**) formed of a mesh material such as expanded metal.

Substantially surrounding the upper reel **16** is a duct or header **18** having a plurality of spaced slots **19** therein disposed in generally parallel relation to the axis of the reel. As described in greater detail in the beforementioned co-pending application of Samuel Cohn et al., the slots **19** may be formed by bending elongated tabs of the header wall toward the center of the reel to define elongated but otherwise restricted outlets or nozzles, through which air, maintained under pressure within the header **18**, may be discharged at relatively high velocity toward the outer surface of the reel. The slots or nozzles **19** are advantageously spaced radially from the reel surface a distance in the order of 1½" and are spaced apart a distance on the order of 2" to 3". As indicated in FIG. 1, the nozzles **19** extend in a series around the

upper portion of the reel **16**, covering an arc in the order of 240°.

A header **20**, generally similar to the header **18**, substantially surrounds the lower reel **17** and is provided with a series of slot-like outlets or nozzles **21** similar to the nozzles **19**. In the illustrated arrangement, the nozzles **21** extend in a series around the reel **17** over an arc in the order of 330°.

As will be described in greater detail, a length of flexible, porous material **22**, such as knit cloth, enters the housing **10** through an inlet opening, generally designated by the numeral **23**. The material entering the housing is directed onto the surface of the upper reel **16**, which is driven to rotate in a counterclockwise direction, and is carried about the reel. The material passes around a substantial portion of the outer surface of the reel **16** and is then directed downwardly onto the surface of the second reel **17**, which is driven to rotate in a clockwise direction. The material then travels around the reel **17**, whereupon it is directed through an exit opening generally indicated by the numeral **24**.

In accordance with one aspect of the present invention, the material **22** is delivered into the housing **10**, which forms a treating zone, by means of a conveyor belt **25**, which takes the material, either in the form of individual pieces of one or more continuous webs, from a supply and carries it to and through a pair of rolls **26**, **27** forming an air seal. The belt **25** then carries the material toward but not onto the surface of the upper reel **16**.

When the apparatus is in operation, substantial quantities of air are blown into the area surrounding the reel **16**, causing some flow of air against the direction of feed of the material **22**. Accordingly, to enable the apparatus to be threaded while the system is under pressure, an outlet nozzle **28** (FIG. 3) is provided in the header **18** in a position to direct a relatively high velocity stream of air along the upper surface of the material **22**, in a relatively narrow space formed between the material and a lower wall **29** of the header. The nozzle **28** is located adjacent the sealing rolls **26**, **27** and is of such size as to provide an air stream of sufficient force to counteract the tendency of air to flow in an opposite direction from the area surrounding the reel. Accordingly, as the material **22** travels along the innermost portions of the feed belt **25** it is urged toward the reel **16** by a relatively high velocity stream of air (e.g., 4000' per minute).

In the illustrated apparatus, the feed belt **25** carries the material **22** to a point adjacent a lower portion of the reel **16**. The outer surface of the reel, at that point, is travelling upwardly, because of the direction of rotation of the reel, and means are accordingly provided for directing the material upward and onto the reel surface. To this end, the apparatus of the invention includes a nozzle **30** formed in an upper portion of the header **20** adjacent the inner end of the feeding conveyor. As shown in FIG. 3, the nozzle **30** is located below the upper reach of the conveyor belt **25** and is oriented to direct a relatively high velocity stream of air in a generally upward direction and obliquely toward the surface of the reel **16**. The stream of air issuing from the nozzle **30** is sufficient to overcome any tendency of air to flow in an opposite direction from the area surrounding the reel and sufficient to urge and direct the material to follow an upward course and move into the annular space between the reel **16** and header **18**.

Cooperating with the nozzle **30** is a nozzle **31** provided in the lower part of the upper header **18** and arranged to direct a relatively high velocity stream of air in a generally upward direction and obliquely toward the surface of the reel. The air stream issuing from the nozzle **31** acts upon the top surface of the material, while the stream issuing from the nozzle **30** acts on the lower surface. Accordingly, the two air streams work in concert to direct the material in the manner desired.

During the traverse of the material around the reel **16**

it is treated, in a manner to be described in more detail, by the action of heated air issuing from the nozzles 19. The heated air passes through and about the material, removing moisture therefrom, and the moisture-laden air passes into the center of the reel and axially out of the annular space between the reel and header substantially in the manner described in the before-mentioned Cohn et al. application.

After the material has traversed a substantial portion of the upper reel 16, it is transferred to the lower reel 17. To this end, the apparatus of the invention incorporates walls 32, 33, forming parts of the headers 18, 20, respectively, defining a channel 34 for guiding and directing the material from one reel to the other. At the upper end of the channel 34 and on the side thereof opposite that from which the material approaches, there is provided a nozzle 35 from which a relatively high velocity stream of air is directed upwardly and obliquely against the surface of the reel 16. The air stream issuing from the nozzle 35 opposes air which would otherwise flow in an opposite direction from the area surrounding the reel, and tends to flow between the material 22 and the surface of the reel to strip the material away from the reel and direct it into the channel 34.

Material directed into the channel 34 is acted upon by a series of nozzles 36, 37 in the walls 32, 33, respectively, which nozzles are directed downwardly and obliquely toward the opposite surfaces of the material. Air issues in relatively high velocity streams from the nozzles 36, 37 and directs and urges the material downwardly toward the lower reel 17.

At the bottom of the channel 34 is a curved deflector plate 38 which deflects air flowing downward through the channel 34, causing it to flow generally tangentially of the reel 17, in the direction of rotation of the reel, into the annular space between the reel and the surrounding header 20. The material 22 is thus directed by the exit air flow from the channel 34 into the annular space surrounding the reel 17 and onto the surface of the reel, the material then having its opposite side exposed and also being shifted and rearranged to assure uniformity of moisture removal. The material then traverses clockwise around the reel, during which time it is acted upon by streams of air issuing from the nozzles 21 in the manner before described.

After the material traverses the lower reel 17 it is removed therefrom and directed onto a conveyor belt 39, which passes about a roll 40 mounted adjacent the reel. To direct the material onto the belt 39 there is provided a nozzle 41 which issues a relatively high velocity stream of air in a generally horizontal direction and obliquely toward the surface of the belt 39. The stream of air thus issued tends to strip the material away from the reel and direct it onto the belt. A second nozzle 42 directs a relatively high velocity stream of air against a deflector plate 43, causing air to flow in a generally upward direction around the conveyor roll 40, to urge the material in an upward direction toward an inclined wall 44 forming part of the upper header 18. The wall 44 is, in turn, provided with a plurality of nozzles 45 arranged to direct streams of air toward the upper reach of the conveyor belt 39, so that the material is urged against the belt to be carried away thereby. The belt 39 carries the material between a pair of sealing rolls 46, 47 and into a cooling chamber 48.

In the illustrated apparatus, the cooling chamber 48 is formed in the rear part of the housing 10 and comprises a pair of headers 49, 50 disposed above and below the conveyor belt 39 and provided with nozzles 51 arranged to direct streams of cool air upon the material travelling through the zone. The cooling air may be drawn in through a duct 52 and directed by a suitable fan into the headers 49, 50.

As shown in FIG. 1, blowers 53, 54, for supplying air to the headers 18, 20, are mounted in the housing 10, above and below the cooling chamber 48, and are arranged to be driven by suitable motors 55, 56 mounted exteriorly of the housing. The blowers receive intake air from chambers 57, 58 located at opposite sides of the housing, and air is supplied to those chambers from large chambers 59, 60 at opposite ends of the reels 16, 17. Suitable heaters 62, 63 separate chambers 59, 57 and 60, 58, so that air is supplied to the blowers at the desired temperature. A small percentage of the air is continuously exhausted from the chambers 59, 60, through duct means 64, to remove moisture from the system and make-up air is supplied, at least in part, through ducts 65 discharging over the bearings of the blowers 53, 54, all as described in greater detail in the before-mentioned co-pending application.

Convenient access is provided to the heaters 62, 63 for cleaning lint, etc., therefrom, by means such as doors 59', 60'.

In accordance with one of the important aspects of the invention, the material within the treating zone (i.e., between the conveyors 25, 39) is maintained in a substantially completely relaxed condition, free of lengthwise and widthwise tensions. To this end the reels 16, 17 are rotated at such a speed, in relation to the speed at which material is fed by the conveyor 25, as to provide for overfeeding of the material onto the reels, even taking into account shrinkage of the material during treating. Likewise, the speed of the exit conveyor is set to operate at a speed sufficiently lower than the speed at which material is fed to accommodate shrinkage in the material and to avoid the application of any lengthwise tension. In this respect, in the apparatus of the invention, the feed conveyor, reels 16, 17 and removing conveyor may be connected in a simple, direct drive relation, each operating at an appropriate speed with respect to the other. This is a notable contrast to prior arrangements wherein the speeds of the various elements are controlled separately by dancer assemblies operating in response to tension in the material. The material leaving the exit conveyor 39 passes around a dancer roll 66, which controls the speed of subsequent processing equipment, such as a folder (not shown). If the loop 68 of material passing around the dancer 66 tends to shorten, the speed of the folder is decreased slightly, and vice versa.

Advantageously the overfed and completely relaxed material travelling through the treating zone is acted upon by discrete, relatively high velocity (e.g., 4000' per minute) streams of air, which cause the material to be agitated or fluttered. Such fluttering action has substantial advantages, in that the material is constantly shifting its positions on the supporting reels to promote greater uniformity of drying, greater drying efficiency is realized through freer circulation of the heated air, and certain stresses in the material are relieved in a uniform and highly effective manner. The latter is particularly important in connection with the treatment of knit materials.

The fluttering action described in the foregoing paragraph may be enhanced, in some instances, by the use of reels having substantially imperforate outer surfaces, and the use of such reels may promote the transfer of heat to the material in a desired manner. However, in an apparatus constructed in accordance with the illustrations of FIGS. 1–3, reels having open mesh material for their outer walls were found to be desirable.

One of the outstanding advantages of the new drying apparatus resides in the fact that the apparatus is entirely self-threading, by reason of the provision of strategically located air nozzles for guiding the material along the desired path. Accordingly, material may be fed into the apparatus in short pieces, such as individual garments, by merely delivering the pieces to the feeding conveyor 25. The apparatus of the invention is thus ideally suited for use in commercial laundries, for example, as well as for use in connection with the treatment of substantial

lengths of web material. Another important advantage of the improved arrangement is that separate webs or strings of material may be fed into the apparatus in side-by-side relation in an advantageous manner. Although this has been accomplished in the past, by maintaining controlled tension on separate strings passing over the same reels, the improved arrangement affords more satisfactory results. However, with the improved apparatus the material is maintained completely relaxed and the rotational speed of the reels does not directly effect the condition of the material, at least in respect of its lengthwise tension.

In accordance with another aspect of the invention, material may be subjected to a combined treatment, to condition the material and stabilize it dimensionally. One such combination treatment is illustrated in FIG. 6, wherein tubular knitted material, in single or multiple strings, is spread and steamed before being delivered to the new drier. The spreading and steaming apparatus, illustrated generally at G, may be of any suitable design, such apparatus being well known in the art. In the arrangement illustrated in FIG. 6, the fabric is pulled or otherwise cause to pass over a spreading frame **70**, which distends the fabric widthwise, substantially to the desired finished width. The fabric is then steamed while in spread condition, as by steamers **71**, to impart thereto substantial dimensional stability, at least in respect of the width dimension. The fabric treated and stabilized in this manner is then delivered to the drier, generally indicated at **72** in FIG. 6, where it is dried and further treated as before described. The finished product is found to have superior dimensional stability as well as other desirable characteristics.

Another advantageous combination treatment is illustrated generally in FIGS. 4 and 5, wherein the fabric is first spread, immersed while in a moistened condition in a stabilizing resin, and then dried and treated as previously described. The entire treatment may be carried out to advantage with parallel strings of material running side by side, although single strings may be processed where desirable or expedient. In some cases, resin impregnated fabric is dried and aired in distinct steps or operations. Advantageously, the capacity of the drier is such that drying and airing occur in sequence in a single pass. However, it is necessary or desirable, in some instances, to pass the material through a second "drier" to effect curing, or to pass the material a second time through a single "drier," which functions the first time to dry and the second time to cure the fabric.

The apparatus of FIGS. 4 and 5 advantageously includes spreading and impregnating equipment of the type described and claimed in the S. Cohn et al. Patents Nos. 2,637,991 and 2,826,167, owned by the assignee of the instant invention and application. The apparatus includes side-by-side spreader mechanisms **72**, **73**, arranged to receive wet material from supply boxes **74**, **75**, the material being drawn through poteyes **76**, **77**. The material is carried over the spreaders at two levels, as shown in FIG. 5, and the separate strings **78**, **79** of material are passed, respectively, over and under rollers **80**, **81**. The strings are next brought into the same plane and passed successively through squeeze rolls **82**, to remove excess water, solution tank **83**, for resin impregnation, and squeeze rolls **84**, to remove excess solution and assure good penetration. The strings may then be deposited on a conveyor **85** for transport to the drier to be dried and cured. The material is spread substantially to its finished width in the spreaders, and the subsequent steps of impregnating, drying and curing are carried out while retaining the fabric in its set width.

Regardless of the pre-treatment utilized in connection with the improved drying treatment, the material may advantageously be processed in parallel strings, with all strings, regardless of shrinkage and other characteristics, being passed over the same drier reels. Different shrinkage characteristics may be accommodated readily by simply varying the degree of overfeeding. Further, auxiliary control may be afforded, as by varying the amount of spreading of the respective strings, as set forth in the S. Cohn et al. Patent No. 2,637,991, but such auxiliary control may well be unnecessary in the improved system.

This invention is applicable to woven fabrics and other materials as well as knitted fabrics, although we have found it to be of particular value in connection with the latter. It is useful in connection with the treatment of tubular knitted fabrics which often contain large percentages of residual shrinkage. Furthermore, it is of course, applicable to the treatment of fairly short as well as long lengths of fabrics and to products, e.g., garments, made of such fabrics. Hence, where the terms "fabrics," "web material," etc., are employed generally herein, they are intended to refer to short as well as long lengths of fabrics, and pieces manufactured therefrom such as garments, and to refer to various forms of sheet-like material. Also, the terms "drier," "drying," etc., are not intended to be restrictive, as it is contemplated that treatments such as curing may be carried out in the absence of any drying, in appropriate cases.

The specific forms of the invention herein illustrated and described are intended to be representative only, as certain changes may be made therein without departing from the clear teachings of the disclosure. Accordingly, reference should be made to the following appended claimed in determining the full scope of the invention.

We claim:

1. The method of drying and treating flexible web materials, which comprises

(*a*) feeding the material toward a first pressurized treating zone at a first predetermined speed,

(*b*) forcibly advancing the material into the first pressurized zone by directing high velocity air streams, toward the web material and in the direction of its advancement, across the width of the material,

(*c*) mechanically engaging and effectively fully supporting one surface of the thus advanced web material across its width, while mantaining the material within the zone relaxed and free of lengthwise tension, and conveying the material through said first zone at a second predetermined and slower speed along a first predetermined path,

(*d*) directing a large plurality of closely spaced, high velocity discrete air streams toward the other surface only of the web material during the conveying thereof through said first zone, said air streams being directed generally perpendicular to said other surface of the supported web material and emanating from sources close to said first path,

(*e*) said web material being advanced past successive high velocity air streams in said first zone, whereby the material is repetitively, continually and forcibly fluttered and rearranged,

(*f*) forcibly transferring said web material out of said first treating zone and into a second pressurized treating zone by directing high velocity air streams toward said material and in the direction of transfer,

(*g*) engaging and effectively fully supporting the other surface of said web material across its width, while maintaining the material within the zone relaxed and free of lengthwise tension, and conveying the material through said second zone along a second predetermined path,

(*h*) directing a large plurality of closely spaced, high velocity, discrete air streams toward said one surface only of the web material during the conveying thereof through said second zone, said air streams being directed generally perpendicular to said one surface of the supported web material and emanating from sources close to said second predetermined path,

(*i*) said web material being advanced past successive high velocity air streams in said second zone, where-

by the material is repetitively, continually and forcibly fluttered and rearranged, and

(*j*) conveying the dried and treated web material away from said second pressurized treating zone,

(*k*) the pressure within said zones, created by the combined effects of the velocity, spacing, and disposition of said air streams and the size and configuration of said zones, being such relative to ambient as to impart substantial resistance to the entry of the web material into said zones.

2. Apparatus for drying and treating flexible web materials, which comprises

(*a*) a housing,

(*b*) a pair of reels supported within the housing for rotation in opposite directions and having outer supporting surfaces for engaging said web material,

(*c*) main air duct means closely embracing said reels over substantial portions of the surface areas thereof and forming elongated, narrow treating zones,

(*d*) said duct means having nozzle-forming openings therein arranged in closely spaced relation for discharging discrete, high velocity air streams in generally radial inward directions toward said reels,

(*e*) first transfer air duct means forming a passage leading into a first one of said treating zones,

(*f*) second transfer air duct means forming a passage leading from the first treating zone into the second treating zone,

(*g*) said transfer duct means having nozzle-forming openings for directing high velocity streams of air across the width of the material and in the direction of its movement into a treating zone,

(*h*) means for feeding the web material at a first predetermined speed into operative association with said first transfer air duct means,

(*i*) means to rotate said reels in opposite directions and at surface speeds less than said first predetermined speed, and

(*j*) means for supplying air under pressure to said main and transfer air duct means to cause discrete, high velocity air streams to issue from said nozzle-forming openings,

(*k*) the air streams directed into said treating zones from said main air duct means being such, in conjunction with the configuration of said zones, as to cause said zones to be maintained under positive pressure relative to ambient and imparting substantial resistance to the entry of said material into said treating zones, and

(*l*) the air streams issuing from said transfer duct means being so arranged and directed as to effect forcible advancement of the material into said zones and onto said reels while maintaining said web material relaxed and free of lengthwise tensions.

3. The method of drying and treating flexible web materials, which comprises

(*a*) feeding the material toward a pressurized treating zone at a first predetermined speed,

(*b*) forcibly advancing the material into the pressurized zone by directing high velocity air streams, toward the web material and in the direction of its advancement, across the width of the material,

(*c*) mechanically engaging and effectively fully supporting one surface of the thus advanced web material across its width, while maintaining the material within the zone relaxed and free of lengthwise tension, and conveying the material through said zone at a second predetermined and slower speed along a predetermined path,

(*d*) directing a large plurality of closely spaced, high velocity discrete air streams toward the other surface only of the web material during the conveying thereof through said zone, said air streams being directed generally perpendicular to said other surface of the

supported web material and emanating from sources close to said path,

(*e*) said web material being advanced past successive high velocity air streams in said zone, whereby the material is repetitively, continually, and forcibly fluttered and rearranged, and

(*f*) conveying the dried and treated web material away from said pressurized treating zone,

(*g*) the pressure within said zone, created by the combined effects of the velocity, spacing, and disposition of said air streams and the size and configuration of said zone, being such relative to ambient as to impart substantial resistance to the entry of the web material into said zone.

4. Apparatus for drying and treating flexible web materials, which comprises

(*a*) a housing,

(*b*) a reel supported within the housing for rotation and having an outer supporting surface for engaging said web material,

(*c*) main air duct means closely embracing said reel over substantial portions of the surface area thereof and forming an elongated, narrow treating zone,

(*d*) said duct means having nozzle-forming openings therein arranged in closely spaced relation for discharging discrete, high velocity air streams in generally radial inward directions toward said reel,

(*e*) transfer air duct means forming a passage leading into said treating zone,

(*f*) said transfer duct means having nozzle-forming openings for directing high velocity streams of air across the width of the material and in the direction of its movement into the treating zone,

(*g*) means for feeding the web material at a first predetermined speed into operative association with said transfer air duct means,

(*h*) means to rotate said reel at a surface speed less than said first predetermined speed, and

(*i*) means for supplying air under pressure to said main and transfer air duct means to cause discrete, high velocity air streams to issue from said nozzle-forming openings,

(*j*) the air streams directed into said treating zone from said main air duct means being such, in conjunction with the configuration of said zone, as to cause said zone to be maintained under positive pressure relative to ambient and imparting substantial resistance to the entry of said material into said treating zone, and

(*k*) the air streams issuing from said transfer duct means being so arranged and directed as to effect forcible advancement of the material into said zone and onto said reel while maintaining said web material relaxed and free of lengthwise tensions.

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