

**Nov. 2, 1943.**

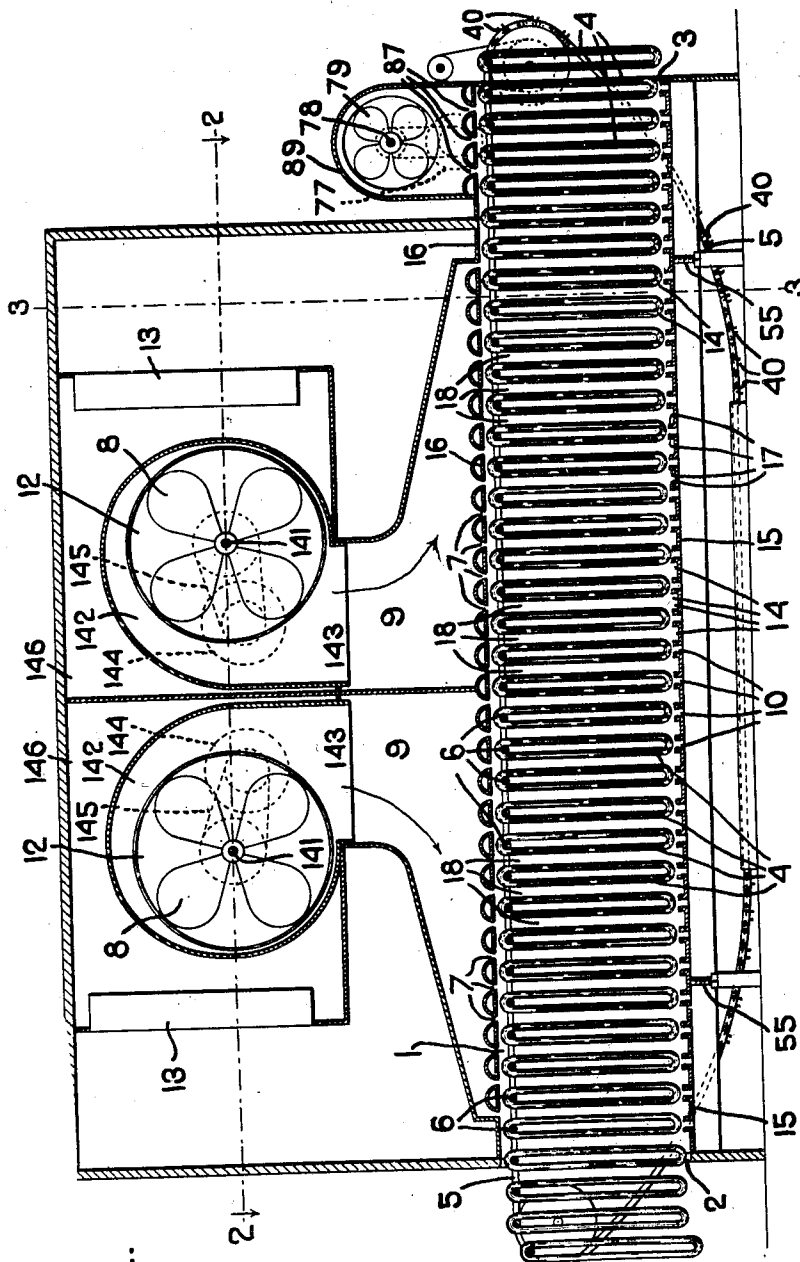
**W. DREISEL**

**2,333,236**

APPARATUS FOR CONTINUOUS DRYING AND CONDITIONING MATERIAL

Filed Dec. 3, 1940

5 Sheets-Sheet 1



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**Nov. 2, 1943.**

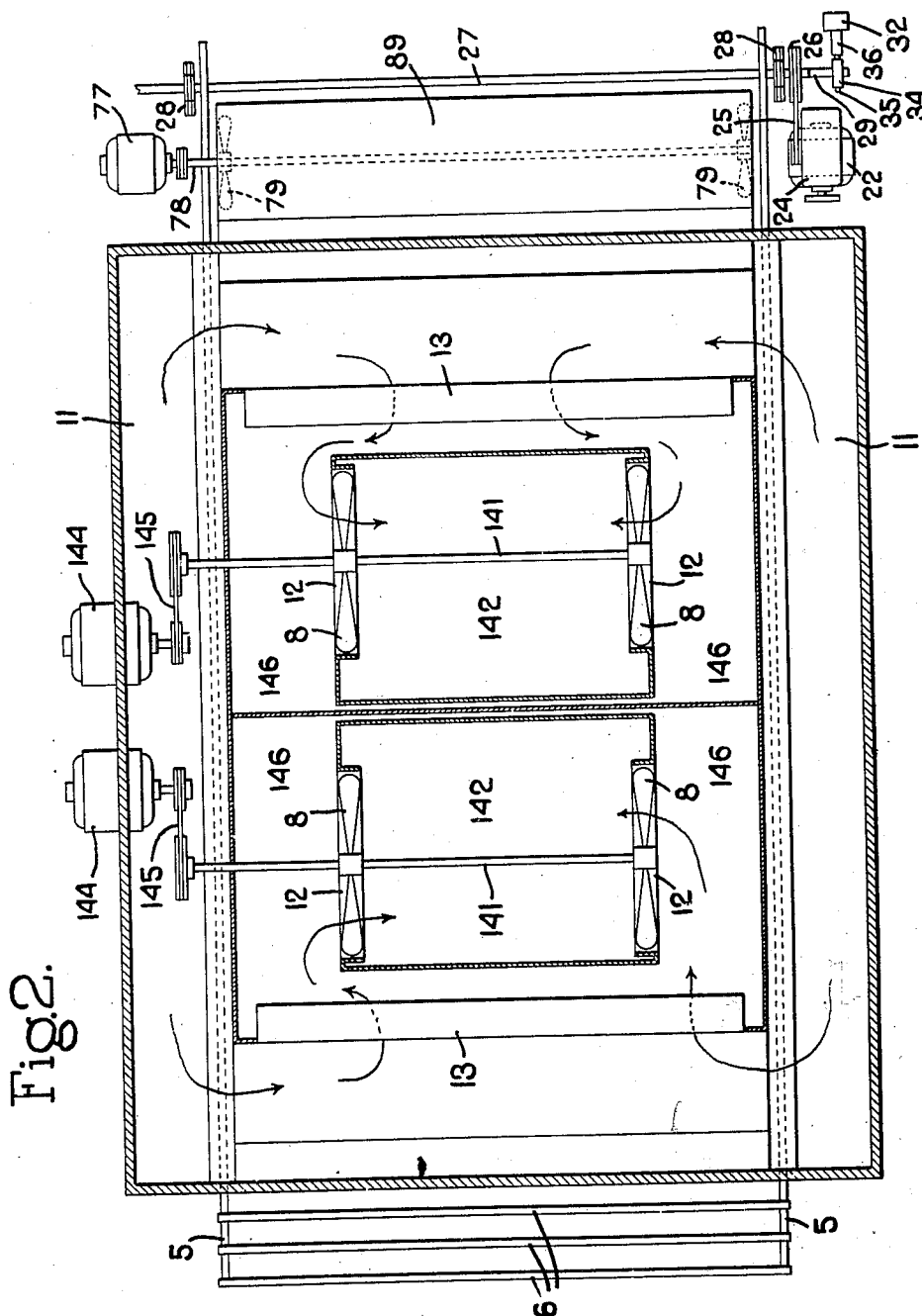
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APPARATUS FOR CONTINUOUS DRYING AND CONDITIONING MATERIAL

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5 Sheets-Sheet 2



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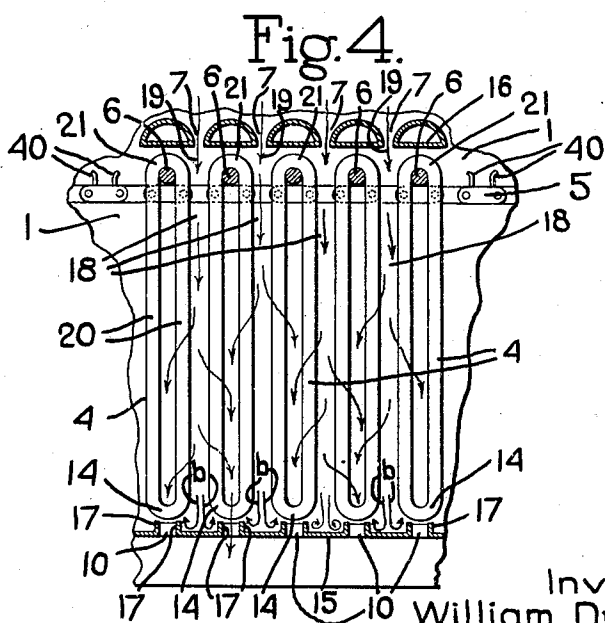
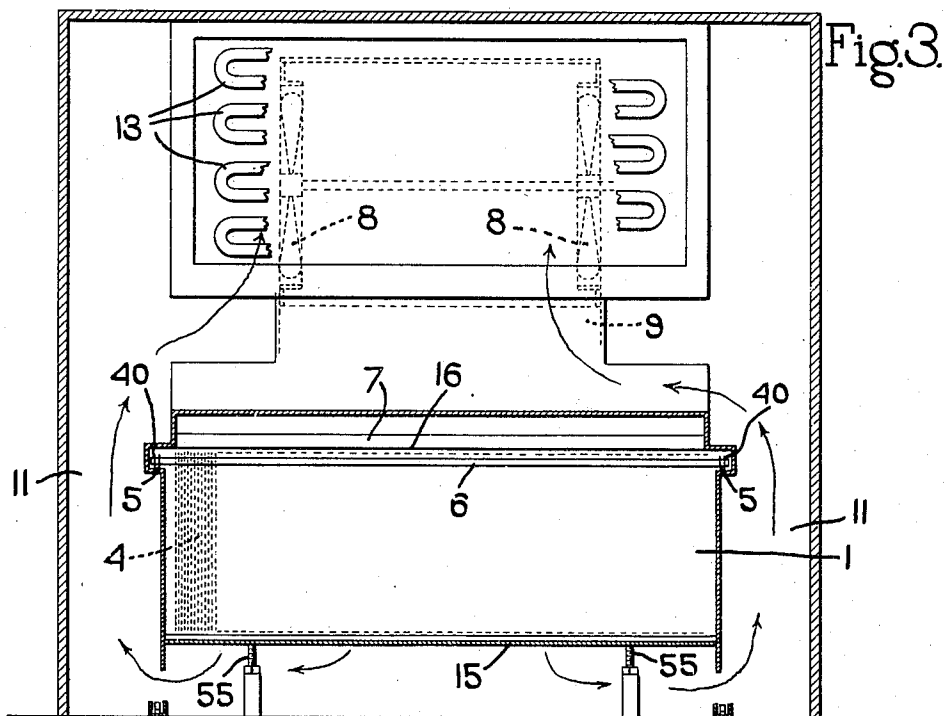
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APPARATUS FOR CONTINUOUS DRYING AND CONDITIONING MATERIAL

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5 Sheets-Sheet 3



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APPARATUS FOR CONTINUOUS DRYING AND CONDITIONING MATERIAL

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5 Sheets-Sheet 4

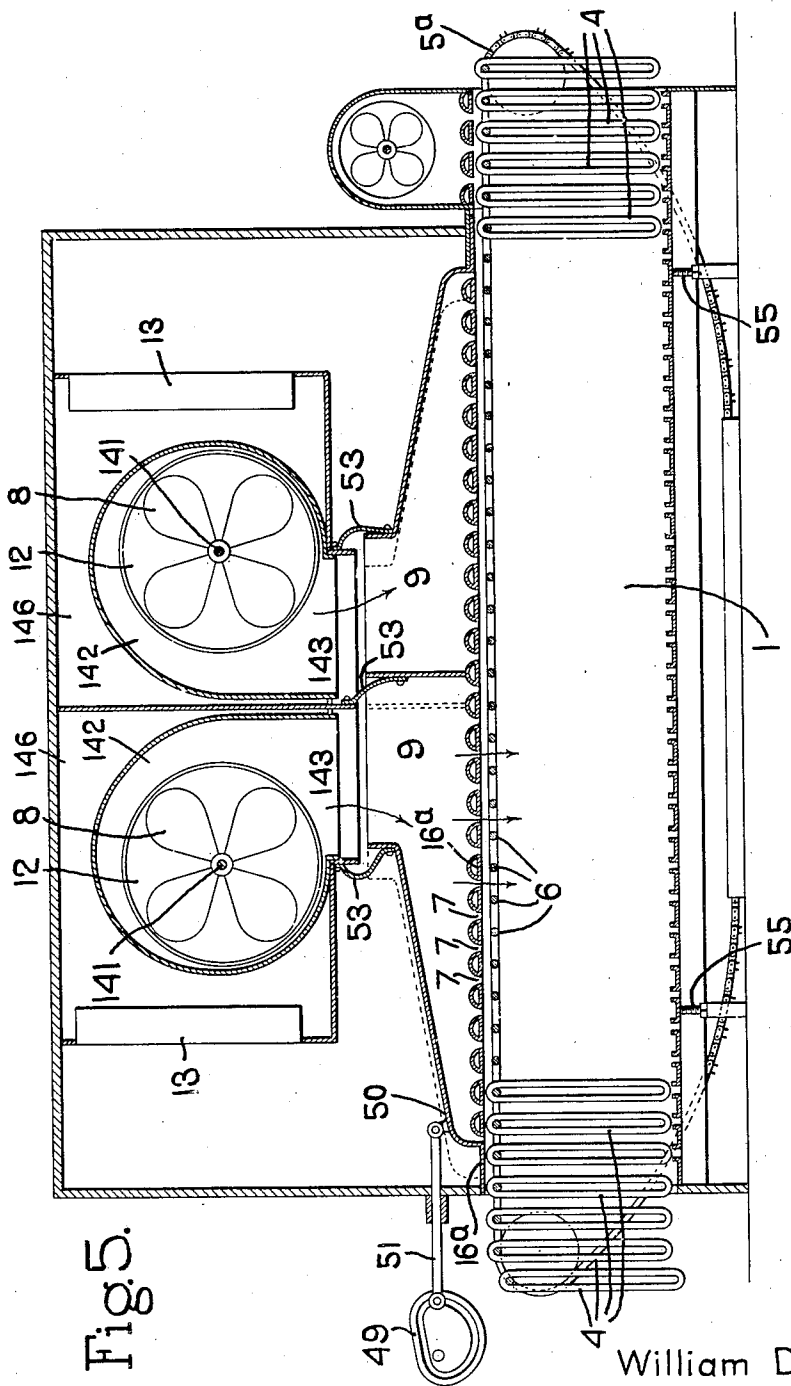


Fig. 5.

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5 Sheets-Sheet 5

Fig. 6.

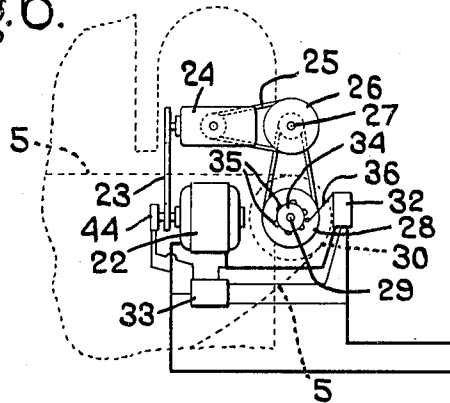


Fig. 7.

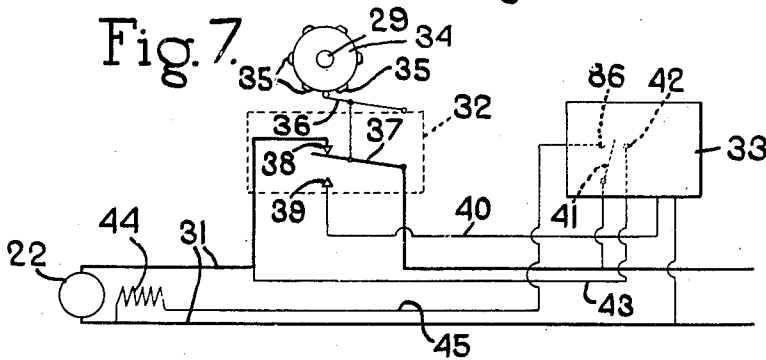


Fig. 8.

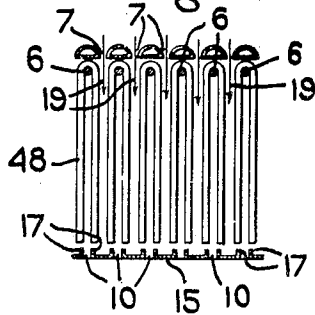
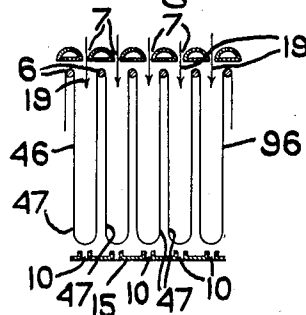


Fig. 9.



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## UNITED STATES PATENT OFFICE

2,333,236

APPARATUS FOR CONTINUOUS DRYING  
AND CONDITIONING MATERIAL

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Application December 3, 1940, Serial No. 368,284

3 Claims. (Cl. 34-155)

This invention relates to an apparatus for conditioning material by subjecting it to the action of a conditioning medium which may operate to remove moisture from the material or dry the latter, or which may operate to impart moisture or some other conditioning medium to the material.

In order to give an understanding of the invention, I have shown it in the accompanying drawings as it might be used in conditioning material by drying the latter, but I wish to make it clear that the invention is equally applicable for treating material to impart to it some conditioning ingredient. Hence, the term "conditioning" as used in the following specification is intended to refer either to conditioning material either by drying it or to conditioning the material by imparting moisture or some other conditioning ingredient thereto.

In some apparatus of this type now in common use, the material to be treated is conveyed at a constant speed through the space in which conditioning takes place by an endless chain device carrying a series of poles or bars or trays on which said material is supported, and the conditioning is accomplished by delivering the conditioning medium into said space from nozzle elements which direct the conditioning medium against the material as it travels forward. In some known conditioning apparatus of this type, the space in which the conditioning takes place is in the form of a chamber through which the conveyor moves, and if such is the case, it is more or less common practice to place the nozzle above the material being conditioned and to provide openings in the lower part of the chamber for the discharge or recirculation of the conditioning medium. With this construction the material supported by the several poles or bars or in the trays may be considered as being supported with separate portions thereof in spaced relation, the portions of the material supported by or depending from the various poles or bars or carried in the various trays, being considered as the separate portions which have the spaced relation. In a device in which the material being treated is supported on poles or bars, the separate portions of such material which have the spaced relation may be said to be disposed in a direction extending away from the nozzle elements.

If the conditioning operation is for the purpose of drying the material which is supported on poles or bars and the material is advanced forwardly at a uniform rate of speed, as is the common

5 practice, the time during which the portion of the material supported by each pole or bar which is nearest the nozzles is subjected to the direct action of the jets of drying medium issuing therefrom as compared with the time during which the jets of drying medium are directed between the individual poles or bars is so great that the upper portions of the material will become dried somewhat faster than the lower portion thereof which is situated furthest from the nozzles, and as the drying operation is continued after the upper portion of the material is completely dried in order to dry the lower portion thereof, the drying medium which is being forced against the already dried upper portion is doing little or no work and is thus operating inefficiently.

10 In order to provide for a more efficient drying or other conditioning operation and one in which the material will be more evenly dried or conditioned, I propose to employ an apparatus for conditioning material in which the material is progressed through the conditioning space in such a way that throughout the major portion of the time that the material is in the drying or conditioning space the poles supporting the material to be treated will be so positioned relative to the nozzle elements that the latter will direct the jets of drying or other conditioning medium into the spaces between the material supported on said adjacent poles while during a small fraction of such time the poles will be so located relative to the nozzles that the jets of drying or other conditioning medium are delivered directly against the upper portion of the material suspended from the poles.

15 As a further means for securing expeditious and even drying or conditioning of the material supported by the poles or bars when the drying or conditioning is done in a chamber, I provide the floor or lower deck of the chamber with a plurality of spaced suction or discharge ports, there preferably being one such discharge port for each nozzle, which discharge ports have the same spacing as the nozzles and are so disposed with relation to the nozzles that during the time that the nozzles are delivering the drying or other conditioning medium into the spaces between the poles or bars, the lower end of the material supported by or suspended from each pole is spanning or in close adjacency to one of the discharge ports, so that in flowing from the nozzles to the discharge ports the drying or other conditioning medium is compelled to flow through the lower portion of the material suspended from each pole. In this way, the drying or condi-

tioning of such lower portion is facilitated and the material supported by each pole will be evenly dried or conditioned from the top to the bottom.

In order to secure the existence of the above condition throughout the greater portion of the time that the material is in the chamber, I propose to provide means to give the conveyor and the nozzles a variable relative motion which is so timed that during such greater portion of the time the conveyor and nozzles will have a minimum relative motion, and during a small fraction of the time they will have the maximum relative motion, and to so arrange the parts that when the nozzles and conveyor have their minimum relative motion, said nozzles will be in a position to deliver the jets of drying or other conditioning medium between the poles or bars and the lower ends of the material which is supported on each pole or bar will span a suction or discharge port, while during the time of maximum relative motion, the poles or bars will be moving past the nozzles.

This variable relative movement between the nozzles and the conveyor may be provided for by using stationary nozzles and giving the conveyor a variable movement, or it may be provided for by giving the conveyor a continuous movement and reciprocating the nozzles in such a way that during the forward movement of the nozzles they will have little or no movement relative to the conveyor, while during the backward movement, there will be a maximum speed of relative movement between the nozzles and the conveyor.

The invention is applicable for drying or otherwise conditioning material, whether the latter be in the form of sheets, or in the form of layers, or in the form of a web, or in the form of strands, and in the illustrated embodiments of the invention, I have chose to show it as it might be used for drying skeins of yarn which are hung on the poles or bars, or as it might be used in drying material in web form in which the web is festooned over the bars or poles, or material in sheet form in which the sheets are supported on the poles or bars. These embodiments, however, are only illustrative of many forms which the invention may take.

In the drawings:

Fig. 1 is a vertical section through a drying apparatus embodying my invention showing said apparatus as used for drying skeins of yarn.

Fig. 2 is a section on the line 2—2, Fig. 1.

Fig. 3 is a section on the line 3—3, Fig. 1.

Fig. 4 is an enlarged fragmentary view illustrating the manner in which the drying medium circulates through the individual skeins to secure the even drying thereof.

Fig. 5 is a view similar to Fig. 1, but showing a different embodiment of the invention.

Fig. 6 is a fragmentary view showing the means for giving the conveyor its variable forward movement.

Fig. 7 is a wiring diagram of the motor controlling device.

Figs. 8 and 9 are fragmentary views showing the way in which the invention may be used for drying material in sheet form or in web form.

In the embodiment of the invention shown in the drawings, the drying space in which the material is dried is in the form of an elongated drying chamber that is indicated at 1 and through which the material to be dried is conveyed, said chamber having the open entering end 2 through which the material enters the drying chamber

and also having the open delivery or exit end 3 through which the dried material is delivered from said chamber. In Figs. 1 to 4, the material to be dried is represented as skeins of yarn 4 which are hung on poles or bars 6 removably mounted on the upper runs of two endless chain elements 5 which are operated to carry the skeins through the drying chamber. Each chain element is provided with pairs of fingers 40, each pair of fingers forming an open slot adapted to receive one end of a pole 6. These bars or poles 6 are separable from the endless chain elements 5, and in the operation of the device, a pole or bar 6 will be loaded with the requisite number of skeins 4 to be dried and then placed on the endless chain elements 5 at the entering end of the drying apparatus. As each pole or bar 6 with its load of dried skeins 4 emerges from the delivery end of the drying chamber, an operator will remove the bar from the endless chain elements and strip the dried skeins therefrom.

The roof or upper deck 16 of the drying chamber is provided with a plurality of nozzle elements 7 spaced from each other and through which streams or jets of drying medium are simultaneously delivered into the drying chamber 1. These nozzles may be conveniently in the form of slots extending transversely of the drying chamber and provided with converging throats, so that the drying medium issuing from each slot or nozzle will be in the form of a thin sheet-like stream.

Any suitable means for forcing the drying medium through the nozzles under the required pressure may be employed without departing from the invention. As herein shown, fans or blowers 8 are employed for circulating the drying medium, two blowers being shown. Each fan or blower serves to deliver drying medium under pressure into a hood or chamber 9 above the roof of the drying chamber and with which the nozzles 7 communicate, whereby the drying medium will issue from the nozzles in the form of sheet-like jets.

The floor or lower deck 15 of the drying chamber is open to provide for the discharge of the drying medium therefrom, and in the preferred form of my invention said floor is provided with transversely extending exhaust ports or suction ports 10 which communicate with passages 11 through which the greater part of the drying medium is delivered back to the intake 12 of the fans or blowers, thus establishing a re-circulation of the drying medium, a small part of the drying medium being discharged into the atmosphere.

It will be understood, of course, that a fan or blower 8 having any suitable construction may be employed for circulating the drying medium. As shown in Fig. 2, each blower comprises two fan elements 8 mounted on the same shaft 141, said fan elements delivering the drying medium inwardly from spaces 146 to a chamber 142, from which it passes to the hood 9 through the discharge passage 143.

Each shaft 141 is operated by a motor 144 which is belted to the shaft through the medium of a driving belt 145.

The spaces 146 communicate with the passages 11, and if it is desired to use a heated drying medium, I will preferably employ heaters 13 which are so arranged that the drying medium flowing from the passages 11 to the chambers 146 will flow through said heaters and thus become heated.

Any other appropriate means may be employed

for heating the drying medium and circulating it through the drying chamber, however, without departing from the invention.

The conveying apparatus is so constructed and positioned that when any skein is directly over one of the suction ports 10, the lower loop 14 of the skein will span such suction port, as shown in Figs. 1 and 4. These suction ports 10, which may be in the form of transversely extending slots in the floor 15, are each preferably provided with upstanding ribs or flanges 17 at each side of the slot which cause more or less turbulence in the drying medium in the vicinity of said ports, as will be more fully hereinafter set forth.

These flanges 17 have such proportions that as the skeins are advanced through the drying chamber, the lower loop portion 14 of each skein will just clear the upper edges of said flanges 17, as clearly seen in Figs. 1 and 4.

There are as many nozzles 7 in the roof or upper deck 13 of the drying chamber as there are suction ports 10 in the floor or lower deck 15 thereof, and these nozzles 7 have the same spacing as the suction ports and are so disposed with reference to them that when the material supported by the various poles 6 is directly over the suction ports, each jet nozzle 7 will be situated between two adjacent poles and thus directly over the space 18 between the skeins or other material which is suspended from two adjacent poles.

The mechanism for moving the conveyor to advance the skeins or other material through the drying chamber is so constructed that during the greater portion of the time in which each skein is in the drying chamber, the nozzles are in positions to deliver the drying medium into the various spaces 18 simultaneously, and the lower loop portions 14 of the skeins are spanning the suction ports 10, as best seen in Fig. 4.

When this condition exists, the jet 19 of drying medium issuing from each nozzle 7 will be directed downwardly into the space 18 between the skeins or other material supported on adjacent poles 6, as shown by the arrows in Fig. 4, and since the suction ports 10 communicate with the intake of the jet or blower, a suction will be created at each intake port with the result that the drying medium which is delivered from the jet 7 will filter through the sides 20 and lower loop portion 14 of the various skeins in its flow from the jet nozzles 7 to the suction ports. This movement of the drying medium is indicated by the arrows in Fig. 4.

The presence of the up-standing flanges 17 on each side of each suction port causes more or less turbulent action of the drying medium as it approaches and just before it enters the suction ports. This is indicated by the arrows b, Fig. 4. Such turbulent action facilitates the drying of the lower portion of the skein or other material, and this is a factor in producing the even drying of the material from the top to the bottom.

One way of providing for delivering the drying medium into the various spaces 18 simultaneously during the greater portion of the time required for the material to be conveyed through the drying chamber is by giving the conveyor an intermittent or step-by-step motion, each forward step being equal to the distance between two adjacent suction ports 10 and two adjacent nozzles 7, and so operating the conveyor that it will be brought to rest after each forward step

in a position in which the nozzles will simultaneously deliver into the various spaces 18, and that the time interval during which the conveyor is at rest between successive forward steps is considerably greater than the time during which the conveyor is in motion.

An embodiment of the invention operating in this way is disclosed in Figs. 1, 6 and 7, and in such embodiment, the conveyor element is brought to rest at the end of each forward step with each pole 6 directly over one of the suction ports 10 and midway between two adjacent nozzles 7, so that the lower portions 14 of the skeins or other material which is hung on any pole 6 will be spanning the corresponding suction port 10 and the nozzles 7 will be delivering drying medium into the spaces 18 between the skeins or other material carried by adjacent poles.

When the period of rest has terminated, the conveyor-moving mechanism moves the conveyor forward one step, thus advancing each skein from one suction port to the next adjacent suction port, and moving the upper loop portion 21 of each skein underneath one of the jet nozzles 7, during which time said upper loop portion 21 receives the full drying effect of the jet of drying medium.

The mechanism for giving the carrier its intermittent motion may be arranged to provide a rest period between successive forward steps of any desired time interval, depending somewhat upon the nature of the material which is being dried.

I will preferably so construct this operating mechanism that the material being dried will be at rest from 75% to 90% of the time required for passing through the drying chamber, but the rest period between any two forward steps may be shortened or lengthened as necessary to secure the even drying of the skeins.

Any suitable means for thus giving the conveyor its intermittent or step-by-step motion may be employed without in any way departing from the invention. As herein shown, the conveyor is driven by a motor 22 which is connected by a sprocket or belt 23 with a speed reducer 24, the latter being connected by a belt 25 with a pulley 26 on a countershaft 27. Said countershaft is belted to a pulley 28 on the shaft 29 carrying the sprocket wheels 30 by which the endless chain elements 5 are driven.

The circuit 31 of the motor has therein a limit switch 32 and a suitable timer 33. The shaft 29 has a cam element 34 thereon provided with cam projections 35. The limit switch 32 and timer 33 may have any usual or known construction, these being devices which are on the market and can be readily purchased, and of themselves form no part of my invention.

Whenever any cam projection 35 engages the arm 36 of the limit switch 32, the motor circuit will be opened and the motor will stop. The actuation of the limit switch starts the timer in operation, and said timer operates in a known way to start the motor again at the end of the prescribed time interval. When the motor has been thus again started, it will run until another cam 35 engages the arm 36 of the limit switch and again stops the motor, and these operations will be repeated, thus giving the conveyor its intermittent or step-by-step motion.

A partial wiring diagram of the limit switch and timer is shown in Fig. 7, and from this it will be observed that when the arm 36 of the

limit switch is actuated by a cam 35, the switch arm 37 thereof is separated from the contact 38 in the motor circuit, thereby stopping the motor, and is closed onto a contact 39 in a circuit connection 40 leading to the timer, thereby setting the timer in operation. When the timer has operated for the predetermined time interval, then it functions to close the switch arm 41, which is connected to one side of the main circuit, onto a contact 42 in the circuit connection 43, thereby starting the motor again, and as soon as the motor has started, the cam projection 35 will move off from the arm 36 of the limit switch to allow the switch arm 37 of the limit switch to close onto the contact 38, thereby maintaining the motor circuit closed until another cam projection 35 engages the arm 36 and thus opens the motor circuit.

In order to bring the conveyor to rest promptly when the motor circuit is open, I may, if desired, employ a suitable magnetic brake 44 on the motor shaft which is connected in a circuit 45 that will be closed by the switch arm 41 engaging the contact 39 when the timer is started. With this device, the conveyor will be brought promptly to rest. The use of the magnetic brake insures that when the motor is stopped, the conveyor will be brought to rest with the poles 6 between the various nozzles 7 and with the material supported by the poles hanging directly over the exhaust ports 10.

The timer may be set to maintain the conveyor at rest during any desired time interval. I have had good results when the timer is set for a period of thirty seconds so that the skeins will remain at rest in the position shown in Fig. 4 for thirty seconds and will then be advanced one step and again brought to rest. The advancing movement may take only two or three seconds, but again the speed of the advancing movement may be varied without in any way departing from the invention.

With the arrangement above described, the time interval during which the upper loop portion 21 of each skein 4 is situated under a nozzle 7 and is thus subjected to the direct action of the jet of drying medium issuing therefrom is only a small fraction of the entire time in which the skein is in the drying chamber, and during the greater portion of such time the skeins are stationary and the jets of the drying medium are being delivered through the roof of the drying chamber into the spaces 18 between adjacent skeins, and said drying medium is being filtered through the skeins as it flows to the suction ports 13. This prevents overdrying of the upper portion of the skein and produces drying conditions under which the suspended skeins will be evenly dried from top to the bottom.

In Figs. 1 and 4, the invention is shown as used for drying skeins of yarn, but as stated above, the invention is equally adaptable for drying other material than skeins. In Fig. 9, I have shown the invention as it might be used for drying material in web form, and when so used the material, indicated at 46, may be festooned over the poles 6 so as to hang in festoons 47, the construction being such that during the rest period between adjacent forward steps of the conveyor, the lower ends of the festoons span the suction ports 10 and the poles 6 are situated between the nozzles 7 so that the jets 19 of drying medium will be directed into the festoons.

In Fig. 8 I have shown the invention as adapted for drying material in sheet form wherein the

various sheets, indicated at 48, are hung over the poles or bars 6.

In Fig. 5 I have illustrated a still different embodiment of the invention, wherein the intermittent relative motion between the material to be dried and the nozzles is secured by moving the material uninterruptedly through the drying chamber at a uniform speed and oscillating the nozzles 7 so that for the greater portion of the time that the material is in the drying chamber the jet nozzles are moving with the material and are, therefore, at rest relative thereto, while during the remainder of the time said nozzles and material have a movement relative to each other.

In the construction shown in Fig. 5, the conveyor chains, indicated at 5a, are moved through the drying chamber 1 at a uniform speed by any suitable mechanism, and the roof or upper deck 16a of the drying chamber having the nozzles 7 therein is adapted to be reciprocated in the direction of the length of the drying chamber, the amplitude of reciprocation being equal to the distance between any two adjacent jet nozzles. The upper deck 16a may be given its reciprocation in any suitable way, as by means of a cam 49 which is connected by a link 51 to the wall 50 of the chamber 9 that is rigid with said upper deck. This cam is designed so as to give a slow forward movement of the upper deck 16a which is synchronous with that of the conveyor and a quick return movement, the forward movement occupying a greater portion of the cycle.

The walls of the chamber 9 which move with the upper deck 16a may have flexible portions 53 connecting them with the fan housing so as to provide for this reciprocating movement.

If desired, I may make the floor or lower deck 15 of the drying chamber so that it can be adjusted vertically to accommodate skeins or loops or sheets of different sizes. This may be provided for by adjusting screws 55 underneath the floor or lower deck.

In the drying apparatus embodying my invention, the material to be dried is arranged with separate portions of such material disposed in a direction extending away from the nozzles through which the drying medium is discharged, and the drying operation is so carried out that as the material is conveyed through the drying space, there is an increase in the time period during which the nozzles discharge the drying medium into the spaces between the separate portions of material and a decrease of the time during which the nozzles discharge the drying medium against the end of such separate portions adjacent said nozzles, and in addition the drying operation is so carried out that during the time the nozzles are discharging the drying medium into the said spaces, the end of each separate portion of material furthest from the nozzle is closely adjacent to and spanning one of the suction ports.

This increase of the time during which the drying medium is delivered between the separate portions of material and a decrease of the time during which said drying medium is delivered against the ends of such separate portions is obtained in one form of the invention by giving the conveyor which conveys the material through the drying space a variable motion relative to the nozzles such that the relative motion between the nozzles and the material will be at a minimum speed during the greater portion of the time the material is moving through the drying space and

will have a maximum relative speed during the lesser portion of such time, and further, so operating the conveyor that during the period of minimum relative speed the nozzles are delivering the drying medium into the spaces between the separated portions of the material.

In a device in which the conveyor is given a step-by-step or intermediate motion, the minimum relative speed between the conveyor and the nozzles is reduced to zero so that the nozzles are at rest relative to the conveyor, but the invention would not be departed from if the conveyor were so operated that during the period of minimum relative speed the nozzles and conveyors were moving slowly relative to each other.

While I have illustrated the invention as embodied in an apparatus in which the separate portions of the material being dried hang vertically and are suspended from poles or bars, yet the invention would not be departed from if the drier were so organized that the separate portions of material which are disposed in a direction away from the nozzles occupied some other position than a vertical position.

While I have described the invention as used in connection with drying material, which operation may be considered as one form of conditioning material, yet the invention is by no means limited to drying material but is equally applicable to treating the material with other mediums than drying medium for the purpose of conditioning said material in some other way than by drying.

79 indicates a cooling fan operating in a housing 99 at the discharge end of the chamber 1. The floor of this cooling chamber is provided with nozzle openings 87 through which cooling air is delivered by the operation of the fan 79, the object of this fan being to cool the material in case heated conditioning medium is used for the conditioning operation. This fan 79 is carried on a fan shaft 78 which is driven from a suitable motor 77.

I claim:

1. A drying apparatus comprising a drying chamber, means extending transversely of the chamber and uniformly spaced longitudinally of the chamber to support the material to be dried in said chamber with separate portions of said material extending from one wall of said chamber toward the opposite wall, a plurality of uniformly spaced nozzle elements to deliver jets of drying medium into the drying chamber from said first-named wall thereof, said nozzle elements having the same uniform spacing longitudinally of the drying chamber as said supporting means, a plurality of spaced discharge ports for the drying medium in the opposite wall of said chamber, said discharge ports having the same uniformly spaced relation longitudinally of the drying chamber as that of the nozzle elements, but having a staggered relation longitudinally of the chamber with respect to said nozzle

elements, means to advance said material through the drying chamber, and means to maintain the material at rest relative to the nozzle elements and the discharge ports with said nozzle elements situated to deliver their jets of drying medium into the spaces between the separate spaced portions of the material and with each spaced portion of material spanning a discharge port during the greater portion of the time in which the material is in the drying chamber.

2. A drying apparatus comprising a drying chamber, a conveyor for conveying the material to be dried through said drying chamber, said conveyor comprising a plurality of bars for supporting the material to be dried, said bars extending transversely of the chamber and uniformly spaced from each other longitudinally of the chamber, a plurality of nozzle elements to deliver jets of drying medium into the drying chamber at the upper portion thereof, said nozzle elements extending transversely of the chamber and having the same uniform spacing longitudinally of the chamber as that of the bars, a plurality of spaced suction ports in the bottom of the chamber extending transversely thereof, said suction ports having the same spacing longitudinally of the chamber as that of the bars and also having a staggered relation longitudinally of the chamber with respect to the nozzle elements, and means operative during the greater part of the time in which the material is in the chamber to maintain said material and the nozzles and suction ports at rest relative to each other and with the nozzles situated to deliver their jets into the spaces between adjacent bars and with each bar positioned directly above one of the discharge ports.

3. A drying apparatus comprising a drying chamber, a conveyor for conveying the material to be dried through said chamber, said conveyor having a plurality of bars from which the material to be dried is suspended, said bars extending transversely of the chamber and spaced from each other longitudinally of the chamber, nozzle elements also extending transversely across the chamber to deliver jets of drying medium into the drying chamber from the upper end thereof, said nozzle elements having the same spacing longitudinally of the chamber as the bars, said drying chamber having spaced transversely extending discharge ports in its floor, which ports have the same spacing longitudinally of the chamber as the bars and nozzle elements, but are staggered longitudinally of the chamber with respect to the nozzle elements, and means to give the conveyor an intermittent or step-by-step feeding movement which brings said conveyor to rest at the end of each step with the nozzles in position to deliver their jets into the spaces between said bars and with the lower edge of the material supported on each bar spanning one of the discharge ports.

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