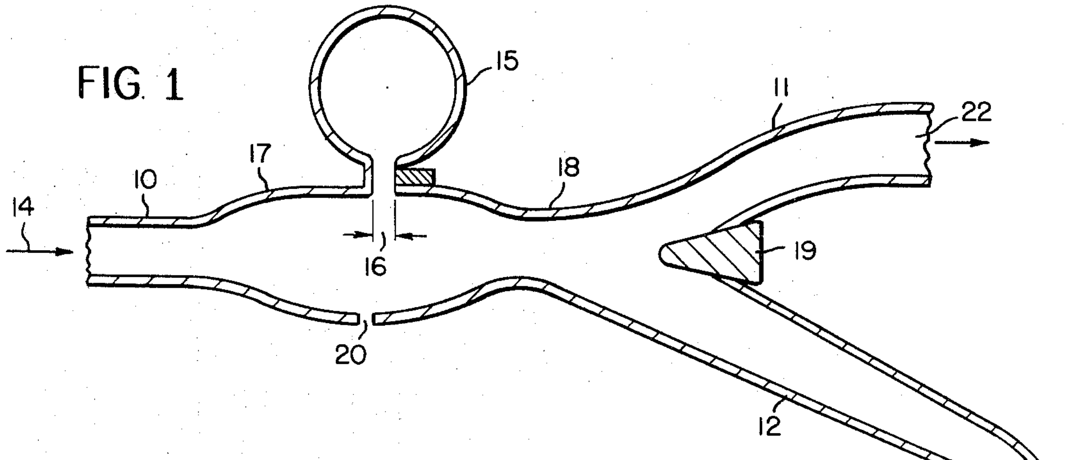
PNEUMATIC FIBER CONVEYING SYSTEM

Filed Feb. 3, 1969 4 Sheets-Sheet 1

FIG. 1



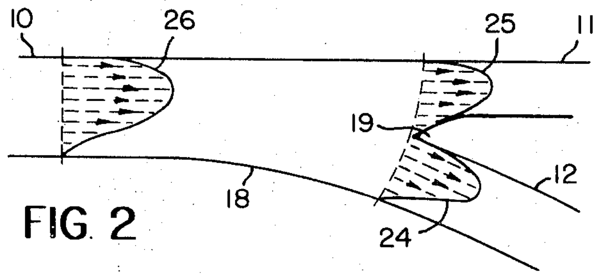


FIG. 2

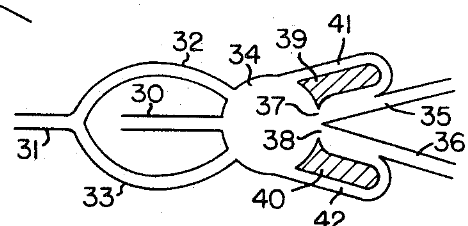


FIG. 3

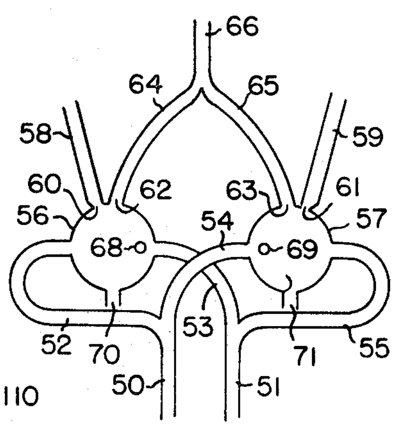


FIG. 4

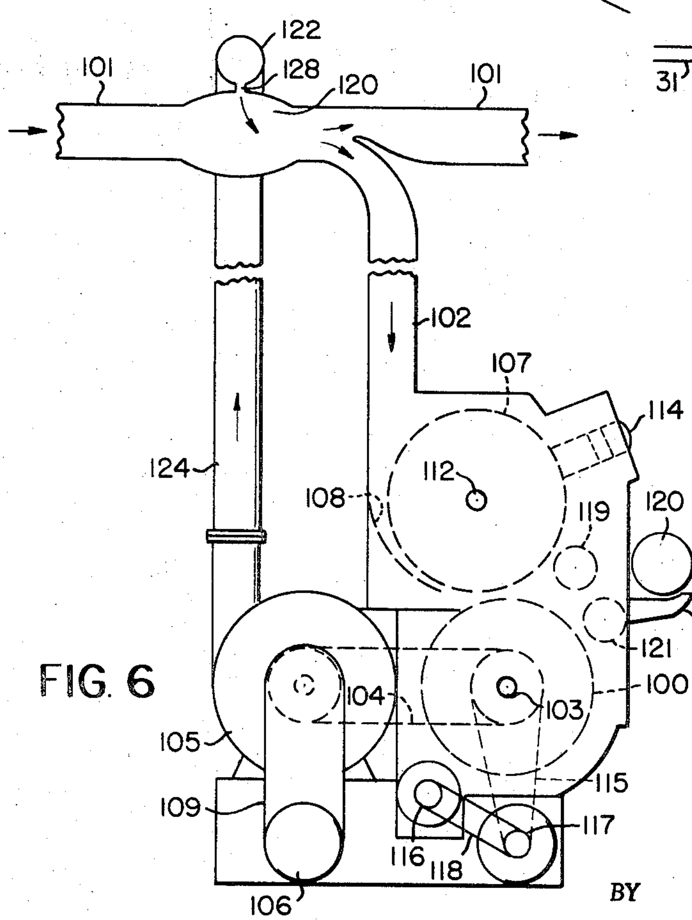


FIG. 6

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PNEUMATIC FIBER CONVEYING SYSTEM

Filed Feb. 3, 1969

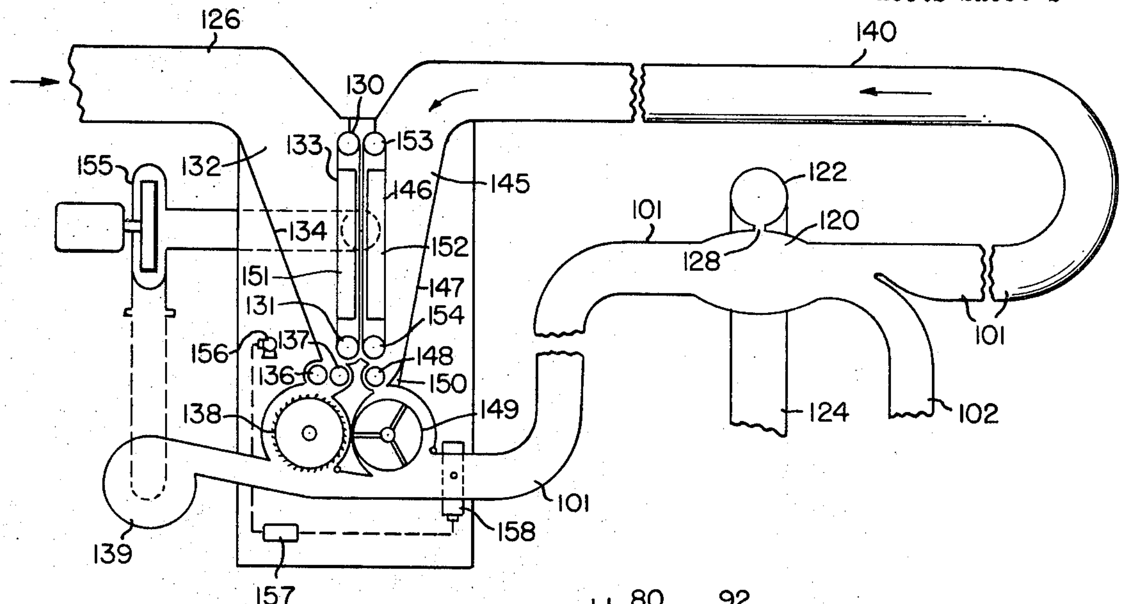

FIG. 7

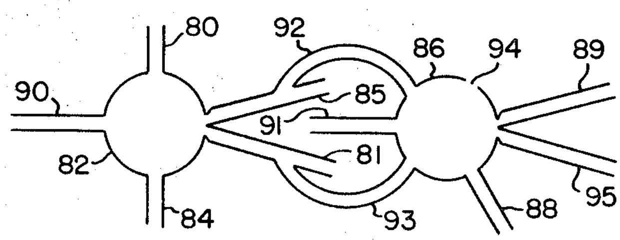

FIG. 5

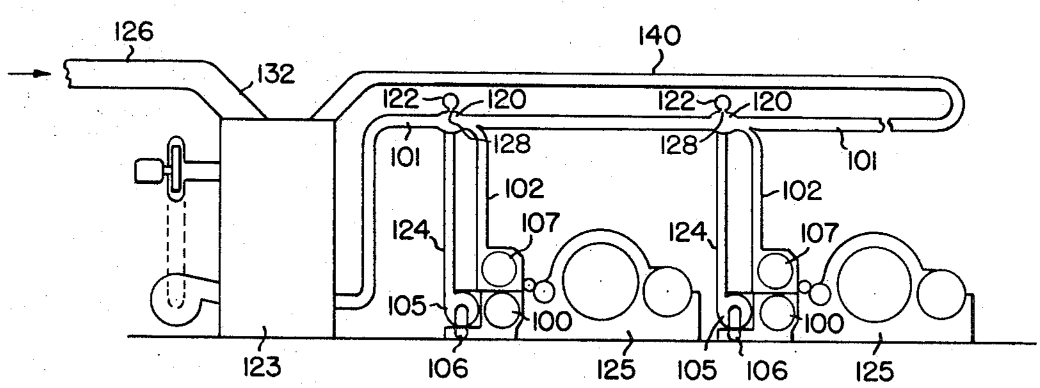

FIG. 8

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PNEUMATIC FIBER CONVEYING SYSTEM

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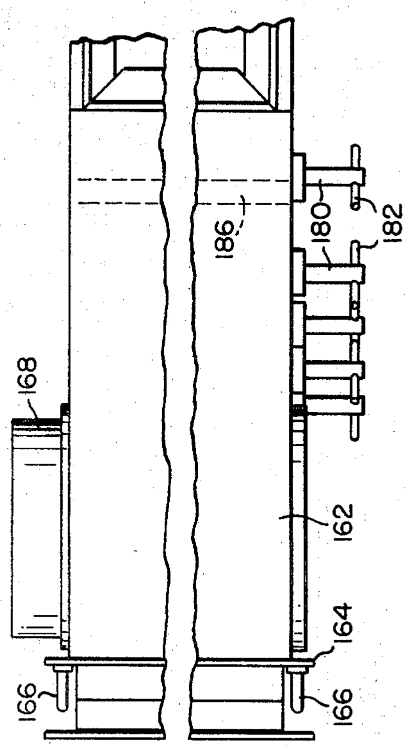

FIG. 10

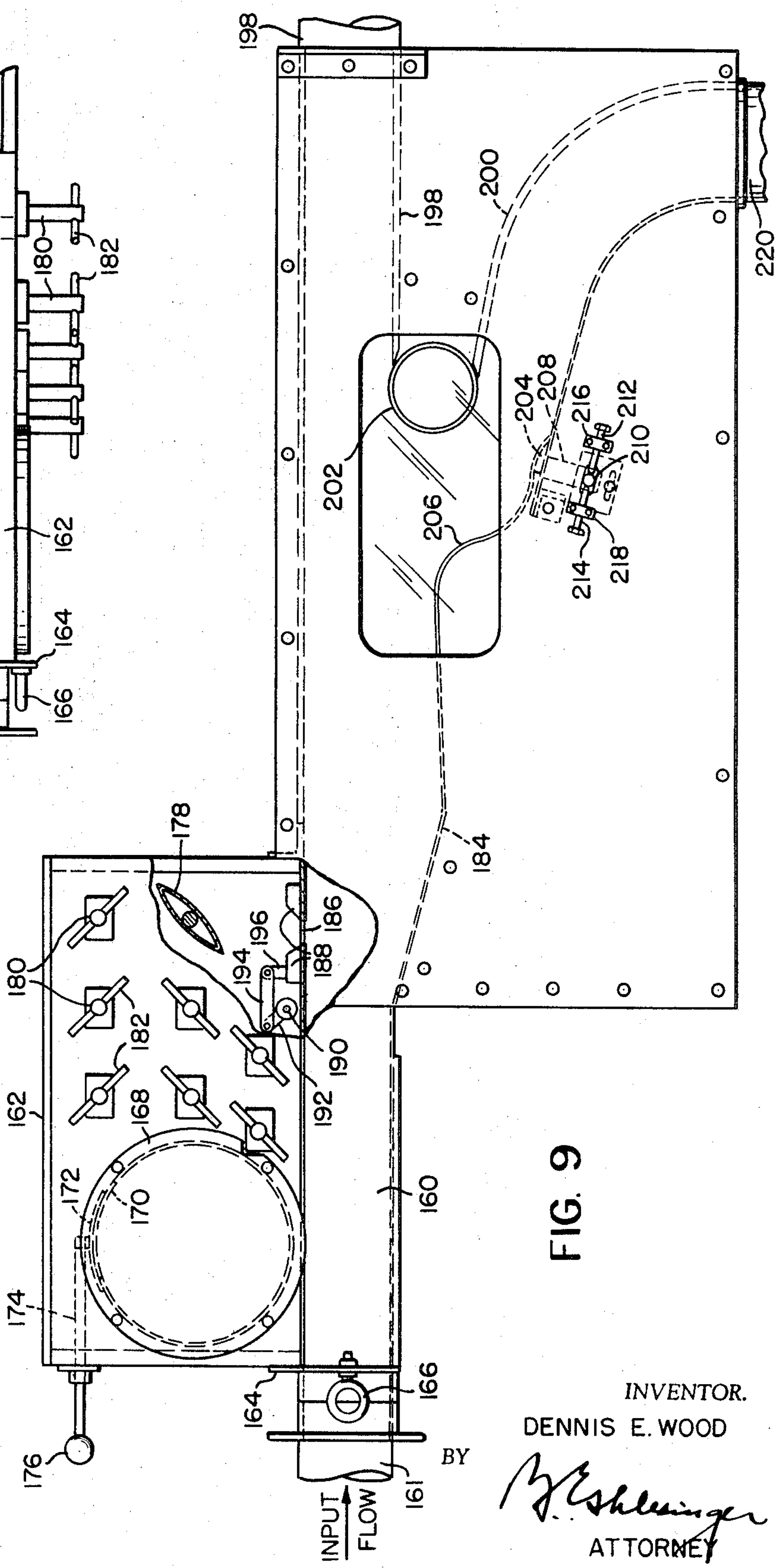

FIG. 9

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PNEUMATIC FIBER CONVEYING SYSTEM

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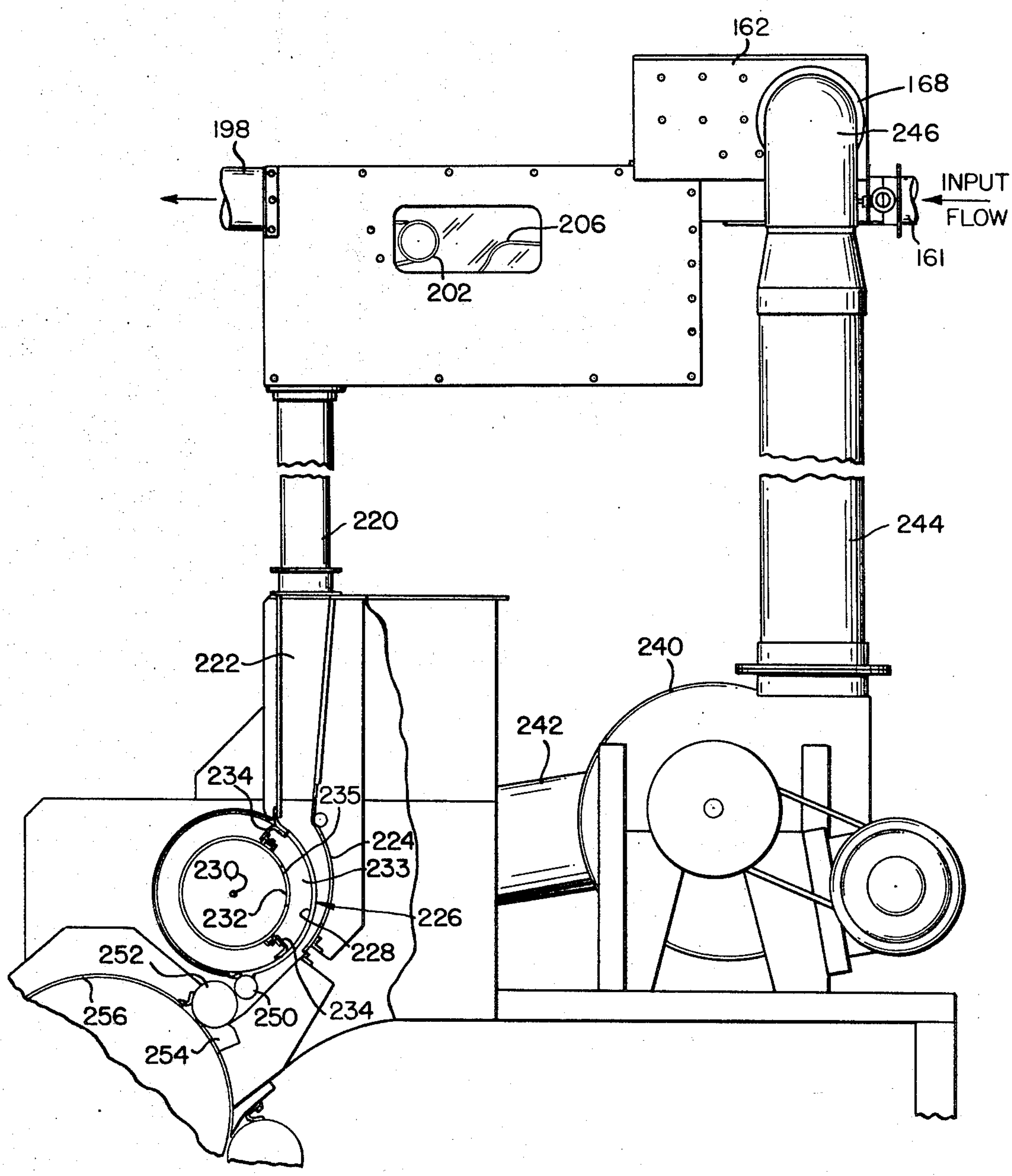

FIG. 11

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3,567,288
PNEUMATIC FIBER CONVEYING SYSTEM

Dennis E. Wood, Penfield, N.Y., assignor to Curlator Corporation, East Rochester, N.Y.

Filed Feb. 3, 1969, Ser. No. 796,070
Int. Cl. B65g 53/04
U.S. Cl. 302—28 16 Claims

ABSTRACT OF THE DISCLOSURE

An air jet is used to divert fibers and air from a trunkline into a branch line to feed the fibers to a card or a machine for forming random fiber webs, etc. The branch line may carry the air and fibers through a trumpet section to a moving foraminous condenser on which the fibers will be deposited while the air is sucked by a fan through the condenser and returned to the trunkline to form the air jet. Thus, the amount of fibers at any one time in the trumpet section will control the supply of fibers to the branch line. The trunkline may be of increased diameter just upstream of a branch line to help control the direction of flow of the fibers.

The present invention relates to apparatus for transferring fibrous material from a pneumatic conveying duct to equipment such as opening, blending, cleaning, carding, and random fiber web forming machines. More particularly, this invention relates to apparatus for transferring fibers from pneumatic conveying ducts, which have a plurality of branches, one for each of a plurality of carding machines or the like, and automatically controlling the amount of transferred material to each branch, and forming said material, at each branch, into mats of fibers which are uniform in depth, width, and length, and of any desired thickness, and feeding the mat from each branch to the corresponding card or web forming machine.

The apparatus used heretofore has employed various means, such as perforated screens disposed adjacent to or in the air stream, flaps, valves, and other mechanical appurtenances, which have been coupled with hoppers, chutes, and the like, for diverting the fiber flow from the pneumatic conveying system. All these have various shortcomings. For instance, flaps, condensers, screens and the like interfere with the flow of fibers, causing flocking, and hang-ups; and the structure of the towers or chutes becomes large and costly. Such apparatus, moreover, requires periodic surveillance of the working conditions, which is inconvenient and expensive.

In the majority of the prior systems there are pneumatic by-pass ducts leading from the main pneumatic duct to each of the machines to be fed. In each duct there is a damper or flap which controls the feed of the fibers from the main duct to the individual machines.

To avoid the disadvantages of the prior systems, a prime object of this invention is to provide an apparatus for delivering fibrous material, which is simple in structure, and can control fiber material flow from the main duct of a pneumatic duct system into each of the branches.

Another object of the invention is to provide an apparatus for continuously delivering fibrous material from a pneumatic conveying system as a uniform lap to web forming machinery.

Another object of the invention is to provide apparatus for not only continuously forming fibrous material into a uniform mat of desired thickness at each of the branches, but for also continuously delivering said mats to web forming machinery.

Other objects of the invention are to provide apparatus of the nature described which has no moving parts, high reliability, long life, low maintenance, high tolerance to environment and temperature changes, does not generate electrical noise, and whose operating characteristics are ideal for hazardous locations.

Another object of the invention is to increase the overall pneumatic line efficiency and supply for a plurality of machines.

Another object of the invention is to provide a fiber feeding and distributing system which will minimize the labor required for conventional transfer systems and also eliminate picker and like machines.

Other objects of the invention will be apparent hereinafter from the specification and from the recital of the appended claims particularly when read in conjunction with the accompanying drawings.

In the drawings:

FIG. 1 is a diagrammatic view illustrating the principle, upon which machines built according to the present invention, operate;

FIG. 2 is a velocity diagram of the transfer operation;

FIG. 3 is a diagrammatic view illustrating a modification of the transfer control apparatus;

FIG. 4 is a diagrammatic view illustrating another modification of the invention;

FIG. 5 is a diagrammatic view illustrating still another embodiment of the invention;

FIG. 6 is a side elevation, partly broken away, illustrating how in one embodiment of the invention, the flow control may be incorporated in the feed to a line of carding engines, random web forming machines, or the like;

FIG. 7 is a fragmentary diagrammatic view illustrating how the fiber and air supply apparatus may be connected with the pneumatic fiber transport system of the present invention;

FIG. 8 is a diagrammatic view illustrating how a pneumatic transport system built according to the present invention may be connected to supply fibers to a line of carding machines;

FIG. 9 is a fragmentary side view illustrating a further, presently preferred modification of the invention and showing the means controlling delivery of air and fibers from a trunkline to a branch line duct that feeds a random fiber web or other machine;

FIG. 10 is a fragmentary plan view of part of the control means shown in FIG. 9; and

FIG. 11 is a view on a somewhat reduced scale, looking at the opposite side of the apparatus of FIG. 9, and illustrating further the connection of the feed mechanism with the condenser of the random fiber web forming machine.

In the system of this invention, the force of fluid in motion is used to transfer fiber from the conveying duct work to the feeding machine, and to control the amount of fiber so delivered.

The fiber control elements consist of a duct with both input and output ports, a branch outlet and a fluid control port for each machine.

Basically the system is based upon the well-known "Boundary Layer Theory of Hydrodynamics." The "boundary layer" occurs between any surface and a fluid which is in contact with that surface and has a velocity relative to that surface. It is well known that by applying boundary layer suction at the periphery of a diverging passage full expansion of the flow can be achieved. Also, if suction be applied to only one side of the passage, the fluid will adhere to that side. A similar effect can be obtained by injecting a jet of fluid into the boundary layer. For instance, if fluid flowing under pressure enters a pipe, which communicates with two branches to form a Y, the fluid will flow along the pipe until the Y branch is encountered; and then the fluid will split allowing a percentage of the original input to be divided between the two arms of the Y. If, however, a control port is provided in the main pipe, and a jet is positioned to act upon the input fluid entering the pipe, the fluid will be forced from the surface of the pipe at the control jet side and become attached to the other side of the pipe, thereby flowing only out of the arm of the Y which is disposed at the same side of the pipe as that along which the fluid is compelled to travel by the jet. Only an impact in the opposite direction to the control jet will force the fluid to flow out the other arm of the Y.

Even after the control jet is shut off, the fluid will continue to flow out of the pipe through the part at the side of the pipe against which the jet forces the fluid; and the fluid can be moved out of this path only by another control jet opposite to the first jet.

If, however, the pipe is enlarged before it reaches the two arms of the Y so that the fluid cannot attach to the one wall, a further effect can be obtained. Here, the fluid normally divides evenly at the junctures of the arms of the Y with the leg thereof, but if a control jet is forced against the supply flow, before the fluid reaches the enlargement, the total flow will be diverted through the outlet port at the same side of the pipe as that against which the jet forces the fluid. However, because the fluid cannot attach itself to the opposite wall, the flow will only continue through the outlet port as long as there is a control jet present. Should the force of the control jet be reduced, then the flow will divide at the juncture of the arms of the Y with the leg thereof, but only in the proportion that the force of the control jet is decreased.

Therefore, the direction and amount of flow in any continuously moving fluid can be controlled by injection of a small amount of fluid into the main stream bound layer. It is not necessary that the control fluid and the main fluid be the same.

FIG. 1 is a diagrammatic view illustrating a typical fiber supply control system comprising a pipe **10** constructed according to the present invention, and having a general Y configuration with two arms **11** and **12**, and a portion **17** of enlarged cross sectional area upstream of the arms **11** and **12**. The input of fibrous material and fluid is at **14**, as denoted by the arrow; and **15** denotes the control air jet. **11** is the extension of the main stream, that is, of the main line trunk duct **10**; and **12** is a branch output duct leading to a machine, to which fibers are to be supplied.

The area of the duct **10–11** is calculated using known conventional methods for pneumatic conveying. However, it should be noted that when a jet is used for controlling fibrous materials, that, if the main supply stream is increased in pressure, this decreases the amount of pressure required to control the supply, and that, also, the control flow necessary to force the supply from one branch to another decreases as a percentage of the main supply flow.

Furthermore, should the area **16** of the control nozzle be increased, this, of course, permits decrease in the control velocity, and vice versa. Also, an increase in the force of the control jet increases the tendency of the main supply flow to oscillate in the interaction region which is forward of the cusp area **18** between enlarged portion **17** and arms **11** and **12**.

A large increase in the angle at which the branches **11** and **12** intersect the main duct **10** will increase the flow and move the stream attachment point downstream further in the branch duct work. Also, any increase in the area of the branch apertures will increase the tendency for counterflow and also decrease the pressure recovery. If a splitter **19** or wedge is provided; and this splitter or wedge is moved away from the cusp area **18**, this has the effect of increasing the counterflow which decreases the output energy and also decreases the pressure recovery of the flow. However, this adjustment also tends to decrease the tendency of the main supply flow to oscillate.

A vent is provided at **20** opposite the control port **16**.

By varying the area of the cusp **18**, the same effect is achieved as a change in area **16** of the nozzle. However, by increasing the cross-sectional area of the cusp, the control flow necessary for changing the direction of the main supply flow must be increased. This also has the adverse effect of decreasing the control flow through the boundary layer.

During operation, when the supply flow impinges on the wedge or splitter **19**, the flow oscillates about the wedge tip. The flow moves back and forth about the vortex. This oscillation occurs at high speed and at high frequency.

When the supply flow is issuing from the main supply output **22**, the main supply oscillates between the tip of the wedge or splitter **19** and the cusp **18**. This action produces a dynamically stable output flow which will continue to flow through the main supply output **22** in the absence of a control jet.

When a control jet signal is applied to the top of the main duct at **15**, the supply flow moves to the lower side of the splitter **19** where it begins to oscillate between the splitter **19** and the cusp **18**. The supply flow is then forced into the outlet branch **12** and will continue to flow through this branch until the control jet diminishes enough to allow the supply flow to return to the outlet **22**.

Switching the supply flow from one output to the other takes places in the high frequency range. Because the supply flow is oscillating it is easily forced from its equilibrium position when a control force is applied.

Investigation of the velocity profile of the output flow suggests the configuration shown in FIG. 2. Because of the cusp, the profile is skewed so that the flow velocity is greatest towards the wedge side of the duct. Thus, the velocity profile **24** for flow through branch duct **12**, when the jet **15** is in operation, is skewed toward the upper side of that duct adjacent the wedge side of the duct. The flow velocity profile in main line **10**, approaching control jet **16** is then as shown at **26**. When the jet **15** is inoperative, however, and the flow is through main duct **11**, the velocity profile is skewed toward the lower side of duct **11**, as indicated at **25**.

In some pneumatic conveying operations in an automated textile mill it is necessary to be able to change the flow of material from the main duct work to two secondary supply lines. This may be carried out by modification of the above method. In this case the control jet does not decrease in velocity or pressure. The fiber control device as shown diagrammatically in FIG. 3 is bi-stable with feedback ducts **41**, **42** between the output ducts **35**, **36** and the interaction chamber **34**. Fiber is continuously supplied, from such equipment as opening and blending machines, to the main input duct **30**, and exits from either output **35** or **36**.

Here the control input port is shown at **31** and supplies two branches **32** and **33** which communicate with the interaction chamber **34**. From the interaction chamber the flow is into the branches **35** and **36** through the cusp points **37** and **38** formed by the partition walls **39** and **40**.

If the flow is issuing from the branch **35**, some of the flow is captured by the feedback duct **41** and returned to the interaction chamber. This feedback is not enough to change the direction of the main flow to the output duct **36** but it does cause a slight kink in the main fiber flow from the duct **30**.

When an air pulse is applied to the control input at **31**, the pulse divides and enters the interaction chamber **34** from two sides. The control pulse combined with the flow from the feedback duct **41** causes the fiber flow to change direction to the output duct **36**. Now feedback through the duct **36** occurs. When the next control pulse is applied, the fiber flow will change direction back to the output **35**.

Each time a pulse is applied to the control input, the output fiber flow switches in the opposite output duct. With such a fiber control device it can be seen that it is possible to change the type of blend or fiber from one set of web forming machines to another without any mechanical equipment or the like in the conveying duct work.

Further modification may be made to the basic control element of FIG. 1. For instance, it is possible to combine the two such elements so that mixing or a limited amount of fiber blending may be carried out in the pneumatic conveying duct work. Further transfer arrangements can be provided, as shown in FIG. 4.

In this figure, there are two control ducts **50**, **51**, each of which has a pair of branches **52** and **54**, **53** and **55**, respectively. One branch of each pair goes to a reaction chamber **56** and the other branch of each pair goes to a reaction chamber **57**. From the reaction chambers, the fiber-fluid flow goes to the branch ducts **58** and **59**, respectively, passing from the reaction chambers through the cusp points **60** and **61**. From the reaction chambers **56** and **57**, also, the fluid flows past the cusp points **62** and **63**, respectively, to the branches **64** and **65** which unite in the main trunk line **66**.

The type of device shown in FIG. 4 only gives an output at **66** when one or other of the two control signals **50**, **51** is present. With no control signal present, the vents **68**, **69** in the interaction chambers **56**, **57**, respectively, cause the main supply flow at **70**, **71**, respectively, to exit through the branch output ducts **58**, **59**. When a signal is applied to the control duct **50**, the control signal divides and flows to both reaction chambers **56**, **57**. In the reaction chamber **56**, the control signal switches the main fiber flow **70** to the output duct **66** where it remains as long as the control signal is present at **50**. The control signal does not affect the fiber flow from reaction chamber **57** because the fiber and air mixture is already issuing from the output duct **59** farthest from the control signal. If the control signals, that is, the air jets, are applied to both control inputs **50** and **51**, the control signals divide and enter the reaction chambers **56**, **57** from both sides of these chambers. Since the fiber control units are monostable, the opposed control signals cancel each other and the supply flow exits through the outputs **58** and **59**. Thus, the supply of fiber from either mainline **70** or mainline **71** is not diverted when both control signals are present.

It is also possible by locating the vent hose at the outside of the interaction chambers **56**, **57** to have the two fiber supply flows through **70** and **71** diverted into the central outlet **66**. This will have the effect of pneumatic blending in the conveying network.

A further system based upon the characteristics described above is obtained by a combination of a bistable and monostable control elements. Both units have a continuous supply of fibrous material which may be of the same type or of different types. Here, if a signal is applied to the prime control input **80** (FIG. 5), it causes the supply of fiber to exit from the outlet **81** of interaction chamber **82**. On the other hand, if the signal is applied to the control input **84**, the supply flow issues from the outlet duct **85** of interaction chamber **82**. **90** and **91** are ducts which supply fiber to the interaction chambers **82** and **86**, respectively. **92** and **93** are branch ducts connecting duct **85** with interaction chamber **86** and duct **81** with interaction chamber **86**, respectively. The interaction chamber **86** requires a signal from the control port **80** and a signal from the control input **88** to produce a supply flow through the output duct **89** of interaction chamber **86**. If the control signal is through duct **84**, the supply flow in the unit **86** will not exit from the output duct **89**. If the signal controls of interaction chamber **86** are pulsed, however, the supply flow from chamber **86** switches and exits from duct **89**. **95** is the other output duct from chamber **86**.

It follows that not only does such a unit provide a different form of switching, it also provides for percentage blending through the feed connection ducts **92** and **93**. A vent **94** is preferably provided in the interaction chamber **86**.

In the embodiment shown in FIG. 6, there is a feeding condenser **100** associated with each web forming machine; and the main duct **101** extends longitudinally from the fiber distribution unit over the several machines in the line, returning to the distributor. A branch duct **102** leads from the main supply line **101** to the condenser **100** at each web former. It carries fibers from the main supply line to the condenser, which forms the fibers into a mat that is fed to the feed plate of the web forming machine. A fan **105** associated with each unit generates the air supply to the control jet **128**, causing the fiber flow to be diverted from its normal path into the branch duct **102** and thence to the metering area **108** and condenser **100**.

The foraminous condensing drum **100** (FIG. 6) may be similar in construction to that shown in U.S. Pat. No. 2,451,915. It is rotatably mounted on a horizontal axis **103** and connected through a suction box or pipe **104** to the fan **105**. Fan **105** is driven from a motor **106** through a belt **109**.

The fibers flowing from the main duct **101** into the branch duct **102** are compacted between a rotary metering roll **107** and the inside wall **108** of the trumpet section of duct **102**. The metering roll is of smaller radius than the wall section **108** so that the space between the periphery of the metering roll and wall or plate **108** decreases around the metering roll so that fibers may thus be compacted.

The metering roll **107** rotates in the opposition direction to the condenser and is so arranged that fibers forming on the condenser surface pass between the condenser and the metering roll. The metering roll **107** is driven by a variable speed D.C. motor (not shown) and is mounted in bearings which define a rotational axis **112** parallel to the condenser axis **103**.

The condenser fiber mat is fed to the feed plate **110** of the web forming machine. The metering roll **107** is adjustable toward and from the wall **108** of the duct **102** by adjustment of the yoke or trunnion **114**, on which the end bearings of the metering roll are mounted.

Variation in the cross-sectional area of the trumpet through this adjustment adjusts the final thickness of the mat for given roll and condenser rotational speeds. The surface speed of the condenser is also variable, the condenser being driven through a belt drive **115** or a gear train from the jack shaft **116** which is driven by a belt **118** or other conventional means through a variable speed transmission **117**.

The reservoir **102** is supplied with tufts of opened fiber in a manner which maintains the reservoir and trumpet full until the air flow through the fiber restricts the fan output. The trumpet area has a concave curvature so that the cross-sectional area decreases, wall **108** approaching the metering roll downwardly.

Rolls **119** and **121** are auxiliary feed rolls which guide the mat from the condenser **100** to the feed plate of the web forming machine; and roll **120** is the feed roll for feeding the mat off feed plate **110** to the lickerin of the forming machine.

The pneumatic conveyor or main supply duct **101** receives the fiber and air mixture from a conventional pneumatic tufting opener **123** (FIG. 8), to which the fiber is delivered through pipe **126**. Each web forming machine here shown as a carding machine **125**, has a branch duct **102** connected to a fiber flow control section **120**. The main supply duct **101** constitutes a pneumatic conveyor, which is part of the main trunk line, which connects with the various web forming machines. Connected to the control section **120** are the air control ducts **122** positioned above the main supply line and supplied with air from the fans **105** and connecting ducts **124**.

In the operation of the equipment, each condenser, which is foraminous, has air sucked through it continuously by operation of the fans **105**. The fans return the air to the control jet ports **128** which are situated in the top of the interaction chambers **120**.

The fiber in the conveying ducts enters the fiber control element through main line **101** at high velocity. The control jets **128** contact the main supply flow in the interaction chambers **120**. The supply flow is diverted into the branch lines **102** where it is acted upon by the suction of the mat forming unit; and the fibers are condensed upon the continuously revolving condensers **100** until the trumpets **108** are full of fibers.

As the buildup of fiber increases in a trumpet, the air flow through the suction chamber is reduced in proportion to the head of fiber in the associated chute **102**. The reduction in air suction causes a like decrease in air output of the associated fan **105**, which in turn reduces the control jet action in the associated interaction chamber **120** so that as the mat forming unit adjusts the head of fibers in the chute **102**, the control jet either decreases or increases in force, causing the main supply flow to split at the juncture of main line **101** and a branch **102** in proportion to the action of the associated control jet. Hence, a constant supply of fiber is maintained in the mat-forming air bridge associated with each condenser.

Since the air bridge is progressively narrowed in the area of the respective concave back plate **108** of the branch duct **102**, and of the associated metering roll **107** so as to restrict the air flow to the suction chamber of the condenser, as the trumpet is filled with fiber a condition of balance is obtained between the delivery of fiber to a chute **102** and the jet air flow through the associated port **128** into the main supply line.

This is a continuing function, self-regulating, and completely automatic without the action of any flaps or the like. In extreme cases, when an air bridge trumpet is empty, there will be an inrush of air through the corresponding chute **102**, giving maximum jet action at the associated fiber control port **128**, forcing the fiber flow to be diverted at the maximum flow rate into the corresponding branch duct **102**. On the other hand, when a trumpet is full and compacted by the action of air suction and the associated metering roll **107**, the flow rate of air to the associated jet control port **128** will not be sufficient to divert flow from the main supply duct to the associated branch, but the fibers and air will be carried on to the next branch **102** down the line which is calling for fibers.

It is normal practice when using pneumatic conveying means, to have an overfeed of fibrous material. This overfeed is normally within the region of approximately 20% of the total hourly output of the line of machines which are to be supplied with fiber. For instance, if ten cards are to be fed from a single pneumatic conveying duct, and each carding engine withdraws 50 lbs. per hour, the total fiber requirement would be 500 lbs. per hour for the line plus about 20% of the total to insure that all cards have an adequate supply. However, since the optimum conveying rate for this hourly poundage for normal fiber length and denier would be about 260 c.f.m. per lb. of fiber, or in this case, 130,000 cubic feet per minute for 500 lbs. plus 20% increase for overfeed, this volume becomes impractical. Therefore, a dilution ratio of air to fiber has to be introduced such that a practical amount of air may be used to minimize coagulation of the fiber during conveying. It has been found that the formula

$$\frac{890 P.L.^2}{D.K.}$$

gives a practical air volume. Here:

P=production rate in lbs./hr.
L=fiber length in inches.
D=denier.
K=dilution factor.

The dilution factor to conveying rates for normal materials will be in the region of 28% to 35%.

However, it should be remembered that as each card in the line withdraws the required amount of fiber from the main supply duct, the quantity of air to fiber increases. At the last card in the system of ten units the concentration of air to fiber delivered from the main supply duct would be 50 lbs. plus the initial overfeed of 100 lbs., or 150 lbs. per hour. However, the amount of air within the supply line remains substantially the same so that the concentration of air to fiber is four times greater at the last card than at the first card in the system.

The coacting functions of air "cut-off" in the air bridge reservoirs, as they fill with fiber, along with a corresponding change in effectiveness of the control jets assure, therefore, no fiber flow when the reservoirs are full, and maximum fiber flow when the reservoirs are empty. The present invention uses the air, that passes through the trumpet, condenser, and fan, to supply a working force to assure removal of fiber from the main supply duct without the use of any mechanical or other appurtenances in the system. This is a most important and novel feature of this invention.

As fiber is extracted from the main supply line to the successive mat forming equipment, which, in turn, feed the web forming units (the cards), the fiber to air ratio would normally decrease in the supply line. Since the control jet pressure needs to be more than 10% of the supply pressure before a change in direction of supply flow is present, adjustment of the jet nozzle pressures permits increase or decrease of the effectiveness of the jet force applied to the main supply flow at the different points of withdrawal along the main trunkline.

The fiber returned to the distribution unit, due to the overfeed, should not be required to pass again through the opening stage since the second pass through the opener would not only be superfluous and wasteful, but it would also be harmful to the fiber length, etc. Therefore, a combined fiber tuft opening and tuft delivery system is combined herein with means for returning the overfeed directly to the conveying system without it passing through a second opening stage.

In FIGS. 7 and 8 one means for supplying air and fibers to the pneumatic conveying and transfer system is shown. Here, a pneumatic conveyor **126** supplies fibrous material from a conventional bale opener or from other conventional cleaning and blending equipment to the main chute **132**. The fiber is allowed to fall in chute **132** under the influence of gravity and is also carried downward by the action of the endless foraminous screen **133** which travels over rollers **130, 131** and whose upper (left-hand) reach moves in a downward direction over a suction box **151**. The fibrous material is compacted through this action and because of the wedge-shaped reservoir formed between the wall **134** and the upper reach of the screen **133**, and is fed by the feed rolls **136, 137** to a conventional high speed spiked opening drum **138** driven by any suitable means. The open tufts of fiber are released from the pins or spikes of drum **138** by the action of centrifugal force and the stripping action of the high velocity air flow from a fan **139**. The small tufts of fiber are then blown into the main duct **101** of the pneumatic conveying system. As previously described, the fiber control elements **122, 128, 120** direct the flow of material as required into the branch duct **102**. The surplus fibers are returned through return duct **140** to the return chute **145**. This return chute has a moving foraminous endless screen belt **146** in it and a sloping wall **147**. Screen **146** travels over rolls **153** and **154**. In a manner similar to the chute **132**, therefore, the return fiber tufts are fed to a single feed roll **148** which acts with a feed plate **150** to feed the tufts to the action of the brush type roll **149**. This action loosens the tufts and returns them to the main line duct **101**.

Situated behind the foraminous screens **133** and **146** are suction boxes **151** and **152**, respectively, which withdraw the air from the chutes **132** and **145** by action of the fan **155**, the output of which supplies the distribution fan **139**.

A conventional measuring device **158** in the duct **101** adjacent the input end of this duct produces an electrical signal corresponding to the weight of fibrous material passing into this duct per unit of time. This signal is passed through the amplifier **157** which in turn regulates the armature voltage of the motor **156** which drives the feed rolls so that the supply of fiber from the chute **132** is increased or decreased depending upon flow conditions. If the return supply of tufts through the chute **145** is increased with respect to the flow conditions, a corresponding decrease is made in the rate of feed by the feed rolls **136** and **137** into chute **102**, and vice versa.

A presently preferred form of apparatus embodying features of the invention is shown in FIGS. 9 to 11 inclusive. Here **160** denotes the section of the main line duct, to which fibers and air are supplied from pipe **161**. Disposed above section **160** is a plenum chamber **162**. The main line section **160** is supported from the plenum by a collar **164** and eye-bolts **166**.

Air is supplied to the plenum from the exhaust side of the condenser of the fiber forming machine, with which the pneumatic transfer system of this invention is associated, through the pipe section **168**. Within the plenum **162**, this pipe section has an opening **170** extending in the direction of its axis. A plate or damper **172** is slidably adjustable angularly on the pipe section to control the amount of this opening. The position of the damper is adjusted by means of the rod **174**, which extends out through an opening in the plenum, and which is operated by the knob **176**.

Within the plenum there are mounted for angular adjustment a plurality of baffles **178** (in the case shown, eight). Each baffle is mounted on a shaft **180**, which is journaled at opposite ends in the sidewalls of the plenum, and which is rotatably adjustable by means of a handle **182** that is secured in one outer end of the shaft.

The plenum is adapted to communicate with the section **184** of the main line duct through an opening **186** in the upper wall of this section. The area of this opening is controlled by a sliding plate or closure **188**, which is manipulated by a handle (not shown) that is connected to the shaft **190**, which is journaled at opposite ends in the sidewalls of the plenum. An arm **192** is secured to this shaft and is connected by a link **194** with an arm **196** that is fastened to or integral with the slide **188**. Rotation of shaft **190** adjusts slide **188**, thereby controlling the area of the opening **186**.

The baffles insure even distribution of the fibers and air across the whole width of the slot **186** to aid in securing a uniform thickness of the mat built up by the fibers on the condenser.

The section **184** of the main line duct is enlarged and communicates with the next following section **198** of the main line duct and with the branch duct **200** that leads to the condenser of the machine which is to be fed. A cylindrical bar **202** at the juncture of the main line section **198** and the branch duct **200** acts as a splitter.

The rate of flow of fibers and air to the branch duct **200** is further controlled by an adjustment of a nose piece **204** which is secured to the flexible stainless steel lower wall **206** of the section **200** of the branch duct. This nosepiece **204** has an arm **208** attached to it which has a rod **210** secured to it adjacent its lower end. Screws **212** and **214**, which thread through brackets **216** and **218**, respectively, that are fastened to the upper frame work of the machine, and which engage at their inner ends against the rod **210** serve to adjust the position forward or back of the nosepiece **204** and thereby of the flexible wall **206**. When the screws are manipulated so that, for instance, the arm **208** is pushed to the left, the direction of flow of the air and fibers into the branch duct **200** will be lifted somewhat so that less fibers and air will go to the branch duct **200** and more will continue on into the main line section **198**, and vice versa.

The branch duct connects with the pipe **220** which leads to the trumpet section **222** (FIG. 11). The trumpet section, in conventional manner narrows downwardly so that its cross section is reduced downwardly. It is curved in its lower portion **224** to extend arcuately about the condenser **226**, approaching the periphery of the condenser more and more as it extends down.

The condenser is of standard construction and comprises a foraminous drum **228** that is journaled at opposite ends in the machine to rotate about an axis **230**. A duct **232** is mounted within the condenser screen **228** coaxially thereof, and carries a plurality of wipers **234**, which wipe the inner periphery of the screen as the screen revolves, to sweep fibers, which may gather on the inside of the screen therefrom.

A suction fan **240**, which is connected to the ends of the duct **232** serves to draw air through the screen and cause fibers to be delivered into the trumpet sections **222** and **224** onto the screen so that they are deposited in random fashion thereon.

The air is drawn by the fan **240** from the condenser **226** through a slot **235** extending in the direction of axis **230**. The air is exhausted by the fan **240** into the duct **244**, which is connected by the elbow **246** with the pipe section **168** that extends into the plenum **162**. Thus, the exhaust air from the condenser is delivered into the plenum **162**. From the plenum the air flows through jet opening **186** to cause air and fibers to be deflected from the main line duct section **160** into the by-pass duct section **200**.

The fibers deposited on the condenser screen **228** are doffed by a doffing roll **250**, and delivered by the feed roll **252** over the nose bar **254** to a conventional lickerin **256**, which forms no part of the present invention.

Having thus described my invention, what I claim is:

1. The combination with a plurality of machines for operating on fibers,

of means for supplying fibers to said machines, comprising

a trunkline for carrying fibers in suspension in air,

a plurality of branch ducts, one for each machine, connecting said trunkline to the respective machines,

means disposed upstream of the juncture of each branch duct and said trunkline for directing a jet of air against one wall of said trunkline to divert air and fibers from said trunkline into the respective branch line,

said trunkline having an interaction chamber of enlarged cross-sectional area upstream of each said juncture into which the jet of air flows, and

a splitter member is disposed at each said juncture,

each splitter member being adjustable toward and away from the associated interaction chamber.

2. The combination claimed in claim **1**, wherein

each branch duct conveys fibers and air to a movable foraminous condenser,

a fan is connected to each condenser to draw air therethrough from the branch line and to cause deposit of fibers on the condenser, and

a duct connects the exhaust side of each fan with the associated jet directing means to supply air to said means for said jet.

3. The combination claimed in claim **2**, wherein

each condenser is a rotary condenser, and

each branch duct has a trumpet section of progressively reduced cross-sectional area around a portion of the associated condenser into which fibers may pack, whereby as a trumpet fills with fibers the air flow through the associated fan is reduced, thereby reducing the effectiveness of the associated jet directing means, and as fiber is removed from the trumpet the air flow through the associated fan to the associated jet directing means is increased to increase the fiber flow into the corresponding branch duct.

4. The combination with a plurality of machines for operating on fibers,

of means for supplying fibers to said machines comprising

a trunkline for carrying fibers in suspension in air,

an interaction chamber of enlarged cross-sectional area into which said trunkline flows, two lines leading from said interaction chamber and connecting said chamber to different machines,

a feedback duct connecting each of the last-named lines to said interaction chamber to return some of the air and fibers flowing in the respective last-named line to said interaction chamber, and

two ducts for supplying a jet pulse of air simultaneously to two separate points around said interaction chamber thereby to cause the air and fibers to flow alternately respectively, into the two last-named lines.

5. The combination with a plurality of machines for operating on fibers,

of means for supplying fibers to said machines comprising

two reaction chambers,

a trunkline for conveying fibers suspended in air to both said chambers,

two branch lines leading from each chamber to convey fibers suspended in air therefrom,

one of the branch lines from one chamber being connected with one of the branch lines from the other chamber to form a continuation of the trunkline, and

two control ducts,

each control duct being split and having two air-conveying ducts leading therefrom, one to each reaction chamber to direct jets of air into said chambers, whereby by supplying air selectively to one or both said control ducts the flow of air and fibers to said branch lines can be controlled.

6. The combination with a plurality of machines for operating on fibers,

of means for supplying fibers to said machines comprising

two reaction chambers,

a trunkline for supplying fibers in suspension in air to each chamber,

two control input ducts for directing jets of air into one of said reaction chambers,

two outlet branch lines leading from said one reaction chamber,

a by-pass duct leading from each said outlet line to the other reaction chamber,

two output ducts leading from said other reaction chamber, and

a control input duct for supplying a jet of air to said other reaction chamber.

7. The combination claimed in claim **3**, wherein there is a plenum associated with each machine,

an exhaust duct connects the exhaust side of each fan with the associated plenum, and

a jet opening connects each plenum with said trunkline upstream of the juncture of each branch line with the trunkline to divert fibers and air in the trunkline.

8. The combination claimed in claim **7**, wherein means is provided for adjusting the area of said jet opening.

9. The combination with a plurality of machines for operating on fibers,

of means for supplying fibers to said machines, comprising

a trunkline for carrying fibers in suspension in air,

a plurality of branch ducts, one for each machine, connecting said trunkline to the respective machines,

means disposed upstream of the juncture of each branch duct and said trunkline for directing a jet of air against one wall of said trunkline to divert air and fibers from said trunkline into the respective branch line,

each branch duct conveying fibers and air to a movable foraminous condenser,

a fan is connected to each condenser to draw air therethrough from the branch line and to cause deposit of fibers on the condenser, and

a duct connects the exhaust side of each fan with the associated jet directing means to supply air to said means for said jet,

each condenser is a rotary condenser, and

each branch duct has a trumpet section of progressively reduced cross-sectional area around a portion of the associated condenser into which fibers may pack, whereby as a trumpet fills with fibers the air flow through the associated fan is reduced, thereby reducing the effectiveness of the associated jet directing means, and as fiber is removed from the trumpet the air flow through the associated fan to the associated jet directing means is increased to increase the fiber flow into the corresponding branch duct,

said jet opening extends across the whole width of the associated plenum, and

a plurality of baffles are mounted adjustably in each said plenum to direct air from said plenum across the whole width of said jet opening.

10. The combination claimed in claim **7**, wherein the lower wall of each branch line is flexible, and

means is provided to flex each said lower wall to vary the area of each branch line at its juncture with said trunkline.

11. The combination claimed in claim **7**, wherein means is provided adjustably to control the area of the opening of each exhaust duct into the associated plenum.

12. The combination with a plurality of machines for operating on fibers,

of means for supplying fibers to said machines, comprising

a trunkline for carrying fibers in suspension in air,

a plurality of branch ducts, one for each machine, connecting said trunkline to the respective machines,

said trunkline having an interaction chamber of enlarged cross-sectional area upstream of each said juncture,

a foraminous condenser rotatably mounted in each branch duct,

a fan connected to each condenser to draw air therethrough from the associated branch duct to cause deposit of fibers on the condenser,

a duct connecting the exhaust side of each fan with a jet port in the associated interaction chamber to supply a jet of air to said interaction chamber,

each branch duct having a trumpet section of progressively reduced cross-sectional area disposed around a portion of the associated condenser into which fibers may pack, whereby as a trumpet section fills with fibers the air flow through the associated fan is reduced, thereby reducing the effectiveness of the associated jet,

each jet port being located asymmetrically with reference to the longitudinal center of the associated interaction chamber.

13. The combination claimed in claim **12**, wherein a splitter member is disposed at each juncture, and

each splitter member is adjustable toward and away from the associated interaction chamber.

14. A fiber distribution system for conveying fibers to a machine, comprising

a trunkline for carrying fibers in suspension in air,

a chute,

an elongate fluid interaction chamber for controlling the level of fibers in the chute,

means connecting said trunkline to said chamber at one end of said chamber,

said chamber having a pressure jet orifice adjacent one end thereof,

two discharge conduits for selectively conveying fiber-laden air from said chamber as determined by the pressure on said stream exerted by a jet of air flowing from said orifice into said chamber,

one of said discharge conduits being connected to said chute to deliver fiber-laden air thereinto, a foraminous condenser rotatably mounted in said chute,

said chute being curved opposite said condenser to converge toward said condenser around the periphery of said condenser,

and a suction fan for drawing air through said condenser to separate the fibers from the air and cause deposit of fibers on said condenser, and

a return duct for conducting the exhaust air from said fan back to said jet orifice, whereby when the level of fibers in said chute is below the location of the fan suction there is a high rate of flow of fibers and air from said interaction chamber to said chute, and cut-off of air flow when the level of fibers in the chute is above the location of the fan suction.

15. A fiber distribution system comprising

an elongate interaction chamber,

means for supplying a stream of fiber-laden air to said chamber,

at least two discharge conduits connected to said chamber,

and means for selectively deflecting the fiber-laden stream flowing through said chamber to either of said discharge conduits,

a movable foraminous condenser,

a duct connecting one of said discharge conduits to said condenser to deliver fiber-laden air to said condenser,

suction means for drawing air through said condenser to separate the air from the fibers and cause deposit of fibers on the condenser and for recycling the air to said chamber in the form of a jet to control the discharge conduit into which the fiber-laden air will flow from said chamber, whereby the direction and rate of flow of the fiber-laden air from said chamber is controlled by the demand of said suction means.

16. A system as claimed in claim **15**, wherein an expansion chamber is provided ahead of said interaction chamber,

said supply means is connected to said expansion chamber to deliver air and fibers thereto,

said air jet orifice constitutes the outlet from said expansion chamber and connects said expansion chamber with said interaction chamber, and

a plurality of baffles are mounted adjustably in said expansion chamber to direct the fiber-laden air across the whole width of said orifice.

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