Nov. 30, 1965 J. T. UNDERWOOD 3,220,812

APPARATUS FOR FORMING AND COLLECTING FIBERS

Filed Oct. 17, 1961 3 Sheets-Sheet 1

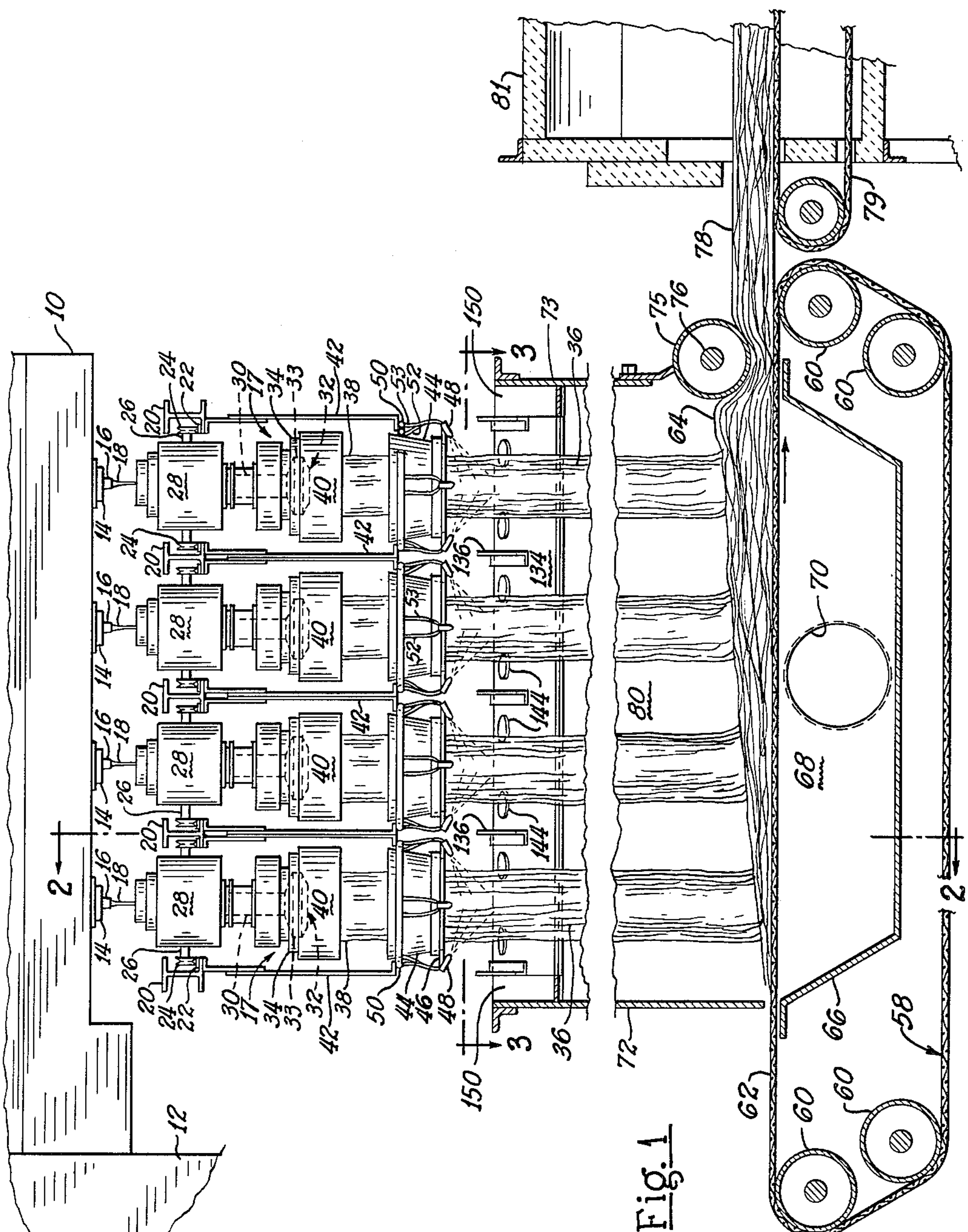

Fig. 1

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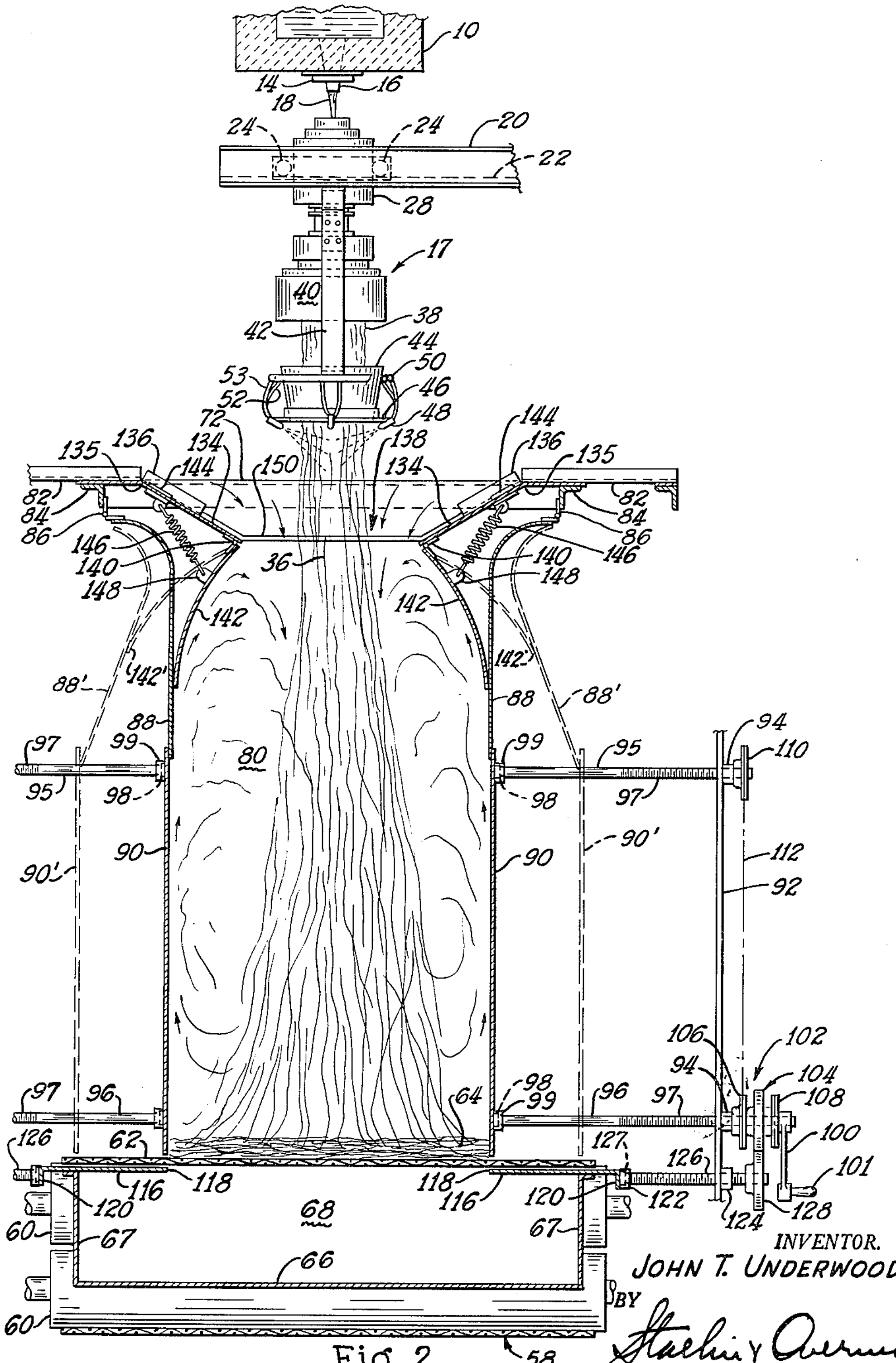

Fig. 2

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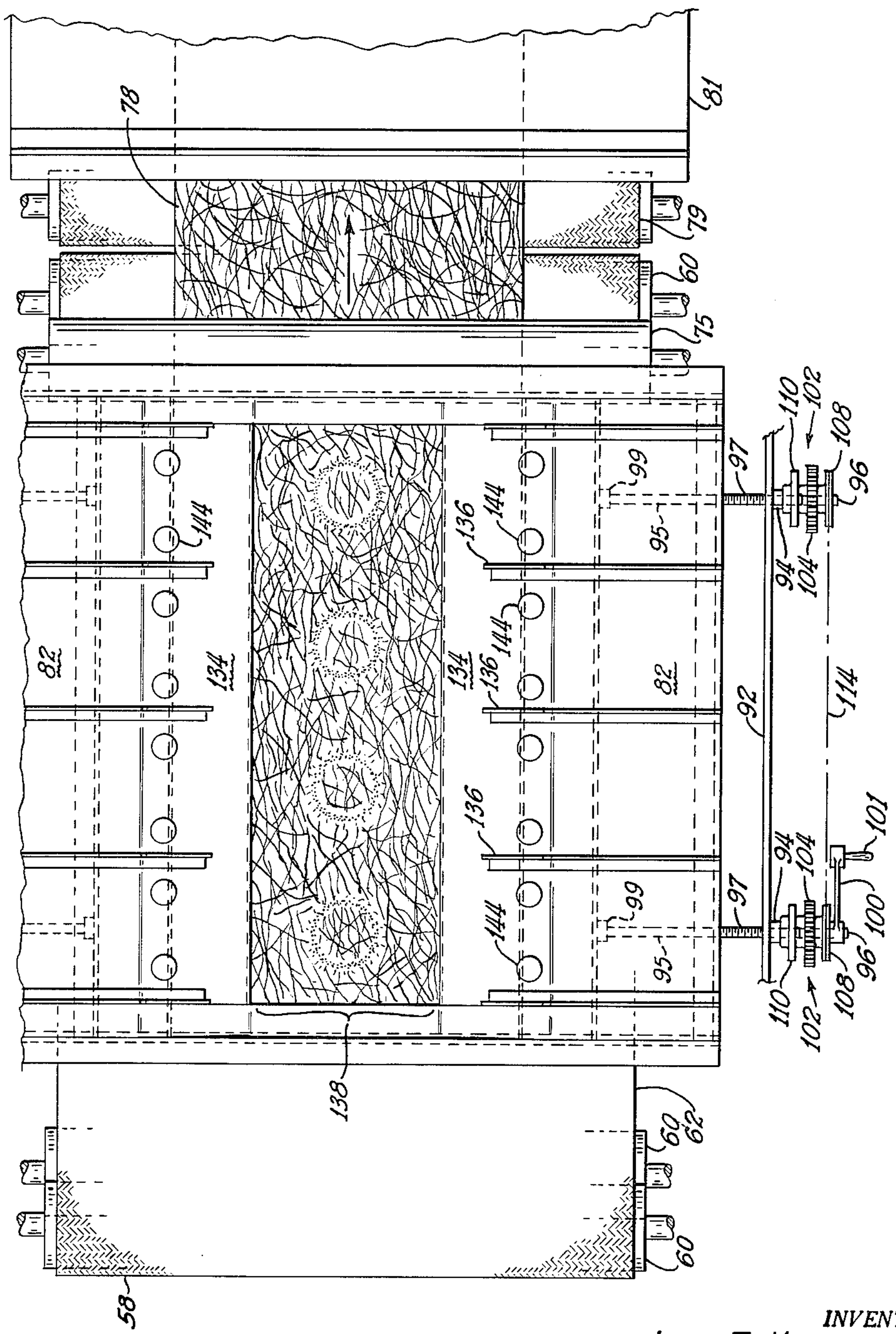

Fig. 3

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3,220,812
Patented Nov. 30, 1965

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3,220,812
APPARATUS FOR FORMING AND COLLECTING FIBERS

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Filed Oct. 17, 1961, Ser. No. 145,730
4 Claims. (Cl. 65—9)

This invention relates to a method of and appartus for forming and collecting fibers and more particularly to a method and arrangement for forming and collecting fibers of heat-softenable materials and more especially fibers of mineral materials, such as glass, wherein high velocity gas streams are engaged with primary filaments or fine streams of glass for attenuating the streams to fine fibers of varying lengths.

It has been commercial practice in forming fibers of glass or other mineral materials to deliver molten or heat-softened glass into a hollow rotor or centrifuge having a comparatively large number of peripheral orifices and, through high speed rotation of the rotor or centrifuge, the softened glass is delivered through the orifices providing primary filaments or fine streams which are engaged by an annularly-shaped gaseous blast and thereby attenuated into fine fibers of varying lengths oriented in the blast in the form of a hollow beam of fibers.

The gases of the blast and entrained fibers are delivered into an open-ended unrestricted hood, shroud or enclosure, the fibers moving downwardly through the hood and collected upon a foraminous conveyor moving normal to the direction of flow of the fibers in the blasts. Deposition of the fibers upon the conveyor is influenced by a region of reduced pressure or suction maintained beneath the conevyor for conveying away spent gases of the attenuating blasts.

In such arrangement employing an unrestricted open-ended hood, the hood entrance is an appreciable distance below the rotor and hence large amounts of blast-induced air flow into the hood with the gases of the blasts necessitating the use of a large suction blower in order to effect collection of the fibers on the foraminous conveyor and to effectively convey away the spent gases of the blast and blast-induced air entering the shroud. In such arrangements binder or fiber coating material is delivered onto the fibers in the blast before the fibers enter the hood. Furthermore the width of the mass or pack of collected fibers is determined by the fixed width of the hood. The large amounts of induced air flowing into the unrestricted open end of the shroud and the gases of the blast must be conveyed away by the suction means and, even utilizing a high volume suction blower, the fibers tend to blow back through the entrance of the shroud. Furthermore, the thickness or depth of the pack or mass of fibers that may be formed without substantial blow-back of fibers is limited due to the increasing resistance of the fibrous pack to air and gas flow as the pack increases in thickness.

The invention has for an object the provision of a method of producing fibers through the use of high velocity attenuating blasts and collecting the fibers wherein control or restriction of the blast-induced air reduces the suction required to carry away the spent gases and hence decreases fiber blow-back out of the hood.

Another object of the invention resides in a method for restricting and controlling air flow induced by the high velocity fiber-attenuating blasts wherein a substantial reduction in power is effected in order to convey away the spent gases of the blasts and blast-induced air during collection of the fibers enabling the formation of

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a pack or mass of fibers of greater thickness without appreciable blow-back.

Another object of the invention resides in an arrangement and apparatus for varying the width of the pack or mass of collected fibers and controling or restricting blast-induced air flow for all widths of pack, mass or mat of collected fibers.

Another object of the invention is the provision of a method of restricting the entrance opening into the hood thereby increasing the entrance velocity of the gases of the fiber-attenuating blasts and induced air and reducing the volume of blast-induced air whereby the blow-back gases and fibers therein are caused to re-enter the high velocity blast as the blow-back gases replace induced air that would otherwise enter an unrestricted hood.

Another object of the invention is the provision of an apparatus embodying a fiber-confining hood or enclosure having a restricted entrance effective to direct blow-back gases and fibers at the boundary of the attenuating blast into the high velocity region of the blast to redirect fugitive fibers into the main blast for delivery onto a foraminous conveyor.

Another object resides in the provision of a hood arrangement for receiving attenuating blasts and fibers entrained therein having a baffle defining a restricted entrance to reduce induced air flow whereby substantially less power is required to dispose of exhaust gases enabling the formation of a fibrous pack of greatly increased thickness and enabling the collection of very fine fibers in a comparatively thick mass without "blow back" due to the substantial reduction in suction forces required by reason of the reduction of induced air flow into the hood.

Another object of the invention resides in the provision of a method and apparatus for reducing blast-induced air flow into a walled chamber whereby the application of binder or adhesive onto the newly formed fibers is improved by reason of the reduction in induced air flow and the tendency for fibers to adhere to the walls of the chamber reduced through the provision of continuous movement of gases adjacent the chamber walls.

Further objects and advantages are within the scope of this invention such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

FIGURE 1 is a side elevational view of a plurality of fiber-forming units with certain components of the fiber collecting arrangement illustrated in cross-section;

FIGURE 2 is a vertical transverse sectional view taken substantially on the line 2—2 of FIGURE 1, and

FIGURE 3 is a horizontal sectional view taken substantially on the line 3—3 of FIGURE 1.

While the method and apparatus of the invention are illustrated with fiber-forming units wherein streams of glass or primary filaments are centrifuged into an attenuating blast, it is to be understood that the method and apparatus may be used with other forms of fiber-attenuating apparatus for processing heat-softened fiber-forming materials.

The apparatus of the invention is illustrated in association with a plurality of fiber-forming units wherein heat-softened material delivered into hollow rotors is centrifuged into primary filaments or fine streams which are attenuated to fine fibers through the use of annular attenuating blasts concentric with the rotors.

Referring initially to FIGURES 1 and 2, there is illustrated a portion of a forehearth **10** adapted to contain heat-softened glass or other fiber-forming mineral material, the forehearth being connected with a melting furnace 12 of conventional character wherein glass batch is reduced to a molten or flowable state and the molten glass flowed into the forehearth 10. Arranged lengthwise of the forehearth 10 are spaced feeders 14 which may be fashioned of an alloy of platinum, rhodium or other material capable of withstanding the intense heat of the molten glass.

Each of the feeders 14 is fashioned with a depending projection 16 provided with an orifice through which a stream 18 of heat-softened glass flows into the rotor of a fiber-forming unit 17. In the embodiment illustrated four fiber-forming units 17 are arranged lengthwise of and beneath the forehearth 10, but it is to be understood that any number of fiber-forming units may be employed dependent upon the size or thickness of the pack or mass of fibers to be formed. The fiber-forming units illustrated are of identical construction and each is an independent unit arrangement capable of being readily moved into and out of operative or fiber-forming position for ease of repair or replacement.

Disposed beneath the forehearth 10 and extending transversely thereof is a plurality of I-shaped beams or structural members 20 forming a supporting frame for the fiber-forming units, the transversely extending I-beams 20 being supported by suitable conventional structural members (not shown).

Each of the lower flanges of the I-beams are provided with lengthwise arranged bars or ways 22 forming tracks to accommodate rollers 24 carried by shafts 26 projecting from a housing 28 of each unit 17, except the outermost I-beams, each of which is provided with a single bar 22 which, with a bar 22 on the adjacent I-beam, supports a fiber-forming unit.

The housing 28 of each unit is preferably of cylindrical shape and encloses a motor (not shown) for driving a hollow shaft or quill 30 which supports at its lower end a rotatable hollow rotor 32, the peripheral wall 33 of which is provided with a large number of small outlets or orifices. The stream 18 of glass flows downwardly through the hollow shaft 30 into the rotor 32. Enclosed within each housing 28 is an electrically energizable motor (not shown) for rotating the quill 30 and the rotor 32 at comparatively high speed whereby the centrifugal forces of rotation extrude or project the molten glass within the hollow rotor through the orifices or outlets in the peripheral wall 33 thereof to form small streams or primary filaments of glass.

Surrounding each rotor 32 is a manifold 34 fashioned with an annularly-shaped orifice concentric with the rotor. Means (not shown) is arranged to convey gas under comparatively high pressure to each manifold 34, the gas being discharged through the annular orifice into engagement with the outwardly moving streams or primary filaments of glass and attenuates the streams or filaments to fine fibers 36.

Through the use of an annularly shaped gaseous blast for attenuating the material to fibers, the fibers are entrained in the blast and move downwardly from each rotor in the form of a hollow beam of fibers 38 of generally cylindrical shape. A cylindrically shaped metal guard 40 surrounds each rotor. The blasts may be formed of steam or compressed air or may be hot gases of combustion delivered from an annular combustion burner employed in lieu of the manifold 34.

Means is provided for delivering a binder or adhesive onto the fibers in beam formation. Depending from the I-shaped beams 20 are members 42, each pair of members supporting an inverted frusto-conically shaped hollow sleeve 44. The frusto-conically shaped chamber provided by each member 44 tends to confine the fibers at a region beneath the rotor in order to facilitate improved application of binder. Mounted upon each of the members 44 is an annular member or ring 46 which provides a support for a plurality of nozzles or applicators 48 spaced circumferentially around the ring 46 as shown in FIGURES 1 and 2.

A manifold system 50 includes ducts supplied with binder or adhesive from a supply (not shown) and ducts for conveying compressed air. The ducts of the manifold system are connected with applicators or nozzles 48 by pairs of tubes 52 and 53, there being one pair of tubes for each applicator, one tube being connected with the manifold containing adhesive or binder and the other connected with compressed air or other media for delivering the binder or adhesive from the nozzles in spray formation so as to project the binder or adhesive in fine particle form throughout the fibers.

The invention embraces a novel method of and apparatus for effecting control of the environment of the fibers and gases of the blasts below the binder applicators to the region of collection of the fibers of the beams in a fibrous pack or mat. Disposed a substantial distance beneath the fiber-forming units is a foraminous belt-like conveyor 58 supported by a plurality of rolls 60, one of which is driven by a suitable motor (not shown) for driving the conveyor. The conveyor 58 is driven whereby the upper flight 62 thereof moves in a right-hand direction as viewed in FIGURE 1 whereby the fibers of the beams are collected in a fibrous pack or mass 64.

Positioned beneath the upper flight of the conveyor 62 is a sheet metal receptacle 66 of a shape to provide a chamber 68 beneath the region of deposition of the fibers upon the conveyor flight 62. The receptacle 68 is connected by means of a tube or pipe 70 with a suction blower of conventional character for impressing subatmospheric or reduced pressure in the chamber 68. The reduced pressure in chamber 68 is effective to convey away spent gases of the attenuating blasts and to influence the deposition of the fibers upon the flight 62.

In the arrangement shown in the drawings, the fibers of the beams are confined throughout a substantial distance of their movement from the fiber-forming units to the region of collection. The gas and fiber confining chamber, hood, shroud or enclosure 80 is constructed and arranged whereby to restrict and control air flow into the chamber induced by the gases of the blasts directed into the chamber and, in the embodiment illustrated, for adjusting the width of the confining region of the chamber to vary the width of the fibrous mass or pack 64 formed on the conveyor.

The confining chamber 80, in the embodiment illustrated is inclusive of end plates or members 72 and 73, the plate 73 being at the exit end of the chamber. There may be disposed at the exit end of the chamber a pack or mat sizing roll 75 supported upon a shaft 76 for partially compressing the fibers of the pack to form a mat 78 of substantially uniform thickness. The lateral wall constructions of the chamber 80 may be fixed or non-adjustable but as illustrated in FIGURE 2 are made adjustable for varying the width of the fibrous pack or mass. Supported at the entrance region of the chamber 80 is a pair of substantially parallel horizontal plates 82 provided with longitudinally extending frame members 84, the plates 82 defining a restricted entrance into the hood 80.

Secured to each of the members 84 is a hinge construction 86 which forms a hinge or pivotal support for relatively movable lateral wall portions or sections 88. The lateral or side wall construction includes wall portions or sections 90 which are adjustable or movable in directions transversely of the conveyor belt 62. These wall sections are adjustable in order to vary or control the width of the pack or mass 64 of fibers collected on the conveyor flight 62. Means for adjusting the lateral position of side walls is illustrated in FIGURES 2 and 3.

While the adjusting means is illustrated in connection with one wall section 90 it is to be understood that adjusting means of the same character may be provided for the opposite wall section 90. Spaced laterally from each wall 90 is a stationary supplemental frame structure 92 provided with internally threaded bushings 94 welded or otherwise secured to the frame members 92.

Pairs of rods or shafts 95 and 96 have threaded portions 97 threaded into the bushings 94. The other end regions of the rods or shafts 95 and 96 are provided with head portions 98 rotatably journaled in fittings 99 welded or otherwise secured to the wall sections 90.

One of the shafts of the lower pair of shafts 96 is provided with a crank 100 having a manipulating handle 101 shown in FIGURES 2 and 3. Mounted upon each of the lower shafts 96 is a motion transmitting unit 102 comprising a gear structure 104 and sprockets 106 and 108. Mounted upon each of the upper shafts 95 is a sprocket 110. Chains 112 engage the pairs of sprockets 106 and 110 and a chain 114 engages the sprockets 108 on the lower shafts 96 so that upon rotation of the shaft 96 provided with the crank 100, the shafts 95 and 96 will be rotated simultaneously.

As the threads on each of the shafts are of the same pitch, rotation causes the shafts to be threaded through the bushings 94 and thus simultaneously moved in one direction thereby changing the position of the wall section 90 of the chamber 80 connected with the one group of shafts. The shafts are permitted to rotate relative to the wall 90 through the bearing constructions contained in the fittings or housings 98. The above described adjusting mechanism is provided for each wall section 90.

The adjusting mechanism for each of the chamber wall sections 90 is inclusive of means for covering or screening the portion of the conveyor flight 62 which may be exterior of the chamber 80 defined by the adjustable wall sections 90.

As particularly shown in FIGURE 2, a plate member or baffle 116 extends lengthwise at each side of the wall sections and extends within a slot in a side wall 67 of the suction chamber 68. As illustrated in FIGURE 2, the opposed edge region 118 of each of the plates 116 terminates in registration with the vertical plane of the adjacent chamber walls 90.

Each of the plates 116 is provided with a longitudinally extending depending flange 120 to which is secured a pair of fittings 122. Each of the supporting means 92 is provided with a pair of bosses 124, one of which is shown in FIGURE 2, welded or otherwise secured to the frame member 92. The bosses 124 are bored and threaded to accommodate a pair of shafts 126, the threads on shafts 126 being left-hand threads or threads of pitch opposite to that of the threads 97 on shafts 95 and 96, the shafts being threaded into the bushings 124. The end of each shaft 126 is provided with a head portion 127 contained within the hollow fitting 122 to form a rotatable connection for shafts 126 with the plates 116. Each of the shafts 126 is equipped with a gear 128, the gears 128 being enmeshed respectively with the gears 104 whereby rotation of the crank 100 also effects rotation of the pairs of shafts 126 and relative movement of the baffles 116 simultaneously with the wall sections 90.

When it is desired to change the relative position of a wall section 90 of the chamber 80, the operator manipulates the crank 100 by means of the handle 101.

Through the medium of the chains 112 and 114, the rotation of the shaft 96 to which the crank 100 is secured rotates the sprockets 106 and 108 causing corresponding rotation of the sprockets 110 on the shafts 95 and, through the medium of the gears 104 and 128 the threaded shafts 126 are also rotated in the opposite direction, but as the threads are of opposite pitch, the shafts 126 will be moved longitudinally in the same direction as the shafts 95 and 96. As the threaded portions of the shafts are threaded through the bushings 94 and 124, the adjacent wall section 90 may be moved in either direction depending upon the rotation of the crank 100.

The baffle plate 116 is simultaneously moved in the same direction thus maintaining the edge 118 of the baffle plate in the plane of the wall section 90. If it is desired to enlarge the chamber 80 through repositioning of the wall section 90, the crank 100 is rotated in a direction to move the wall section 90 outwardly, its position of maximum width for the chamber 80 being indicated by the broken lines at 90′.

Simultaneously with the movement of the wall section the screen or baffle 116 adjacent the conveyor flight 62 is moved outwardly thus uncovering additional area of the foraminous conveyor 62 to receive fibers from the fiber-forming units. Both sections 90 of the chamber 80 are movable in the manner above described so that varying widths of fibrous pack or mat may be collected on the conveyor flight 62.

The chamber 80 is fashioned with additional movable wall sections so as to provide a restricted entrance region for the chamber 80 irrespective of the position of adjustment of the side wall sections to vary the width of the chamber 80. Secured to the horizontally disposed plates 82 and extending in downwardly convergent angular directions are longitudinally extending plates or baffles 134 which, in the embodiment illustrated are joined with the respective plates 82 at the regions 135.

The plates 134 are preferably of planar construction and are reinforced by transversely extending members 136 of L-shaped cross-section which are welded or otherwise secured to the plates 134. The opposed edges of plates 134 define a restricted entrance or opening 138 into the chamber 80, the restricted opening being of lesser width than the minimum width of the chamber 80 when the side wall sections 90 are moved to their inner most position.

The opposed edge regions of plates 134 are provided with hinge members 140 arranged to provide a pivotal connection of each of the plates 134 with a curved baffle plate 142 illustrated in FIGURE 2. The baffle plates 142 extend lengthwise of the chamber 80, the lower edge regions of the baffles 142 bearing against the inner surfaces of the wall sections 88 as shown in FIGURE 2.

Spaced lengthwise of the plates 134 and secured thereto are brackets 144 providing anchor members to which a like number of coil springs 146 are connected as shown in FIGURE 2. The baffle plates 142 are formed with a plurality of spaced ear portions 148 and the opposite ends of the springs 146 are connected with the ear portions or brackets 148.

The springs 146 are of the contractile type and serve to exert forces on the baffles 142 to bias the baffles into contact with the wall sections 88 irrespective of the positions of adjustment of the wall sections.

From examination of FIGURE 2, it will be apparent that when the wall sections 90 are adjusted in either direction, the contractile forces of the springs 146 acting on the plates 142 cause the plates 88 to move simultaneously with the plates 90 as the plates 142 are maintained in constant contact with the wall sections 88. When the wall sections 90 are moved to the broken line position indicated at 90′ in FIGURE 2, being the position of maximum width of the chamber 80, the wall sections 88 and baffle plates 142 are moved to the broken line positions indicated at 88′ and 142′.

Thus, irrespective of the relative position of the wall sections 90 defining the width of the chamber 80, the wall sections 88 and the baffles 142 cooperate with the wall sections 90 to provide a confined zone. The adjustment of the wall sections enables control of the width of the fibrous pack 64 collected upon the conveyor flight 62. The spaces between the ends of the plates 134 and the end walls 72 and 73 are closed by means of stationary members or plates 150, the restricted entrance 138 being of rectangular shape and of a length equal to the length of the plates 134. Where the walls 90 are disposed in fixed or non-adjustable relation, the plates or baffles 134, defining the restricted entrance, may be employed without the plates 142 as the plates 134 will be effective to redirect blow-back gases and fugitive fibers into the main blast.

Through the provision of the restricted entrance **138** for the hood or chamber **80**, the volume of induced air is greatly reduced and hence there is less volume of gases to be handled in the suction chamber **68**. The reduction in the induced air flow fosters a more effective disposition of the gases in the hood by the suction means and hence a decrease in the tendency of gases to blow back toward the entrance. While a comparatively small proportion of the gases and fibers entrained therein may move upwardly along the walls **90** as indicated by the arrows in FIGURE 2, such gases and fibers are redirected, because of the restriction provided by the baffles **134**, into the gases of the attenuating blast and are eventually collected out of the blast on the conveyor flight **62**. By reducing the blast-induced air, the binder or fiber coating material delivered from the nozzles **48** may be more effectively directed onto the newly formed fibers thus improving binder application efficiency.

It has been found that with the restricted entrance and reduced air flow into the hood, the fibers may be successfully collected in a pack of approximately fifty percent greater thickness without appreciable blow-back than with a hood having an unrestricted opening. Furthermore the power requirements for the suction blower are reduced approximately fifty percent of that required to form a fibrous pack of the same thickness as a pack formed with a completely open hood without appreciable blow-back.

The mat **78** formed from the fibrous pack or mass **64** may be conveyed by a second conveyor **79** through an oven or curing chamber **81**. The curing chamber may be heated to cure the binder or heated air may be passed through the oven in order to cure the binder.

By reason of the substantial reduction in the flow of induced air into the chamber **80**, the power required to drive the suction blower for producing subatmospheric pressure in the chamber **68** is substantially reduced, effecting substantial savings in the cost of the fibrous end products or mats formed from the collected mass or pack of fibers.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than as herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

I claim:

1. Apparatus of the character disclosed including, in combination, a hollow rotor having a perforated wall, means for feeding heat-softened fiber-forming material into the rotor, means for rotating the rotor to project the material through the perforations to form primary filaments, means for establishing an annular gaseous blast engageable with the primary filaments to attenuate the filaments to fibers oriented in the blast in a generally hollow beam formation, a chamber having opposed side walls in substantially parallel relation to reecive the beam of fibers and gases of the blast, plate means extending inwardly from regions of the side walls at the end of the chamber nearest the blast establishing means and defining an elongated restricted entrance of a width just sufficient to receive the fibers of the beam, baffle members extending outwardly from the edges of the plate means defining the restricted entrance and engaging the inner surfaces of the side walls of the chamber, a movable foraminous surface at the other end of the chamber upon which the fibers are collected, a receptacle disposed adjacent the foraminous surface, and means for establishing reduced pressure in said receptacle for conveying away the gases of the blast and blast-induced air entering the walled chamber.

2. Apparatus for collecting blast-attenuated fibers from a plurality of fiber-forming units, a chamber arranged to receive the fibers and gases of the attenuating blasts from the units, said chamber comprising substantially parallel side walls and end walls defining a substantially rectangular enclosure, plate means extending inwardly from the upper regions of the side walls of the chamber, the inner edges of the plate means defining an elongated restricted entrance of a width just sufficient to receive the fibers from the fiber-forming units, baffle members extending outwardly from the inner edges of the plate means defining the restricted entrance and engaging the parallel side walls of the chamber, a movable foraminous surface at the base of the walled chamber for collecting fibers from the chamber, and means establishing a region of reduced pressure adjacent and beneath the fiber-collecting zone of the foraminous surface.

3. Apparatus for collecting blast-attenuated fibers from a plurality of fiber-forming units, a chamber arranged to receive the fibers and gases of the attenuating blasts from the units, said chamber comprising substantially parallel side walls and end walls defining a substantially rectangular enclosure, plate means extending inwardlly from the upper regions of the side walls defining an elongated restricted entrance of a width just sufficient to receive the fibers from the fiber-forming units, curved baffle members extending outwardly from the edges of the plate means defining the restricted entrance and engaging the inner surfaces of the side walls of the chamber, a movable foraminous fiber-collecting surface at the base of the chamber for collecting fibers from the chamber, means for establishing a region of subatmospheric pressure adjacent and beneath the fiber-collecting zone of the foraminous surface, the side walls of the chamber being adjustable for varying the effective fiber-collecting area of the foraminous surface.

4. Apparatus for collecting blast-attenuated fibers from a plurality of fiber-forming units, a chamber arranged to receive the fibers and gases of attenuating blasts from the fiber-forming units, said chamber comprising substantially parallel side walls and end walls defining a substantially rectangular enclosure, each of the side walls of the chamber including at least two overlapping wall sections, plate means extending inwardly from the upper regions of the side walls defining an elongated restricted entrance of a width just sufficient to receive the fibers from the fiber-forming units, the uppermost of said chamber wall sections being articulately connected with said plate means, means for adjusting said side wall sections to vary the width of the chamber, a movable foraminous surface arranged at the base of the chamber upon which the fibers are collected, a receptacle arranged beneath the fiber collecting region of the foraminous surface, said receptacle being connected with a source of reduced pressure for conveying away spent gases of the blasts and blast-induced air, baffle members extending outwardly from the edges of the plate means defining the restricted entrance and engaging the uppermost side wall sections, spring means biasing the baffle members into engagement with said side wall sections in all positions of adjustment, and means adjacent the foraminous surface arranged to interrupt air flow through the regions of the foraminous surface at the sides of and exteriorly of the chamber.

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