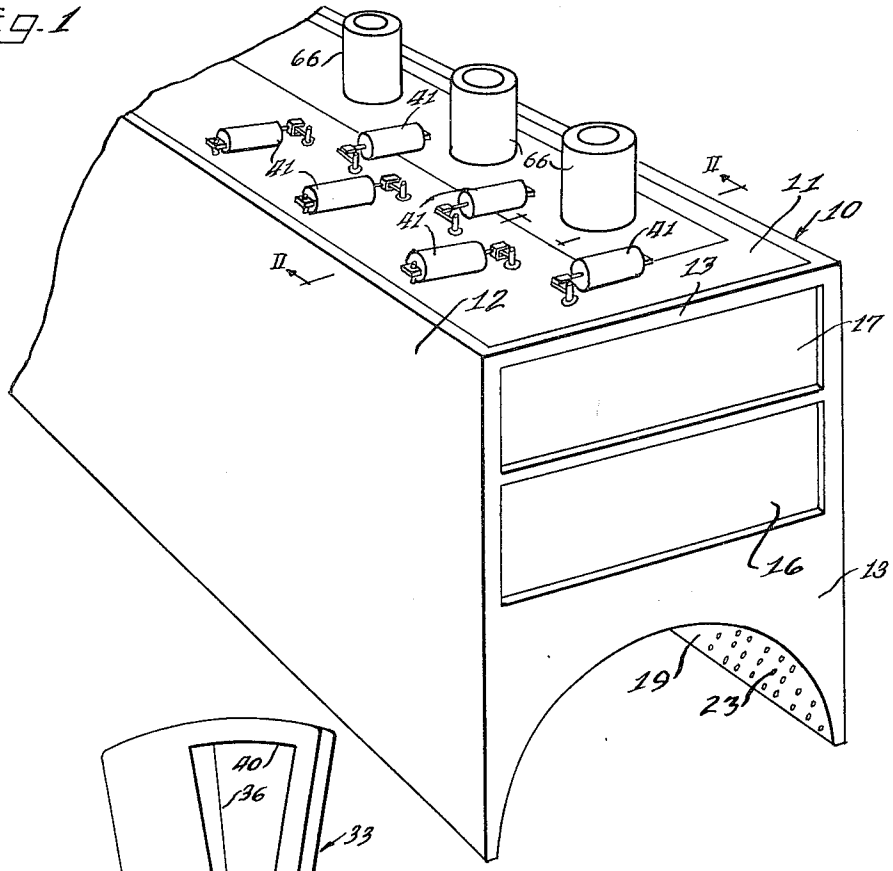
Jan. 26, 1965 E. J. JUSTUS ETAL 3,167,408

DRYER HOOD CONSTRUCTION FOR WEB MATERIAL

Filed Nov. 16, 1961 8 Sheets-Sheet 1

Fig. 1



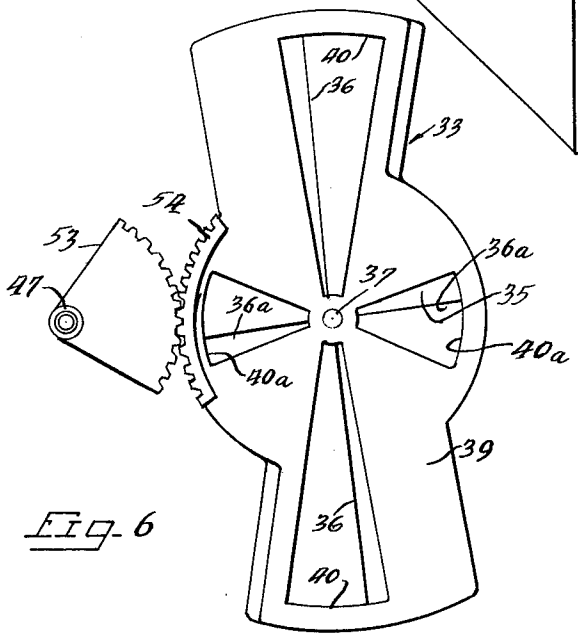


Fig. 6

Fig. 9

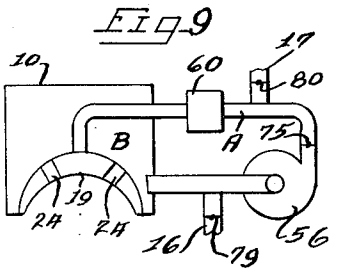


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Fig. 2

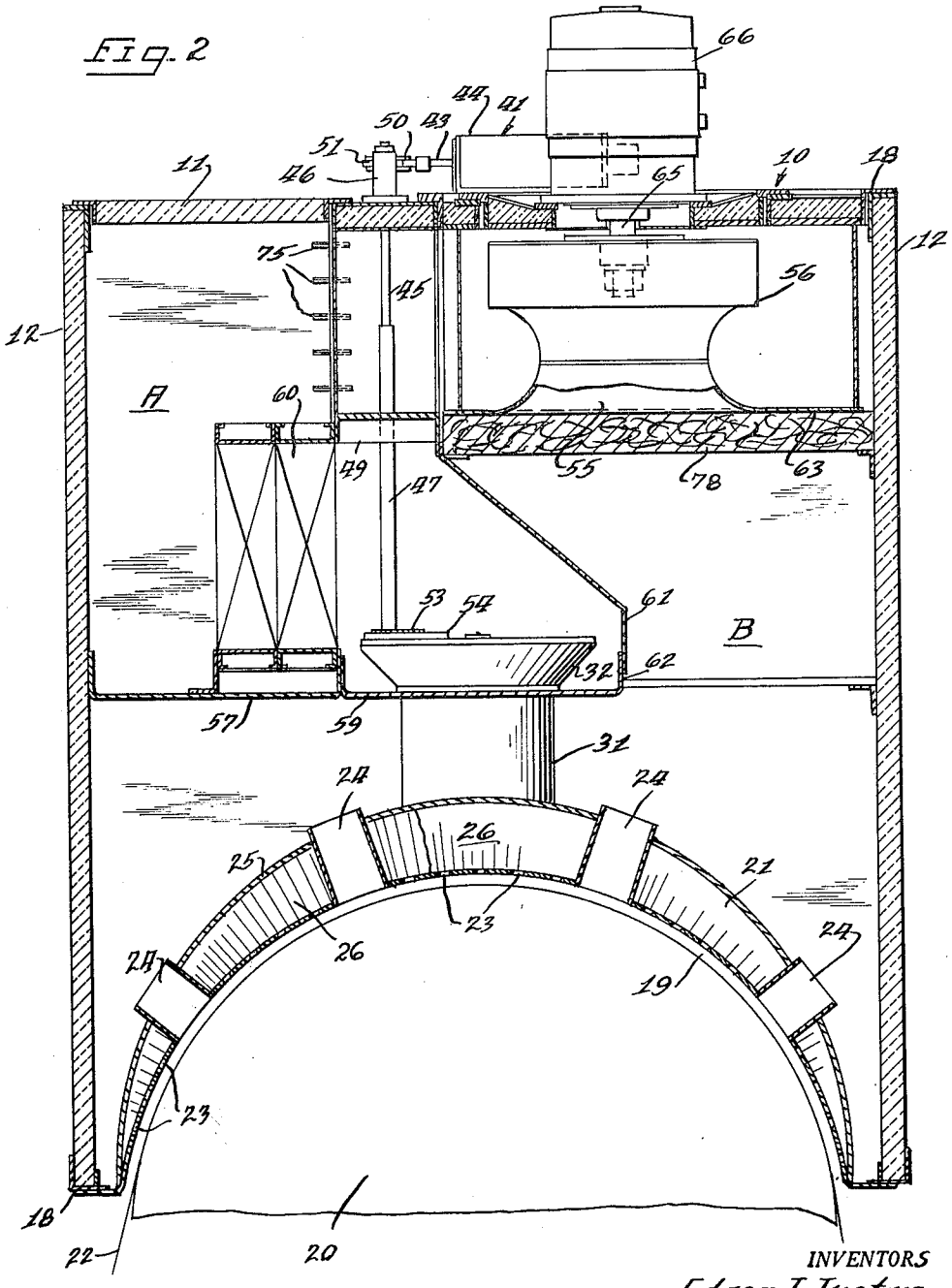

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Fig. 3

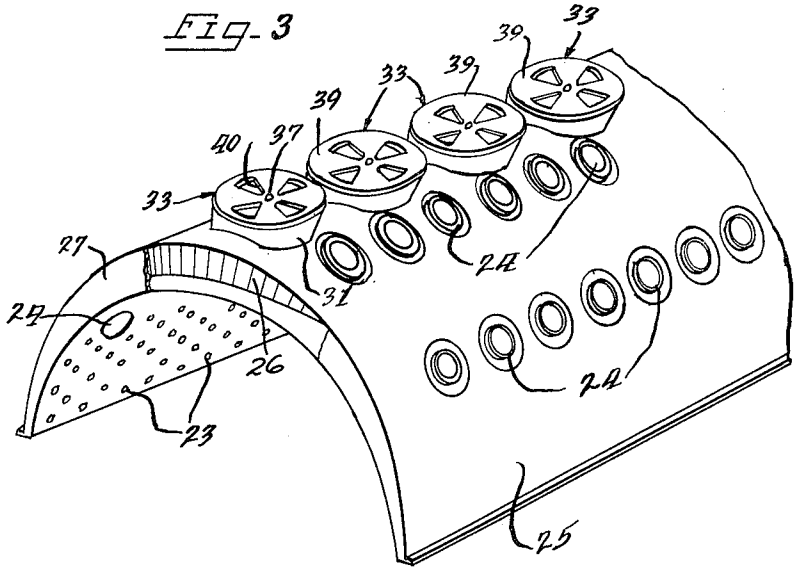
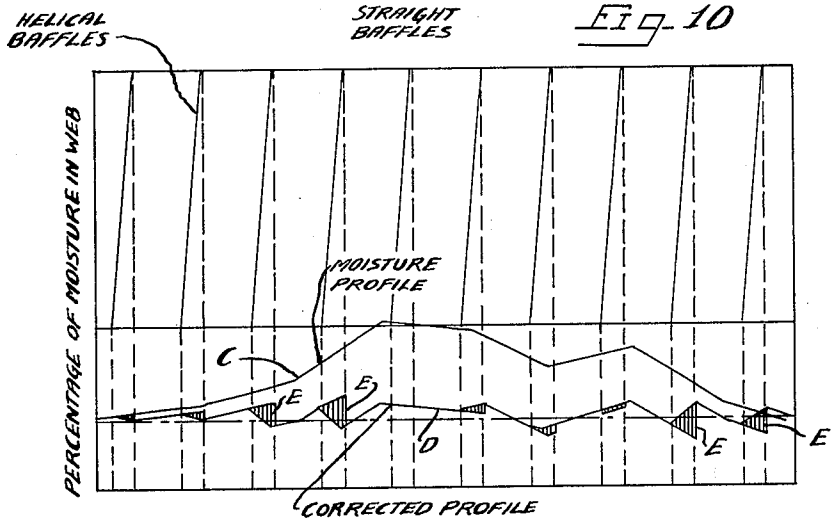


Fig. 10



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DRYER HOOD CONSTRUCTION FOR WEB MATERIAL

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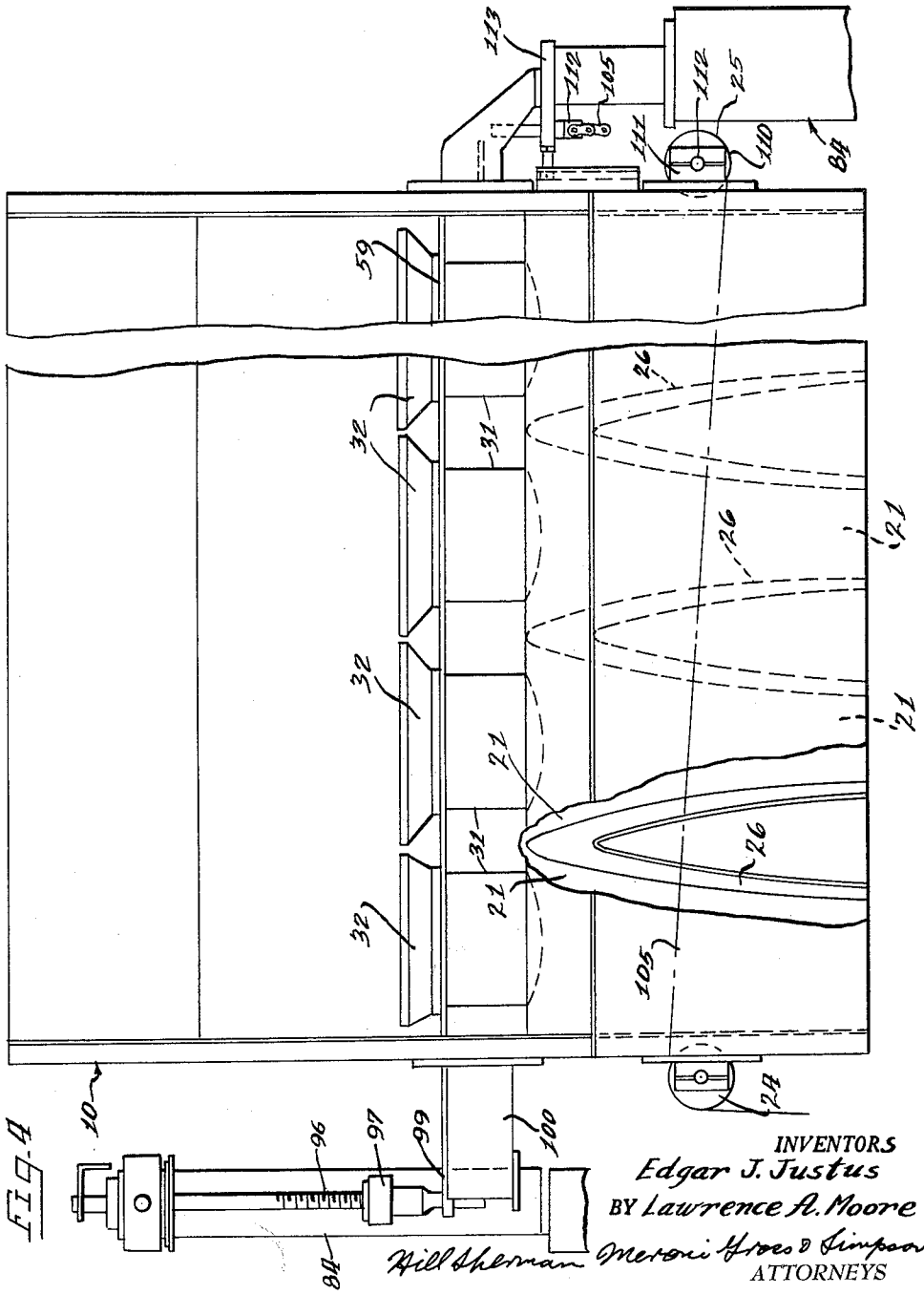

FIG-4

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DRYER HOOD CONSTRUCTION FOR WEB MATERIAL

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Fig. 8

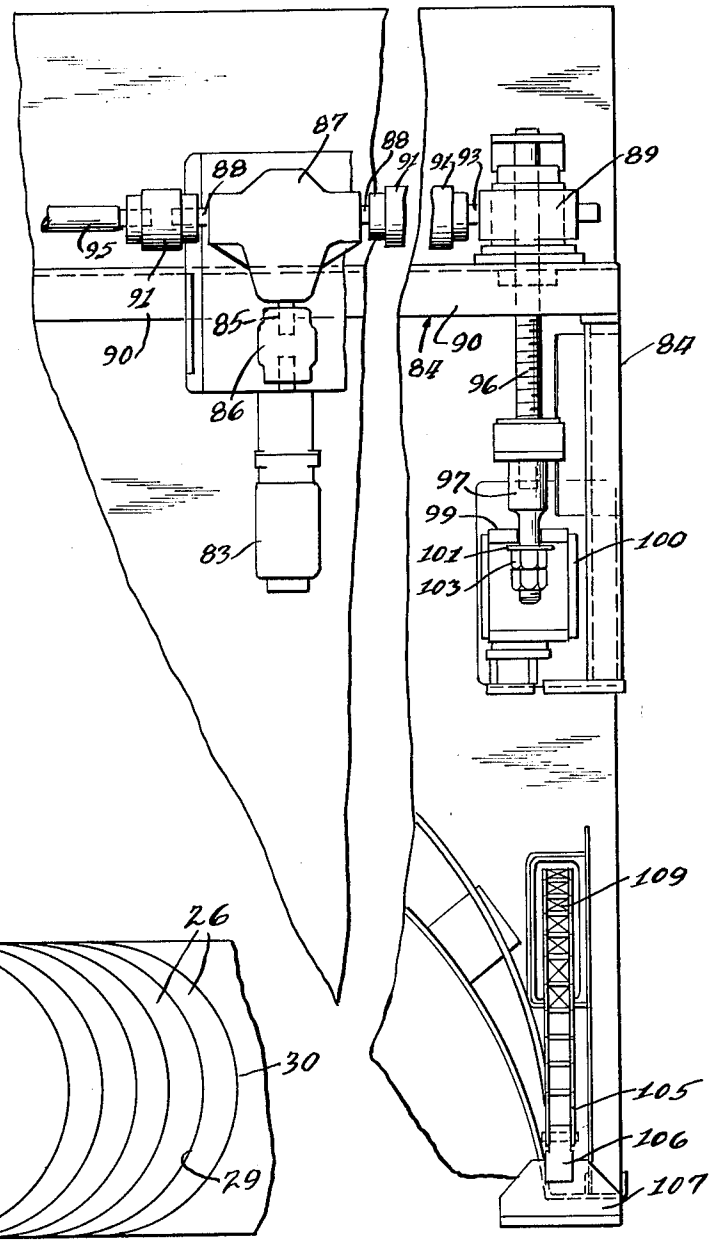

Fig. 5

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DRYER HOOD CONSTRUCTION FOR WEB MATERIAL

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Fig. 1

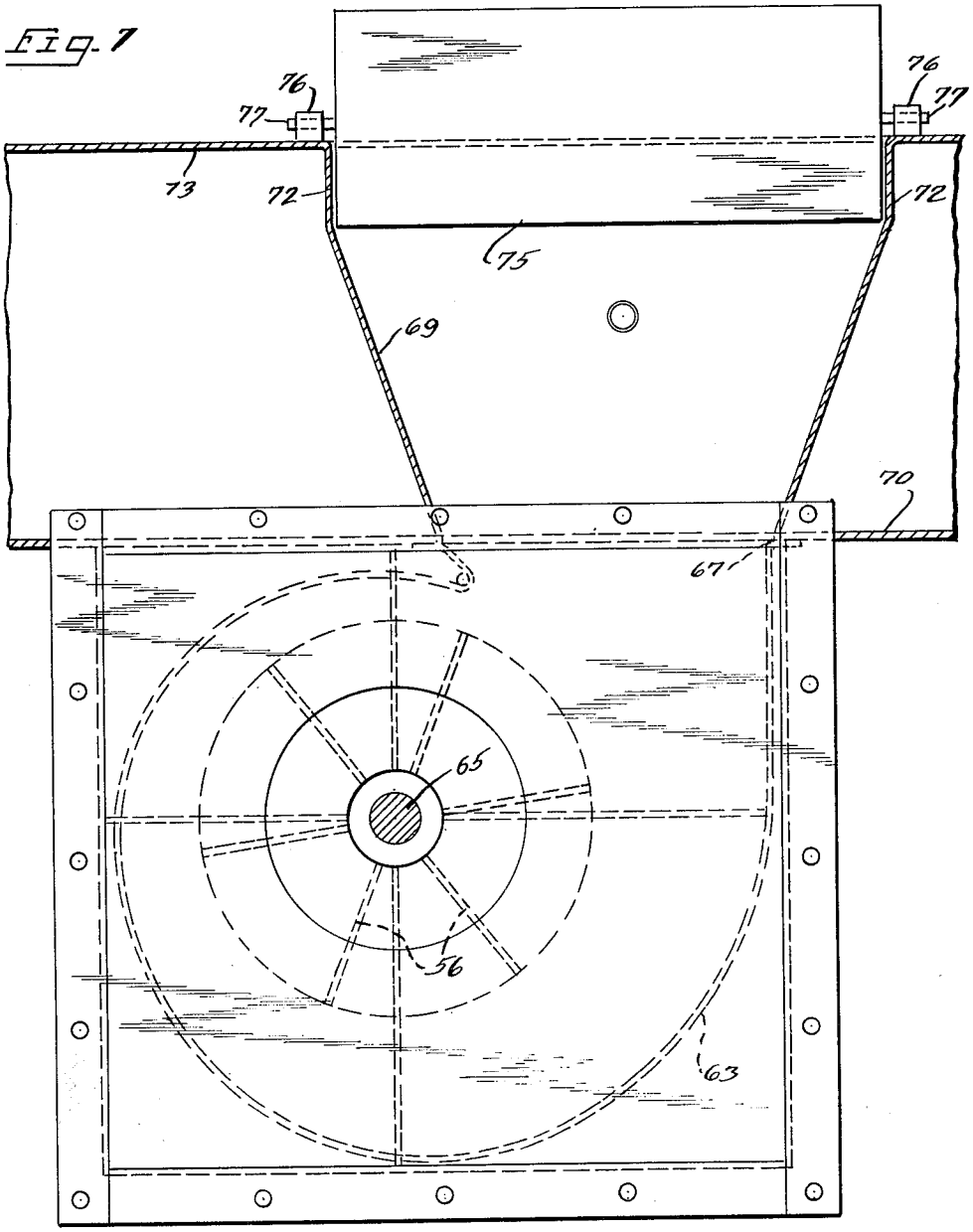

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Fig. 11

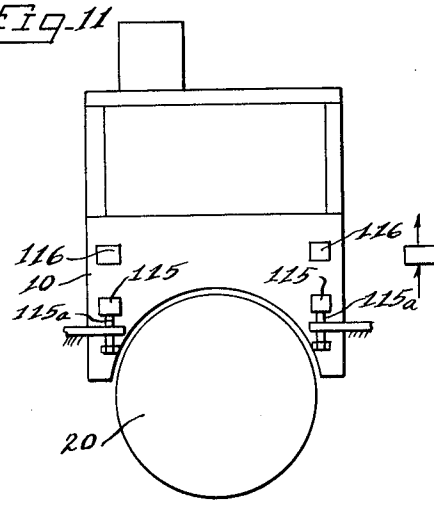


Fig. 12

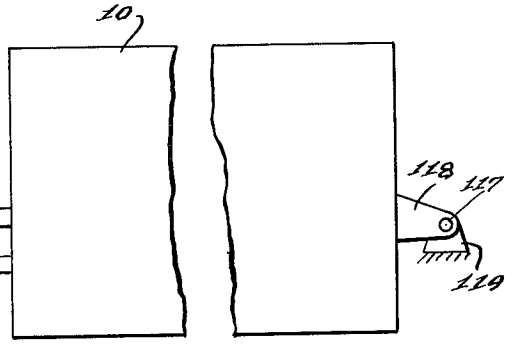


Fig. 13

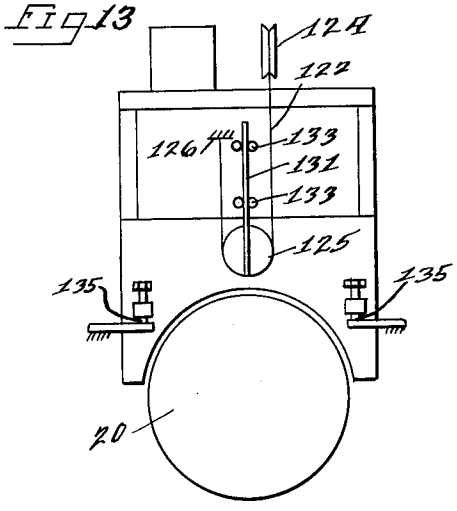


Fig. 14

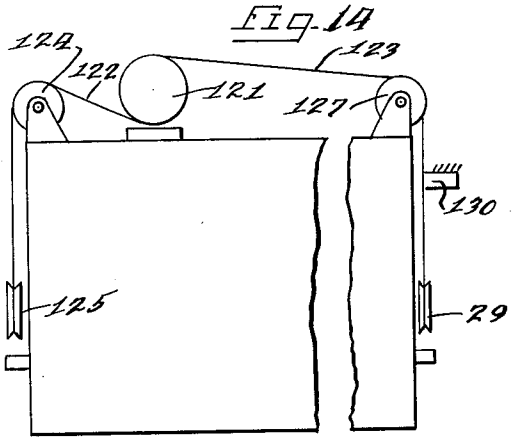
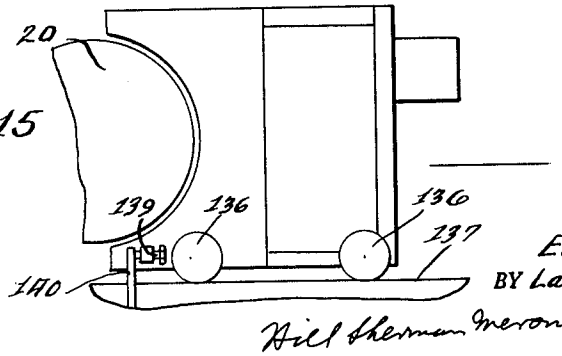


Fig. 15



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DRYER HOOD CONSTRUCTION FOR WEB MATERIAL

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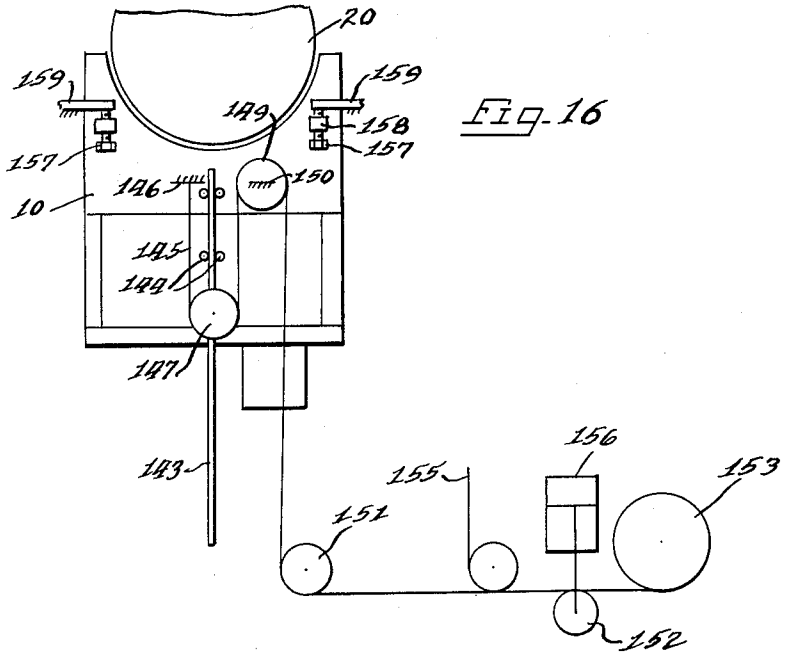

Fig. 16

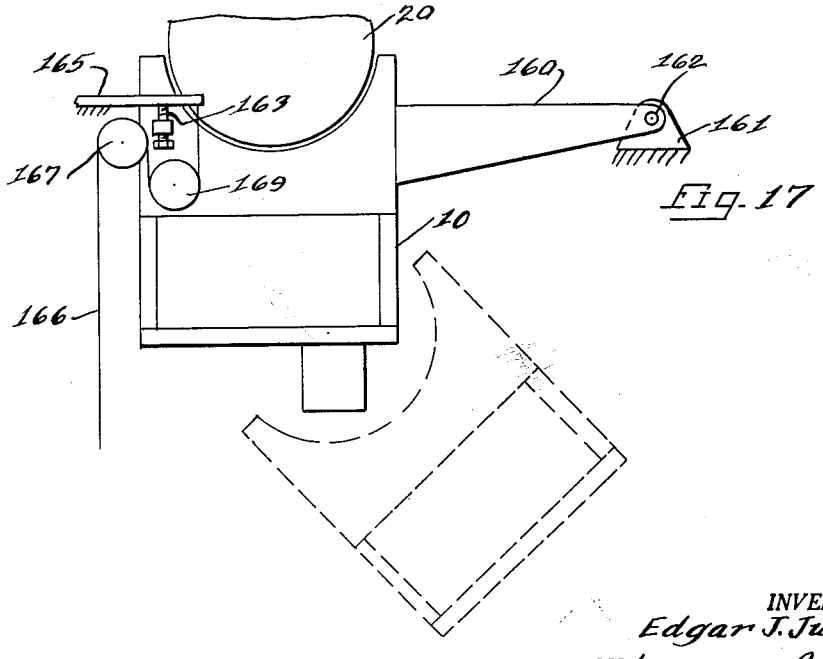

Fig. 17

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United States Patent Office 3,167,408 Patented Jan. 26, 1965

3,167,408
DRYER HOOD CONSTRUCTION FOR WEB MATERIAL

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Filed Nov. 16, 1961, Ser. No. 152,836
7 Claims. (Cl. 34—122)

This invention relates to improvements in dryers for fibrous materials and more particularly relates to an improved form of drier for use in the making of paper.

A principal object of the invention is to provide an improved drier for use in the making of paper arranged with a view toward more uniformly removing moisture throughout the width of a traveling fibrous web.

Another and important object of the invention is to provide an improved form of drier for drying continuously traveling webs of fibrous material, in which the speed and uniformity of moisture removal is increased by varying the application of heat throughout the width of the traveling web and confining the heated air for application to the web, to be discharged through a plurality of adjacent plenum chambers extending helically along the web.

A further object of the invention is to provide a simple and improved form of drier for use in the making of paper, so arranged as to be capable of being used in various positions relative to a surface to be dried.

Still another object of the invention is to provide a simplified and improved form of drier hood for drying traveling webs of fibrous material having a simple and improved power operated mechanism for removing the hood from the traveling web and retaining the hood in fixed relation with respect to the traveling web.

A further object of the invention is to provide an improved drier hood construction for traveling webs of fibrous material, in which the air circulation ducts for circulating heated air to and withdrawing heated air from the traveling web are reduced to a minimum and are self-contained within the drier hood.

A still further object of the invention is to provide a new and improved form of drier hood particularly adapted for use in the making of paper having a simplified and more efficient duct arrangement accommodating the recirculation of the heated air and enabling fresh air to be blended with the recirculating air.

Still another object of the invention is to improve upon the drier hoods for use in the making of paper for drying traveling fibrous webs, in which heated air is distributed along the surface of the web by independent operation of a series of air distribution valves distributing the air to plenum chambers extending along and across the webs, and in which the side walls of the plenum chambers are in the form of helical baffles to enhance the uniformity in drying of the web along adjacent ends of the plenum chambers.

These and other objects of the invention will appear from time to time as the following specification proceeds and with reference to the accompanying drawings wherein:

FIGURE 1 is a diagrammatic perspective view of a drier hood constructed in accordance with the invention looking towards the rear end portion of the hood in order to show the inlet and outlet ducts;

FIGURE 2 is a transverse sectional view taken through the drier hood substantially along line II—II of FIGURE 1;

FIGURE 3 is a perspective view of the plenum chamber, showing the valves for varying the flow of air into the plenum chamber, the impingement nozzles for impinging air on the traveling web and the exhaust passageways for drawing spent air from the web;

FIGURE 4 is a fragmentary side view of the drier shown in FIGURE 1 with certain parts broken away and certain other parts shown in vertical longitudinal section;

FIGURE 5 is a plan view of a plate from which the helical baffles are made, showing the layout of the baffles on the plate for cutting the baffles from the plate with a minimum of waste;

FIGURE 6 is a fragmentary detail plan view showing a form of damper valve that may be used to control the flow of air to the plenum chambers;

FIGURE 7 is a fragmentary plan view of the circulating air fans and damper therefor, with certain of the ducts shown in horizontal section;

FIGURE 8 is an enlarged fragmentary detail front end view of a portion of the hood shown in FIGURE 1, showing the mechanism for raising and lowering the hood with respect to the traveling web;

FIGURE 9 is a diagrammatic view diagrammatically illustrating the air flow through the apparatus;

FIGURE 10 is a moisture content graph comparing the removal of moisture by the use of helical baffles in contrast to parallel baffles in alignment with the line of travel of the web along the hood; and

FIGURES 11, 12, 13, 14, 15, 16 and 17 are diagrammatic views illustrating various ways in which the hood can be installed with respect to the drier surface and various means for moving the hood toward and from the drier surface.

In the embodiment of the invention illustrated in the drawings, in FIGURES 1 and 2 a drier hood **10** is shown as comprising a top wall **11**, side walls **12** and a rear end wall **13** having an air inlet **16** leading thereinto and an exhaust outlet **17** leading therefrom. The hood also has a front wall (not shown) similar to the rear wall **13** and having access openings (not shown) leading into said hood.

The top wall, side walls and end walls of the hood **10** may be made from a suitable insulating material carried in a metal frame structure, a portion of which is shown herein and indicated generally by reference character **18**.

The hood **10** also has a semi-cylindrical bottom wall in the form of an impingement plate **19** conforming generally to the form of the web as it passes about a rotating drying cylinder **20**. The impingement plate **19** forms the bottom plate of a series of plenum chambers **21** arranged in side by side relation with respect to each other for the full length of the hood **10** and drying cylinder **20**, and having a series of air impingement nozzles or orifices **23** leading therethrough for impinging heated air onto a fibrous web **22** traveling about the drying cylinder **20**. The impingement plate **19** also has exhaust passageways **24** leading therethrough withdrawing moist air from the web traveling about the drying cylinder

20 for exhaust to the atmosphere through the exhaust passageway 17, or for heating and recirculation through the air impingement nozzles 23.

The plenum chambers 21 are generally cresent-shaped in transverse vertical section and are formed from the lower impingement plate 19, an upwardly spaced semi-cylindrical plate 25 and a plurality of helical baffles 26 spaced along said plates in the space therebetween and dividing the space between said plates into the plenum chambers 21.

The plate 25 is of the same radius as the plate 19, but is spaced vertically of the plate 19 and has a longer circumferential surface than the plate 19, opposite ends of which abut the plate 19 at the opposite lower end portions thereof and are suitably secured thereto, as by welding. End walls 27 close opposite ends of the plates 19 and 25.

The baffles 26 are shown in FIGURE 5 as being laid out on a strip of plate material. Each baffle 26 has an inner margin 29 conforming to the contour of the inner margin of the plate 19 and an outer margin 30 of the same radius as the inner margin 29, but spaced from the inner margin 29 a distance equal to the spacing between the inner sides of the plates 19 and 25. The baffles 26 may thus be cut from plate material with a minimum of waste of material.

The baffles 26 being cut to the form shown in FIGURE 5 are helically mounted in the space between the plates 19 and 25 in equally spaced relation with respect to each other and at the same pitch, to form the plenum chambers 21 in communiction with the web traveling about the drying cylinder 20 through the impingement orifices 23.

The plate 25 has a plurality of air inlets 31 leading thereinto through the top thereof. Each air inlet leads to an individual plenum chamber 21 and has an outwardly flared upstream end 32 having an air damper valve 33 at the inlet end thereof, controlling the flow of air into the individual plenum chambers in accordance with the requirements for uniformly drying the traveling web.

A preferred form of air damper valve 33 is shown in FIGURE 6 as including an elongated stationary plate 35 mounted in the outwardly flared upstream end 32 of an associated air inlet 31 and having a plurality of segmental air openings 36 and 36*a* of different areas leading therethrough. A vertical pivot pin 37 extends upwardly of the center of the stationary valve plate 35 and forms a pivotal mounting for a rotatable valve plate 39 having segmental openings 40 and 40*a*, corresponding to the segmental openings 36 and 36*a* leading through the stationary plate 35.

Each air valve or damper 33 is operated by an individual air motor 41. The air motors 41 are mounted on the top of the top wall 11 of the hood 10 and are operative to open or close each air valve 33 in accordance with the requirement for air in each plenum chamber 21. Each air motor 41 may generally comprise a piston rod 43 retractibly moved with respect to a cylinder 44 by a spring (not shown) and extensibly moved with respect to said cylinder by a piston or diaphragm (not shown), operatively connected with said piston rod, upon the admission of air under pressure to the head end of said cylinder. The spring (not shown) may be so loaded as to completely close the associated air valve upon the release of air under pressure from the cylinder 44 and to accommodate the air valve to be partially or fully opened, dependent upon the pressure of air admitted to the head end of the cylinder 44. A specific setting of each valve may, therefore, be attained for each selected increment of air pressure.

The operative connection from each piston rod 43 to each air valve 33 includes a vertical shaft or rod 45 rotatably mounted in a bearing boss 46 projecting upwardly of the top wall 11. The rod 45 extends downwardly of the top wall 11 within a sleeve 47 rotatably mounted in a horizontally extending channel 49 extending for the length of the hood 11 and forming a partition within said hood. The piston rod 43 is connected with the shaft 45 through a link 50 pivotally connected at the end of said piston rod, and a crank 51 extending from the rod 45. The connection from the sleeve 47 to the rotatable valve plate 37 includes a gear sector 53 on the lower end of the sleeve 47 and a gear sector 54 fixed to the movable valve plate 37 and meshed with the gear sector 53.

The damper valves 33 may thus be individually fully or partially opened or closed to determine the amount of air to be admitted to each individual plenum chamber, and to thereby control the moisture profile of the web of fibrous material being dried, as will hereinafter be more clearly described as this specification proceeds.

The space above the plate 25 is divided into a pressure zone A in communication with the air valves 33 and air inlets 31, and a vacuum zone B in communication with the exhaust pipes 24 and intakes 55 of individual air fans 56, for each plenum chamber 21. The zones A and B extend for the entire length of the hood 10 between the end walls thereof.

The zones A and B are separated by two channel-like partitions 57 and 59 arranged in abutting engagement with each other and abutting one side wall 12 of the hood and suitably secured to the supporting frame work 18 therefor. The partition 57 forms a mounting for a heater unit 60 extending for the length of the hood 10. The adjacent partition 59 has the air inlets 31 leading therethrough and suitably sealed thereto, and forms a support for said air inlets. A vertical partition 61 is secured to and extends upwardly of an upwardly facing flanged portion 62 of the inner partition 59, and extends upwardly of said flanged portion angularly inwardly to the channel-like partition 49 and upwardly therefrom for the length of the hood 10. The partitions 57, 59 and 61 together with the housing 63 for the air fan 56 thus separate the chambers A and B from each other and accommodate the circulation of air through the exhaust pipes 24 and fan 56 to the pressure chamber A through the heaters 60 and air valves 33 into the plenum chambers 21, and out the plenum chambers 21 through the impingement nozzles or orifices 23.

The fan 56 may be a well known form of suction blower and is shown in FIGURE 2 as being mounted on the lower end of a vertical motor shaft 65, depending from a motor 66 mounted on and extending upwardly of the top wall 11 of the hood 10. The fan housing 63 is shown in FIGURE 7 as being in the form of a scroll having the intake 55 opening through the bottom thereof and extending upwardly to said fan. The fan housing 63 has an outlet 67 in communication with a diverging duct 69 leading through a vertical wall portion 70 of the partition 61 and shown as having outer parallel wall portions 72 terminating in a partition 73 extending vertically of the channeled partition 49 to the top of the hood 10. The parallel wall portions 72 of the duct 69 have a series of damping louvers 75 extending therein. The damping louvers 75 have pivot pins 77 extending outwardly from opposite ends thereof eccentric of the longitudinal centers thereof and pivotally mounted in lugs 76. The lugs 76 project outwardly of the partition 73 adjacent the parallel wall portions 72. The dampers 75 have a greater portion of their weight outwardly of the pivot pins 77 so that the air flow through the duct 69 forces the dampers into the open position shown in FIGURE 7. When, however, an individual fan 56 is shut off, the dampers will close and prevent the short circuiting of air through the fan not in operation.

A filter 78 extends for the entire length of zone B beneath the intake 55 of the fan 56, to filter paper, dust or other contaminants from the exhaust air. The filter 78 may be a conventional form of filter, so need not herein be shown or described further.

The heating element 60 extends for the full length of the hood 10 and may be in the form of high pressure steam coils for raising the temperature of the air to be impinged on the traveling web to the required degree.

The air inlet 16 leading into zone B has a damper 79 therein diagrammatically shown in FIGURE 9. The exhaust outlet 17 in a like manner has a damper 80 therein.

The dampers 79 and 80 may be independently operated and are provided to accommodate the recirculation of air through the system and to mix fresh air with the circulating air, to reduce the moisture content of the air.

During normal operation of the drier the damper 79 may be open to the extent required to maintain the circulating air at the proper moisture content. The fans 56 will then draw air into zone B through the inlet 16 under the control of the damper 79 and will draw in exhaust air through the exhaust passageways 24 through the filter 78, to filter paper fiber and debris therefrom, and force the air through the damping louvers 75 into the pressure chamber A. The air will then be forced through the heater coils 60 and through the individual air valves into the plenum chambers 21 from which the air is forced at high velocity through the impingement nozzles 23 onto the traveling fibrous web. The air having performed its function on the fibrous web is then drawn back into zone B through the exhaust passageways 24, where it may be mixed with fresh air to maintain the air at the required moisture content and recirculated through the air filter 78.

It may here be seen that by regulating the damper 79, the moisture content of the circulating air may be regulated and that by regulating the air damper valves 33 the distribution of hot air over the surface of the web may also be regulated.

In FIGURE 10, we have shown graphic plots of the percentage of water content in the fibrous web at increments of width across the web. Such plots are commonly known as moisture profile curves. Curve C is a curve showing the moisture profile across a fibrous web that may be attained with no correction for moisture content in the web throughout the width of the web. Curve D is a corrected moisture profile curve that may be attained by controlling the air damper valves 33 in accordance with the requirement for removal of moisture from the web across the entire width thereof. This curve shows a relative uniform moisture profile across the width of the web with hatched peaked portions E. These hatched portions E are attained by the use of straight baffles extending in the direction of travel of the web and forming the side walls of the plenum chambers.

Where the baffles are helically mounted in the plenum as in the present invention, the distribution of air from the individual plenum chambers and the resultant drying effect is blended along the adjacent sides of each plenum chamber, resulting in the removal of the peaked hatched portions E from the curve and a relatively level and smooth moisture profile across the width of the web.

Referring now in particular to FIGURES 4 and 8 illustrating a form of mechanism that may be utilized for lifting the hood 10 as a unit from the drying cylinder 20 to afford access to said cylinder for threading a web over said cylinder, or for removing a broken web from said cylinder, a fluid operated motor 83 is shown as being mounted on a transversely extending beam 90 of a frame structure 84 for the drying cylinder 20. The motor 83 drives an aligned shaft 85 through a coupling 86. The shaft 85 is journalled in and extends within a mitre gear box 87 and drives transverse shafts 88 through mitre gears (not shown) contained within said mitre gear box. The shafts 88 extend outwardly from opposite sides of the mitre gear box 87 and drive lifting jacks 89, mounted on the cross beam 90 of the frame structure 84 adjacent opposite ends of said cross beam. The drive from each shaft 88 to the associated jack 89 comprises spaced couplings 91, one of which is driven from the shaft 88 and the other of which drives a shaft 93, for driving the lifting jack 89, and a coupling shaft 95 connecting the couplings 91 together.

The lifting jacks 89 may be well known forms of screw jacks and each has a depending threaded shaft 96 having a coupling member 97 on its lower end extending through a top plate 99 of a bracket 100. A collar 101 on the coupling member 97 abuts the bottom of the plate 99. Lock nuts 103 threaded on said coupling retain said collar to the underside of the plate 99. Operation of the air motor 83 will thus raise or lower the front end of the hood 10 with respect to the frame structure rotatably supporting the drum 20.

The rear end of the hood 10 is raised simultaneously with the front end of said hood by chains 105 extending along opposite sides of said hood. The front ends of the chains 105 have connectors 106 thereon connected to brackets 107 connected to the frame structure 84 supporting the drying cylinder 20. The chains 105 extend upwardly of the brackets 107 around idler sprockets 109 suitably journalled on the drier hood 10 and along opposite side walls 12 of the hood 10 under idler sprockets 110 mounted on brackets 111 on pivot pins 112. The brackets 111 are mounted on the rear wall of the drier hood 10 and frame structure 12 therefor and project rearwardly therefrom. The chains 105 are trained under the idlers 110 and upwardly therefrom and have connectors 112 pivotally connected to their upper ends. The connectors 112 extend through and are connected to brackets 113, mounted on the frame structure 84, supporting the drying cylinder 20. Thus, as the front of the hood is raised, the chains 105 being connected to the frame structure 84 for the drying cylinder 20 at their opposite ends and being trained over and under the respective sprockets 109 will lift the rear end portion of the hood with the front end portion thereof and raise the air impingement plate 19 about the drying cylinder 20.

In FIGURES 11 through 17 we have diagrammatically shown various alternate ways in which the hood 10 may be lifted above the drying cylinder 20 and various positions in which the hood 10 may be installed about the periphery of said dryer drum. In FIGURES 11 and 12 the hood 10 has stops 115 projecting forwardly of its front wall adapted to rest on adjustable stops 115*a* on the supporting frame structure for the dryer drum 20. The hood 10 also has two spaced bars 116 spaced above the stops 115 to which may be attached lifting chains by way of clevices and the like (not shown) for lifting the hood 10 about the axis of a pivot pin 117 spaced rearwardly of the rear wall thereof. The pivot pin 117 pivotally supports an arm 118 extending rearwardly of the rear wall of the hood 10, on a bracket 119 mounted on the supporting frame work for the drying cylinder 20.

In FIGURES 13 and 14 we have shown a hoist unit 121 mounted on top of the hood 10 and have shown flexible cables 122 and 123 extending in opposite directions from said hoist unit. Both cables 122 and 123 are wound in upon operation of said hoist unit. The flexible cable 122 is trained over a sheave 124 mounted at the front end of the hood 10 and is trained downwardly from the sheave 124 to and around a sheave 125 rotatable about an axis perpendicular to the axis of rotation of the sheave 124. From thence the cable 122 is trained upwardly to a fixed abutment 126 which may be the frame structure supporting the drying cylinder 20.

The other flexible cable 123 is trained in a similar manner, but rearwardly of the hoist unit 121 over a sheave 127 at the rear of the hood 10 and downwardly along the rear of the hood around a sheave 129 and upwardly therefrom to a fixed abutment 130 on the frame structure supporting the drying cylinder 20. Guide rails 131 may be positioned at the front and rear of the hood and extend vertically thereof. The guide rails 131 may be engaged by rollers 133 mounted on the front and rear walls of the

hood for guiding the hood as it is vertically moved by the hoist unit 121. The hood 10 may have adjustable stops 135 engageable with the frame structure for supporting the drying cylinder 20, and adjusting the position of the hood with respect to said drying cylinder.

In FIGURE 15 we have shown the hood 10 mounted on flanged wheels 136 riding along rails 137. An adjustable stop 139 is provided to limit movement of the hood 10 with respect to the periphery of the drum 20 by engagement with a fixed abutment 140, which may be on the frame structure supporting the drying cylinder 20.

In FIGURE 16, the hood 10 is shown as extending along the underside of the drying cylinder 20 and as being lowered with respect to said drying cylinder to accommodate the training of a fresh web therearound, or the removal of a broken web therefrom. In this arrangement, the hood is guided for vertical movement along guide rails 143, extending vertically along opposite ends of said hood, on rollers 144, mounted on the front and rear walls of said hood and having rolling engagement with the guide rails 143. A flexible cable 145 is connected at one end to a fixed abutment 146 on the frame structure rotatably supporting the drying cylinder 20 and extends downwardly therefrom to and around a sheave 147 mounted on the hood 10. From thence the flexible cable extends upwardly to and around a sheave 149 mounted on a fixed abutment 150 supported on the supporting frame structure for the drying cylinder 20. From thence the flexible cable 145 extends downwardly to and around a sheave 151 and outwardly therefrom under a tension idler 152 to a hoist 153. The hoist 153 also has a flexible cable 155 wound thereon, trained in a suitable manner to the rear end wall of the hood 10, for lifting said hood in the same manner the forward end portion of said hood is lifted. The take up sheave 152 may serve as a take up for the two flexible cables 145 and 155 and is diagrammatically shown in FIGURE 15 as being operated by a hydraulic cylinder and piston 156. The hood is located with respect to the cylinder 20 by adjustable stops 157 engaging fixed abutments 159 fixed to the supporting frame structure for the drying cylinder 20.

In FIGURE 17, the hood 10 is shown as having a lever arm 160 extending from a side wall thereof and pivotally mounted on a stationary bracket 161 on a pivot pin 162. An adjustable stop 163 is adapted to abut a fixed abutment 165, which may be a part of the supporting frame structure for the drying cylinder 20. The hood 10 is raised and lowered with respect to the drying cylinder 20 by a flexible cable 166 which may be trained from a hoist not shown and is trained upwardly around a sheave 167, which may be mounted on the supporting frame structure for the drying cylinder 20. From thence, the cable 167 is trained downwardly to and around a sheave 169 mounted on the front wall of the hood 10 and upwardly therefrom to the fixed abutment 165, to which it is attached.

The foregoing illustrates a few of the many ways in which the hood 10 may be mounted and withdrawn from and moved into place with respect to the drying cylinder 20 and the fibrous web trained thereabout, and further illustrates the versatility of the self-container dryer hood of the invention and the unlimited positions which it may take with respect to the drying cylinder 20.

It may be seen from the foregoing that a simplified form of self-contained universal dryer hood has been provided containing the pressure and suction circulating passageways within the hood, together with air distributing valves within the hood, controlling the distribution of air along the fibrous web being dried and operable to vary the distribution of air along the web to provide a relatively uniform moisture removal from the web throughout the width thereof.

It may still further be seen that by dividing the plenum into a plurality of individual plenum chambers arranged side by side, by the helical baffles 21, that the air flow from the individual plenum chambers is blended with the resultant leveling off of the high moisture content areas at the junctures between the plenum chambers and a more uniform moisture removal from the web.

It may also be seen that the moisture control of the air impinged upon the traveling web may be more efficiently attained by blending outside air with the recirculated air drawn from the traveling web and that various mixtures of air including the recirculation of the air without blending and the circulation of air from outside of the hood may be attained and controlled in a simple and efficient manner.

While we have herein shown and described several forms in which our invention may be embodied, it may readily be understood that various modifications and variations in the invention may be attained without departing from the spirit and scope of the novel concepts thereof, as defined by the claims appended hereto.

We claim as our invention:

1. In an apparatus particularly adapted for drying a traveling fibrous web in the making of paper;
   - (*a*) a hood,
   - (*b*) a pressure zone within said hood,
   - (*c*) a vacuum zone within said hood,
   - (*d*) at least one air fan in said hood establishing said pressure and vacuum zones,
   - (*e*) an air heater in said pressure zone,
   - (*f*) a plenum in communication with said pressure zone having a plurality of air impingement nozzles leading therefrom,
   - (*g*) exhaust passageways leading from the traveling web and passing through said plenum and having communication with said vacuum zone,
   - (*h*) and spaced helical baffles extending along said plenum and dividing said plenum into a plurality of plenum chambers having helical side walls blending the air passing through adjacent plenum chambers onto the traveling web.

2. In a drying apparatus and in combination with a drying cylinder adapted to have a fibrous web trained thereabout;
   - (*a*) a hood extending along said drying cylinder,
   - (*b*) a pressure zone within said hood,
   - (*c*) a vacuum zone within said hood,
   - (*d*) a fan and common partition means cooperating therewith to establish said pressure and vacuum zones,
   - (*e*) an air filter in said vacuum zone,
   - (*f*) an air heater in said pressure zone,
   - (*g*) a plurality of pressure passageways communicating with said pressure zone and spaced along and within said hood,
   - (*h*) a plurality of plenum chambers extending along said hood in communication with said pressure passageways,
   - (*i*) an air impingement plate forming an outer wall of said plenum chambers and conforming to and spaced closely adjacent said drying cylinder and having
   - (*j*) a plurality of air impingement nozzles leading therethrough,
   - (*k*) exhaust passageways passing through said air impingement plate and affording communication between the traveling web and said vacuum zone, for withdrawing spent air from the traveling web,
   - (*l*) and a plurality of spaced helical baffles extending along the inner side of said impingement plate in the direction of travel of the web and defining the side walls of said plenum chambers.

3. In a drying apparatus for paper and the like and in combination with a rotating drying cylinder adapted to have a web trained thereabout;
   - (*a*) a hood extending along said cylinder and having
   - (*b*) an air impingement plate generally conforming to and spaced closely adjacent said drying cylinder,

(c) a pressure zone in said hood,
(d) a vacuum zone in said hood,
(e) a plurality of independently operable fans spaced along said hood and common partition means cooperating therewith to establish said pressure and vacuum zones,
(f) an air heater extending along said pressure zone,
(g) a plate spaced from said impingement plate and sealed thereto,
(h) a plurality of helical baffles in the space between said plates, extending in the general direction of travel of the web along said cylinder and dividing the space between said plates into
(i) a plurality of plenum chambers arranged in side by side relation with respect to each other,
(j) individual air inlets, leading from said pressure zone to said plenum chambers,
(k) a plurality of exhaust passageways leading through said plate and establishing communication between the web and said vacuum zone,
(l) independently operable air valves in said inlet into said plenum chambers for varying the delivery of air thereto,
(m) and dampers at the discharge end of each of said fans preventing the short circuiting of air through an inoperative fan.

4. In a drying apparatus particularly adapted for drying paper webs and in combination with a drying cylinder;
(a) a hood extending along said drying cylinder and having
(b) an air impingement plate generally conforming to the path of travel of the paper web about said cylinder,
(c) a pressure zone within said hood,
(d) a vacuum zone within said hood,
(e) at least one fan and common partition means cooperating therewith to establish said pressure and vacuum zones,
(f) an air heater in said pressure zone,
(g) an air inlet into said vacuum zone,
(h) damper means in association with said air inlet to vary the flow of air into said vacuum zone,
(i) an air outlet from said pressure zone,
(j) damper means in said air outlet adapted to vary the flow of air from said pressure zone,
(k) a plurality of helical baffles extending along the inner side of said impingement plate in the direction of travel of the web about said cylinder,
(l) a plate extending along the outer periphery of said baffles and cooperating with said impingement plate and baffles to form
(m) a plurality of plenum chambers arranged in side by side relation with respect to each other having helical side walls,
(n) an individual inlet from said pressure zone into each plenum chamber,
(o) valve means controlling the flow of air into said plenum chambers,
(p) and exhaust passageways leading through said plenum chambers into said vacuum zone for withdrawing spent drying air from the traveling web.

5. In a drying apparatus and in combination with a rotatable drying cylinder having a web traveling thereabout;
(a) a hood extending along said cylinder and having
(b) an impingement plate conforming to and spaced closely adjacent said drying cylinder having
(c) a plurality of air impingement nozzles leading therethrough,
(d) an air inlet leading into said hood,
(e) an exhaust outlet leading from said hood,
(f) damper means in said air inlet and said exhaust outlet operable to vary the flow of air into and from said hood,
(g) a pressure zone within said hood having communication with said exhaust outlet,
(h) a vacuum zone within said hood having communication with said air inlet,
(i) a plurality of exhaust passageways passing through said impingement plate into said vacuum zone,
(j) a plurality of fans extending along said hood and partition means cooperating therewith to establish said pressure and vacuum zones,
(k) an air heater in said pressure zone downstream of said exhaust outlet,
(l) a plurality of plenum chambers extending along said impingement plate on the inside thereof and having
(m) opposite helical side walls extending in the general direction of rotation of said drying cylinder,
(n) individual air inlets into each plenum chamber,
(o) individual air valves controlling the flow of air through said inlets to said plenum chambers,
(p) and individually operated air motors having connection with said air valves for determining the positions of said valves.

6. In a drying apparatus and in combination with a rotatable drying cylinder having a web traveling thereabout;
(a) a hood extending along said cylinder and having
(b) an impingement plate conforming to and spaced closely adjacent said drying cylinder having
(c) a plurality of air impingement nozzles leading therethrough,
(d) an air inlet leading into said hood,
(e) an exhaust outlet leading from said hood,
(f) damper means in said air inlet and said exhaust outlet operable to vary the flow of air into and from said hood,
(g) a pressure zone within said hood having communication with said exhaust outlet,
(h) a vacuum zone within said hood having communication with said air inlet,
(i) a plurality of exhaust passageways passing through said impingement plate into said vacuum zone,
(j) a plurality of fans extending along said hood and partition means cooperating therewith to establish said pressure and vacuum zones,
(k) an air heater in said pressure zone downstream of said exhaust outlet,
(l) a plurality of plenum chambers extending along said impingement plate on the inside thereof and having
(m) opposite helical side walls extending in the general direction of rotation of said drying cylinder,
(n) individual air inlets into each plenum chamber,
(o) individual air valves controlling the flow of air through said inlets to said plenum chambers,
(p) and pressure operated dampers at the discharge of each fan, closing upon the shutting off of an individual fan and preventing the short circuiting of air through the fan.

7. In a drying apparatus and in combination with a drying cylinder adapted to have
(a) a fibrous web traveling thereabout,
(b) a hood extending along said cylinder,
(c) a pressure zone within said hood,
(d) a vacuum zone within said hood,
(e) fan means within said hood establishing said pressure and vacuum zones,
(f) an air impingement plate forming a wall of said hood and generally conforming to said cylinder and having
(g) air impingement nozzles leading therethrough,
(h) exhaust passageways leading through said air impingement plate to said vacuum zone,

(*i*) a plurality of plenum chambers spaced along the inner side of said impingement plate,

(*j*) an individual inlet into each plenum chamber,

(*k*) selectively operable valve means controlling the flow of air from said pressure zone through said inlets into said plenum chamber,

(*l*) and helical baffles extending along the inner side of said impingement plate in the general direction of travel of the web about said cylinder and defining the side walls of said plenum chambers and blending the flow of air through said air impingement nozzles along adjacent plenum chambers.

References Cited in the file of this patent

UNITED STATES PATENTS

1,757,948	Hockley	May 6, 1930
2,837,830	Fry	June 10, 1958
2,919,495	Underhay	Jan. 5, 1960
2,928,185	Drew	Mar. 15, 1960
2,939,222	Svavar	June 7, 1960
3,012,335	Allander	Dec. 12, 1961
3,052,991	Goldner	Sept. 11, 1962

FOREIGN PATENTS

620,037	Canada	May 9, 1961