

Sept. 11, 1962

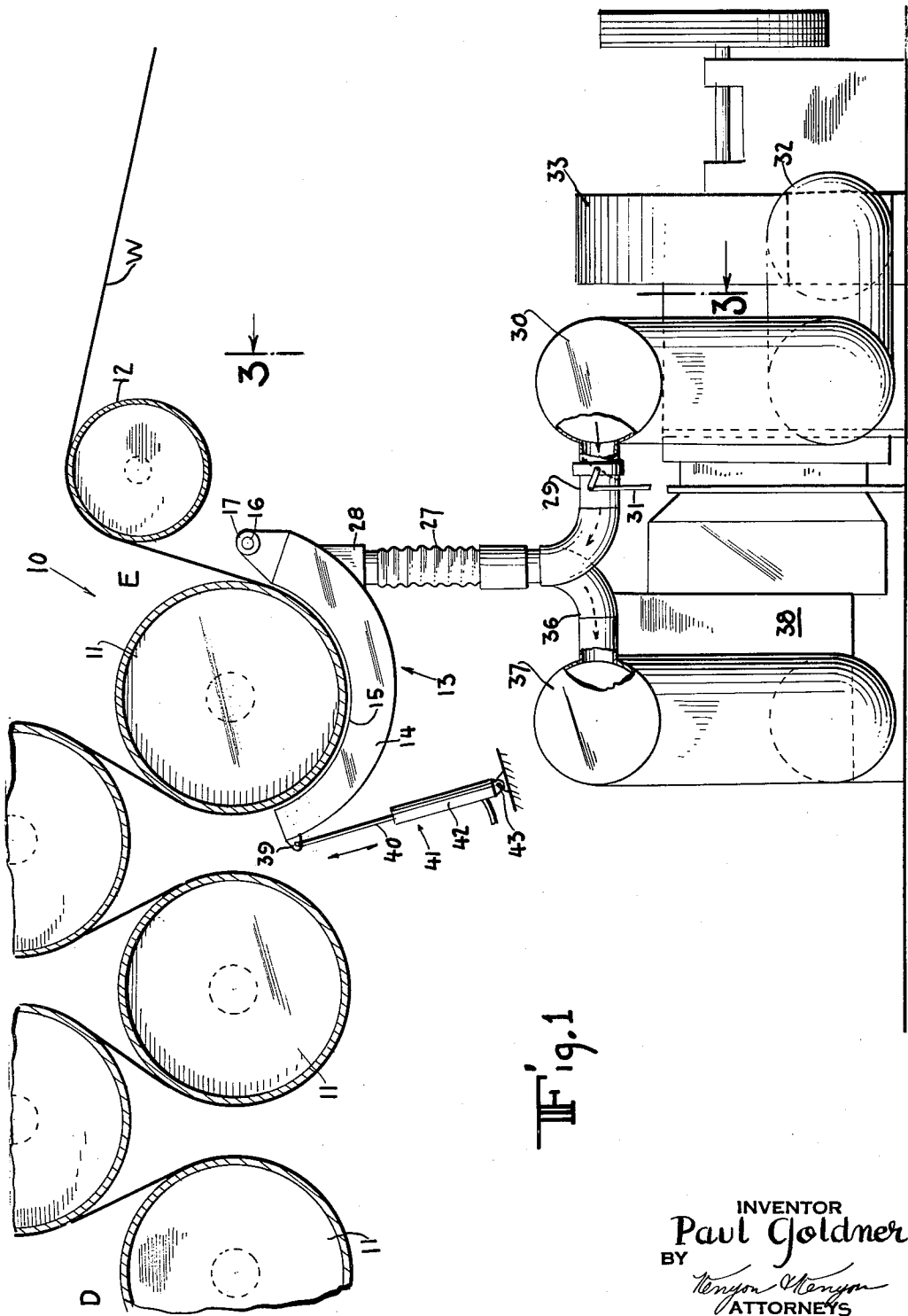
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3,052,991

APPARATUS FOR UNIFORM ACCELERATED DRYING OF WEB MATERIAL

Filed Feb. 24, 1959

5 Sheets-Sheet 1



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5 Sheets-Sheet 2

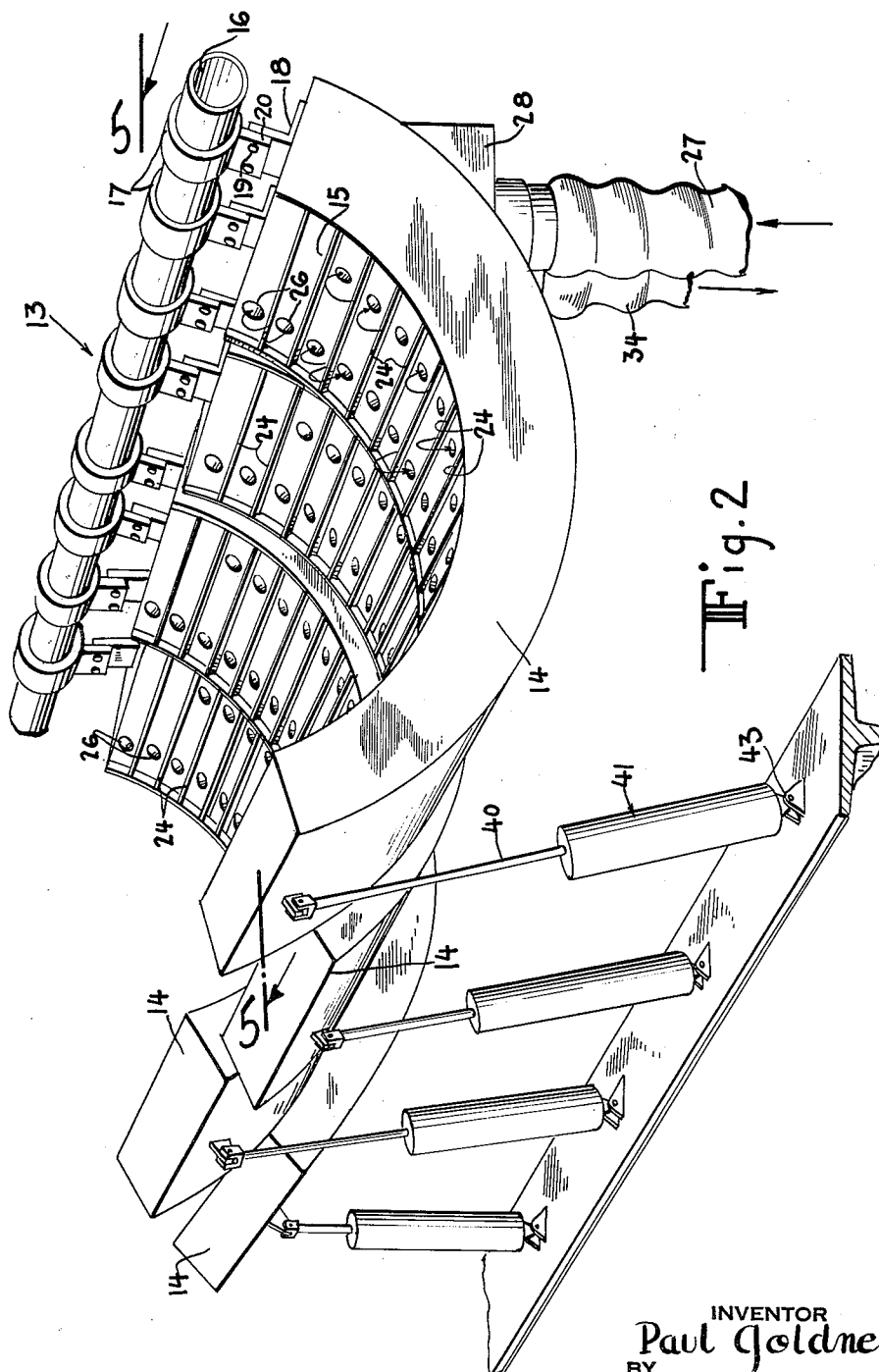


Fig. 2

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5 Sheets-Sheet 3

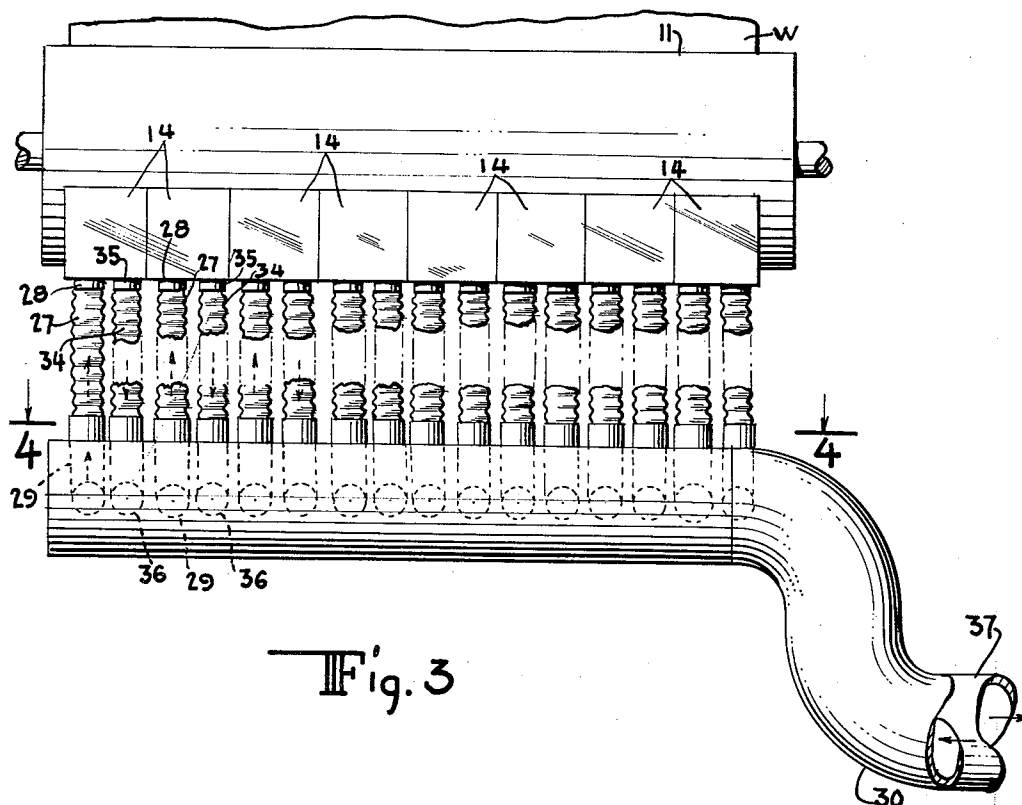


Fig. 3

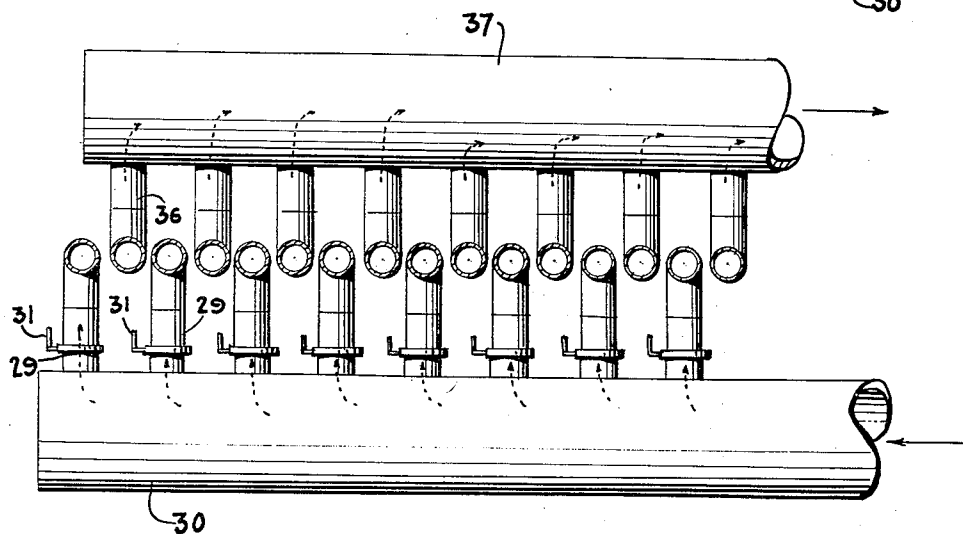


Fig. 4

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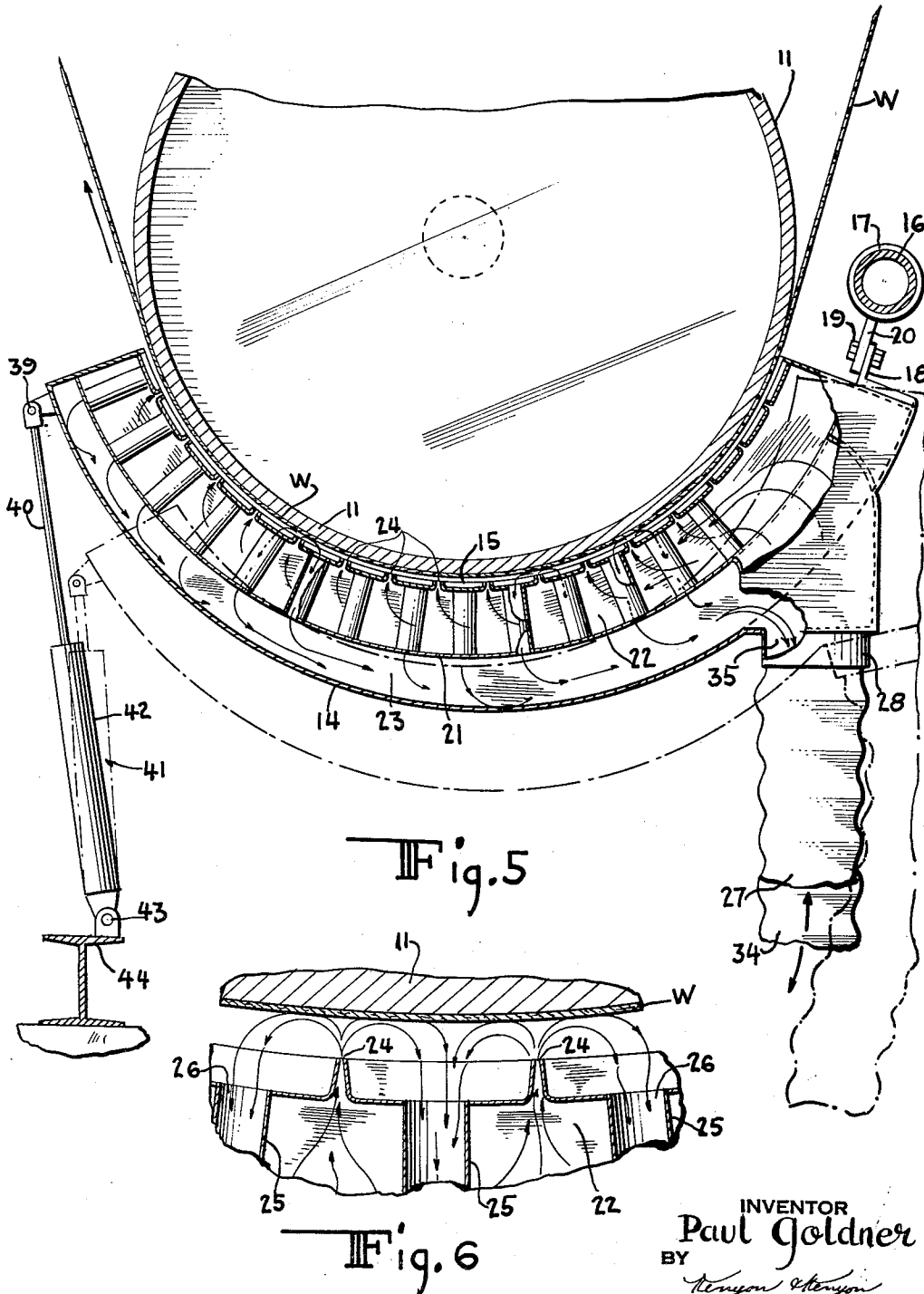
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APPARATUS FOR UNIFORM ACCELERATED DRYING OF WEB MATERIAL

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5 Sheets-Sheet 4



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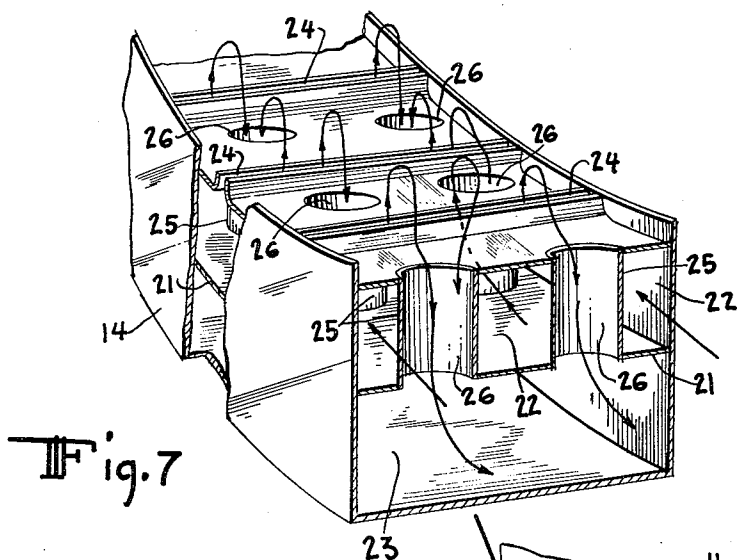
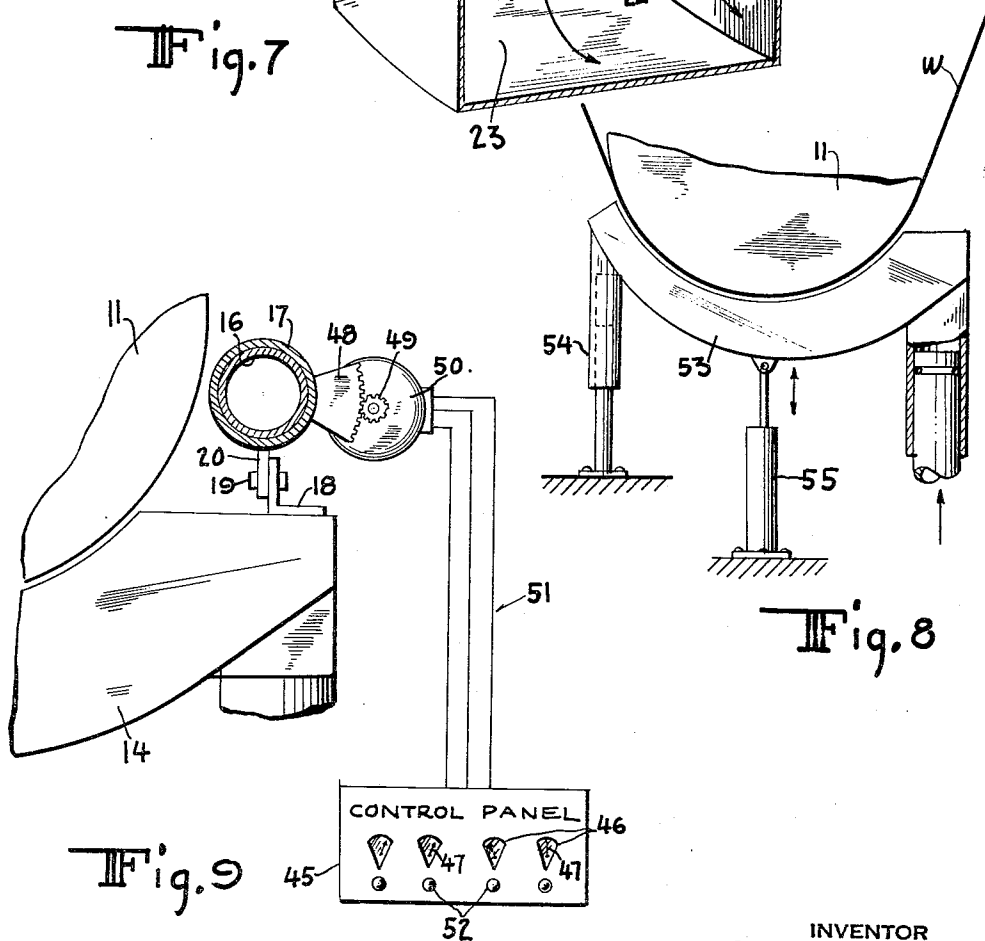
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APPARATUS FOR UNIFORM ACCELERATED DRYING OF WEB MATERIAL

Filed Feb. 24, 1959

5 Sheets-Sheet 5



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APPARATUS FOR UNIFORM ACCELERATED DRYING OF WEB MATERIAL

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10 Claims. (Cl. 34-89)

This invention relates to apparatus for removing moisture in a moving web of material of either uniform or non-uniform distribution at an increased or accelerated drying rate.

This invention is applicable to the drying of web-like or other material either in base form, such as uncoated papers, cloth, paperboard, etc., or as a drying medium for like material after it has been processed either by impregnation or surface coating.

Customary practice has been to utilize conditioned air, varying in temperature and moisture content and blow it at the material at equal velocity across the material width for accelerated drying only, without thought to moisture uniformity in the end result. This has been done either by individual nozzles using single or double rows of nipple type outlets or by an extended length of duct across the material width with the air outlets in the form of continuous slots, nipples, or openings of various shapes and sizes.

This practice, though it does accelerate drying is not wholly satisfactory due partly to the fact that the moisture in the web at many times is not uniform across the width at the beginning of the drying cycle or becomes non-uniform as it moves from its unfinished to its finished states. The same would be true if the material were impregnated or surface coated.

Since the presently known drying arrangements have not taken this non-uniformity into consideration, the result has been a finished product of varying percentages of dryness across the width, and, naturally, the full length of the material. This inefficiency and non-uniformity result in an unsatisfactory or unsalable product, or in undue waste occurring in trying to salvage some part of the end product.

Primary objects and features of this invention are to provide an arrangement for drying of the aforesaid materials uniformly as to the desired moisture content at an accelerated drying rate, regardless of the moisture distribution at the beginning of the process, in a manner that will be economical, efficient and completely and easily controlled.

Generally speaking, the rapidity with which the moisture is removed from the web depends on a combination of the temperature and velocity of the supply air. Individually movable side by side disposed sections or heads arranged widthwise of the material are used in practicing this invention. The individual sections or drying heads can be adjusted to meet the requirements of the material, and their sectional performance lends itself to the needed flexibility for acceleration and uniformity in the drying process.

More in detail and using paper specifically as the material, it will be found that there generally are three problems that continuously face the paper maker.

(1) Sheet moisture content varying across the width of the sheet or web as it enters the drying section of the wet end.

(2) The moisture content of the sheet or web as it enters the drying section may be evenly distributed, but is upset before the web leaves the dry end of the dryer section.

(3) The sheet or web enters the dryer section with even moisture distribution and remains so until a secondary process is introduced, e.g. by adding a surface coating to the sheet, which upsets the moisture distribution.

Other objects and features of this invention therefore are the provision of arrangements adapted to cope with the problems just enumerated and to provide effective inexpensive solutions therefor.

Additional objects and features of the invention are the provision of a versatile arrangement to cope with the unusual and undesired moisture irregularities at any location of the web and of the drying process where they may arise particularly during accelerated drying.

Further objects and features of the invention will become apparent from the following specification and the accompanying drawings wherein:

FIG. 1 is an elevational partially diagrammatic view of a web dryer section including the novel accelerated drying arrangement of this invention;

FIG. 2 is a perspective view of one form of dryer arrangement of this invention;

FIG. 3 is an elevational view of the arrangement seen in the direction of the arrows from the plane of line 3-3 of FIG. 1;

FIG. 4 is a view seen in the direction of the arrows from the plane of line 4-4 of FIG. 3;

FIG. 5 is a sectional view seen in the direction of the arrows along the plane of line 5-5 of FIG. 2;

FIG. 6 is an enlarged fragmentary detail viewed similarly;

FIG. 7 is a fragmentary partially broken away perspective view of one of the independent sections of the dryer arrangement of this invention;

FIG. 8 is a side elevational view of a modified device; and

FIG. 9 is a diagrammatic view of a control panel for determining positions of various of the movable heads of the invention.

Although the invention is described herein for use in drying a web moving on a cylinder, it is applicable likewise for use with flat surfaced webs.

Referring to the drawing and first to FIG. 1, the reference character 10 generally denotes the dryer section of web treating machinery such as in a paper web treating machine. This section 10 includes a plurality of cylinders or rolls 11 over and around which a web W of paper or other web material requiring drying, impregnation and/or surface coating are passed, the said web W being delivered to the moist or entry end E of said section 10 over an initial guide roll 12, and passing progressively over the various rolls 11 through the dryer section 10 to its delivery or dry end D.

The dryer unit 13 constituting the subject matter of this invention, is in the embodiment shown, positioned for application to the web adjacent the first of the rolls 11, it being understood that this unit 13 or substantial duplicates thereof may be positioned adjacent any other intermediate locations or subsequent rolls 11 of the sec-

tion 10 if web moisture conditions are found to require such inclusion and placements.

It is contemplated that the web W may have considerable width approximating 16 feet or more, although the invention is also of utility for treatment of narrower webs. The rolls 11 generally have lengths slightly in excess of the maximum web width to be passed through the dryer section 10.

The dryer unit 13 comprises a plurality of like contiguously disposed sections or heads 14. In the embodiment shown, each head 14 as seen in end elevation has a generally arcuate surface 15 generally concentric with the arcuate surface of the cylinder or roll 11 and of somewhat larger diameter than the combined diameters of the roll 11 and the web W passing around the latter. The heads 14 each have a width which is a fractional part of the width of the web and are all hingedly suspended in side by side relationship widthwise of the web as from a pivot tube, bar or pipe 16, for example by the yokes 17. In the embodiment shown, suspension of each head 14 from its yoke 17 is through the agency of an angle bar 18 secured to the head and which is bolted at 19 to a flange 20 extending from its yoke 17. Thus, each head 14 may be swivelled and/or removed or replaced independently from its supporting yoke 17 without reference to the other heads.

Each head 14 is preferably hollow and is subdivided by an arcuately extending partition 21 (FIGS. 5 and 7) into a pair of plenums 22 and 23, the plenum 22 being intended to serve as a gas delivery distribution chamber, and plenum 23 as a gas withdrawal chamber.

The plenum 22 is provided with a plurality of preferably regularly spaced outlets 24, with spacing as required to meet design conditions of the web material W to be processed, that is, to handle the maximum volume and velocity of the required drying air or other gas. As shown, these outlets 24 having the form of equispaced head width spanning slots or openings provided in the arcuate surface 15 of the head, all of which outlets 24 communicate with the plenum 22.

The second or gas withdrawing plenum 23 is connected by a plurality of conduits or tubes 25 extending through the partition 21 to gas withdrawal openings 26 in the arcuate surface 15. These openings 26 are positioned intermediate the outlets 24. The tubes, return ducts or conduits 25 serve to withdraw air or gas ambient the web surface via openings 26 to plenum 23. The arrangement of withdrawal openings 26 adjacent dispensing openings 24 insures short flow paths for dispensed gas which as shown in FIG. 6 is withdrawn with picked up moisture through the adjacent openings 26 closest to the particular opening 24 from which the gas has been blown against the web.

A flexible supply conduit 27 is connected to a nozzle 28 for each head which communicates with the plenum 22 and also to a nozzle 29 of a common air or other gas supply duct 30. Each nozzle 29 is controlled by an individual damper or valve 31. Air or other gas is delivered to the common duct 30 from a reservoir or tank 32 into which it is forced as by connection to the outlet end of a blower 33.

A flexible supply conduit 34 is connected to a nozzle 35 for each head which communicates with its plenum 23 and, also, to a nozzle 36 communicating with a common duct 37 to a storage reservoir or box 38 also connected to the inlet or suction side of blower 33. The air or other gas withdrawn from the web and drawn into reservoir 38 may be treated therein as desired, e.g. to dehumidification, filtration, heating and/or other steps prior to re-introduction by blower 33 into the reservoir 32 for recycling. Also the reservoir 32 may be provided with an additional means (not shown) for introducing fresh air or other desired gas. Likewise the air or other gas introduced into reservoir 32 may be further conditioned and elevated by conventional means to humidity condi-

tions and to temperatures found optimum under given circumstances for web drying purposes.

It is to be noted that the partition 21 which subdivides the inner space of each head 14 into the delivery and withdrawal plenums 22 and 23 is disposed internally of said head to provide required tapers and if desired the defining walls of said plenum may also be shaped so that the respective plenums 22 and 23 have shapes that equalize gas dispersal and withdrawal flows along lengths of the arcuate surface 15.

In the embodiment shown there are eight contiguously disposed heads 14 each of which is constructed as just described. There are thus eight flexible distributing tubes or ducts 27, eight dampers or control valves 31 therefor, and eight withdrawal conduits or ducts 34. The eight ducts 27 and eight ducts 34 are connected to the respective common ducts 30 and 37.

Each damper valve 31 is independently operable manually or mechanically to control inflow of air via its associated duct 27 to the air dispersing plenum 21 of the particular head 14 connected to such duct. Thus air distributed via the openings 24 of each head and blown therefrom against the outer surface of web W directly adjacent the openings may be controlled as to volume and velocity independently of the control of air dispensed by any other head.

In addition, since each head 14 is swingable independently by its yoke 17 on bar 16, it is possible to adjust the relative spacing of each head surface 15 with respect to the portion of the surface of the web with which it lies in proximate registry, merely by swivelling a particular head toward or away from the said web. The heads 14 are independently adjustable as is depicted in FIG. 2. The individual adjustment of each head 14 may be effected, manually, mechanically, electrically or hydraulically. In the embodiment shown each head 14 is connected pivotally at 39 to an independent movable piston rod 40 of an hydraulic or pneumatic cylinder 41 of conventional construction whose casing 42 is pivotally connected at 43 to a fixed base position 44. Admission or release of water, air or other hydraulic pressure fluid to the respective cylinders 41 may, for convenience, be manipulated from a common control board or panel 45 (FIG. 9).

This control panel also includes indicator devices 46, e.g. movable pointers 47 of meters of volt or ampere type whose individual positions relative scales on the devices 46 serve to depict relative angular dispositions of the individual heads 14 with respect to the surface of web W. In effecting this indication, the respective yokes 17 may be provided with arcuate segmental gears 48 meshing respectively with drive shaft gears 49 of conventional "Selsyn" generators 50. The respective outputs of the said generators are connected by appropriate conduits 51 to respective inputs of the meters 46 so that the electric outputs of the generators 50 serve respectively to move the pointers 47 of said meters to positions representing the respective angular dispositions of individual heads 14.

Control knobs 52 on the panel one for each head may be utilized to manipulate operating pressure delivery to respective of the cylinders 41 for appropriate activation of the said cylinders 41 and consequent individual adjustment of the angular swing or swivel of the individual heads 14 as desired. The exact electrical circuits and mechanisms for achieving the adjustments above are conventional in nature and do not per se form part of this invention.

In addition, while the swivel mounting of the independent heads 14 is presently preferred, the variant depicted in FIG. 8 is possible. Therein the heads 53 which correspond in structure, and purpose to heads 14, instead of being swivelly mounted, are carried on telescoping supports 54. Each head 53 is independently movable in a generally radial direction toward and away from the web

W on cylinder 11 as by a pneumatic or hydraulic cylinder 55 controlled in the same way as cylinders 41 or by other suitable means.

Distribution and blowing of air or gas from heads 53 over prescribed web sections is accomplished in the same way as with heads 14, as is withdrawal of air from the web areas associated with heads 53.

The embodiment of FIG. 8 is applicable also directly to use with flat webs merely by changing the curved shape of its arcuate surface to flat configuration.

Operation

Observation of conditions at the entry end E of the dryer section 10 determines operational conditions. The operator adjusts the rate of air flow to each head 14 so as to effect generally optimum accelerated drying by using maximum volumes, velocities and temperatures for air emanating from the outlets 24 of the respective heads 14. He then manipulates the controls of cylinders 41 to bring the arcuate surfaces 15 of the heads in closest proximity to the traveling web W moving as depicted in the direction of arrows of FIG. 1. If uniform accelerated web drying is observed under these conditions, no further adjustments are required. On the other hand, if non-uniformity is observed in various web locations across the width of the web, the velocity and volume of air flow from the outlets 24 of heads 14 directly adjacent the said locations by appropriate operation of their dampers or valves 31 is effected. Also required spacing of the arcuate surfaces of such heads 14 relative to said web by operation of the required individual cylinders 41 is effected. Since each head 14 only dominates a limited field of web width and a plurality of said heads extending as a group the full width of the web are used, each head being independently movable toward and away from the web surface for controllable distances, and since velocities and volumes of air emanating from the outlets 24 of each head toward the web from the various heads is separately controllable, fine gradients of drying action and humidity control may be effected in all regions across the width of the web so that substantially complete uniformity of drying across the width of the web may be effected even under conditions of accelerated drying. The air or gas streams emanating from individual outlets 24 are as shown in FIG. 6 directed in minimum paths of travel against registering web surface locations and spent air which has picked up moisture from the web is withdrawn directly after such occurrence, traveling in short paths directly to the closest adjacent withdrawal openings 26 for removal via plenums 23 of the heads. These short paths of spent air travel enhance drying efficiency.

The same operations are practiced with the embodiment of FIG. 8 or with flat types of sectionalized heads. In addition, although the heads 14 or 53 have been shown as positioned adjacent the web W at the first of the rolls 11 of the dryer section, similar groups of heads 14 or 53 may be disposed adjacent other of the rolls in the dryer section or at other required locations. The heads, as shown, or others later in the dryer section may also be utilized, in addition, to disperse impregnants, or surface coatings to the web in controlled manners so as to achieve not only uniformity of drying but uniformity of impregnation and/or surface coating of the web.

It may be pointed out here that if accelerated drying is the only problem, the drying arrangement of this invention can effect beneficial results by operating as a complete unit with all heads and valves at like positions of adjustment.

However, the arrangement of this invention, because of its versatility can cope with the more usual and undesired moisture irregularities because it can be located at any point in the drying process where the problem occurs. By adjusting the temperature, velocity, and volume of the air, and the location of each drying head in relation to the non-uniformity of moisture in the sheet

across the width of the web, the desired uniform sheet dryness can be obtained in the finished product. The number of drying heads comprising the complete unit or arrangement of this invention is necessarily determined by the width of the web. By the same token, the number of complete units or arrangements of this invention for an entire dryer section 10 will be determined by the severity of the problem of securing uniformity of moisture removal and/or of effective increased drying capacity as desired. The multiple drying heads of each unit have the advantage over a single drying head in that such units are individually controllable and flexible, insuring satisfactory end results.

Space limitations and facility of operation indicate that the drying heads 14 in the preferred form be mounted at one end on a shaft or pivot bar 16, and eccentrically located so that on full swivelling movement away from the web the distance at the closest position between the web and the drying head surfaces will give ample clearance for the threading of the material to the dryer section. This swivelling movement of the drying head from the web can also be effective in changing the evaporation or drying rate. Moreover, this movement can be accomplished in various ways, the selected way depending upon conformity with practical operation. To clarify this, the drying head can be hinged at the right as shown in FIGS. 1 and 2, or if design conditions demand, it could be opposite hand; the movement could also be straight up or down as shown in FIG. 8, depending on the web and the drying head location. The motivating means of setting the distance of the drying head from the web can be accomplished either automatically or manually as suits the needs of operation.

The air volumes and velocity controls of each drying head are effected by individual valves or dampers 31. This again can be accomplished manually or automatically. Actually, the amount of automation of control effective for the individual operation will be determined by the ultimate results necessary to achieve the desired finished product.

The maximum drying efficacy of each drying head 14 or 53 results from using maximum volumes, velocities and temperature of the air, and also the closest proximity of the drying head to the web allowable, for the individual application.

While specific embodiments of the invention have been disclosed, variations in detail within the scope of the appended claims are possible and are contemplated. There is no intention, therefore, of limitation to the exact structure herein described.

What is claimed is:

1. In a machine of the character described having a treating zone through which a web of material is moved, means for accelerated drying treatment of the web with uniformity of web drying comprising a plurality of independently movable drying gas dispensing devices arranged in side by side condition widthwise of the web, said dispensing device, having drying gas dispensing openings disposed to direct drying gas therefrom transversely of the web and into impingement with its surface, a common source of drying gas, means for supplying each dispensing device with drying gas from said common source, means for varying the quantity and velocity of drying gas dispensed from each such device against the web independently, means for adjusting the spacing and maintaining a selected spacing between each said device and said web independently, and means in said dispensing devices for withdrawing the spent drying gas dispensed against said web by said devices.

2. In a machine of the character described having a treating zone through which a web of material is moved, means for accelerated drying treatment of the web with uniformity of web drying comprising a plurality of independently movable drying gas dispensing devices arranged in side by side condition widthwise of the web, said gas

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dispensing devices each comprising a head having a hollow interior, means subdividing the interior into a pair of plenums, a first of which plenums has gas dispensing openings directed towards the web and the second of which plenums has gas withdrawing openings also directed toward the web, a common source of drying gas, means for delivering drying gas from said common source to the first plenum of each head for dispensation therefrom toward the web via the gas dispensing openings thereof, means for independently varying the quantity and velocity of the drying gas delivered from the common source to the first plenum of each head for dispensation therefrom via the gas dispensing openings of such head and into impingement with the web, common means connected to the second plenum of each head for withdrawing via the gas withdrawal openings of such second plenum of spent drying gas that has been dispensed toward the web by the gas dispensing openings of such head, and means for adjusting the spacing between each said head and said web independently.

3. The machine of claim 2 wherein each said head has a surface in which the said gas dispensing openings of its first plenum are arranged in spaced relationship, and with the said gas withdrawing openings of its second plenum lying in said surface between the gas dispensing openings.

4. In a web drying machine for uniform accelerated drying of a web of material having a treating zone through which a web of material is moved, means for accelerated drying treatment of the web with uniformity of web drying comprising a plurality of independently movable drying gas dispensing devices arranged in side by side condition widthwise of the web, said gas dispensing devices each comprising a head having a surface movable toward and away from the web and a hollow interior, means subdividing said interior into a pair of plenums, a first of which plenums has gas dispensing openings connected therewith and directed toward the web and the second of which plenums has gas withdrawing openings connected therewith and also directed toward the web, said openings being at the said movable surface, a common source of drying gas, means for delivering drying gas from said common source to the first plenum of each head for dispensation therefrom toward the web and into impingement therewith via the gas dispensing openings thereof, means for independently varying the quantity and velocity of the drying gas delivered from the common source to the first plenum of each head and dispensed via the gas dispensing openings of such head against the web, common means connected to the second plenum of each head for withdrawing via the gas withdrawal openings of such second plenum of spent drying gas that has been dispensed toward the web by the gas dispensing openings of such head, and means for adjusting the spacing between each said head and said web independently.

5. The machine of claim 4 wherein said means for delivering drying gas from said common source includes a common gas supply duct connected to said source, separate means connecting the first plenum of each head to said duct, and wherein said means for independently varying the quantity and velocity of drying gas delivered from the common source to the first plenum of each head includes a control valve in each said separate means for regulating gas volume and velocity of flow from said source independently to each said first plenum from said duct.

6. The machine of claim 1 wherein said means for adjusting the spacing between each said device and said web independently includes fluid operated means.

7. The machine of claim 1 including means for indicating the spacing and position of the individual dispensing devices relative to the web.

8. In a machine of the character described having a drying unit including a roller around which a web of material is moved, means for effecting variations in drying conditions along the width of the web as it moves around

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such roller to effect substantially uniform web drying comprising a plurality of contiguous, independently movable dryer heads positioned adjacent the web in the direction of its width, means for pivotally supporting each head about a common fulcrum axis located eccentrically relative to the axis of the roller, means for independently moving each head on said common fulcrum axis and independently adjusting its position thereon relative to the surface of the web, said heads each having a curved surface facing the web whose curvature is similar to the surface curvature of said roller and each such surface having drying gas dispensing openings disposed to direct drying gas therefrom transversely of the surface of the web and into impingement with the latter surface, a common source of drying gas, means for feeding drying gas to the heads from said common source, means for independently controlling the quantity of drying gas dispensed by the dispensing openings of each head to said web, and means in each head for withdrawing spent dispensed drying gas from the web.

9. In a machine of the character described having a drying zone through which a web of material is moved, means for effecting uniformity of drying conditions in the moving web throughout its width during accelerated drying of the web comprising a plurality of independently movable dryer heads positioned contiguous of each other widthwise of said web and each having a first plenum provided with drying gas dispensing openings facing said web for directing drying gas delivered to such first plenum transversely of the surface of the web and into impingement therewith, said heads also each having a second plenum provided with gas withdrawing openings facing the surface of the web via which spent gas after its dispensation from the gas dispensing openings is withdrawn, away from the web surface, a common source of drying gas, means for supplying drying gas from said common source to each said first plenum for distribution to said gas dispensing openings thereof, means for independently regulating the quantity of gas dispensed by the gas dispensing openings of the individual heads and means commonly connected to the second plenums for withdrawing via said gas withdrawing openings thereof of spent drying gas that has been delivered to the web from the drying gas dispensing openings in proximity to the regions of its dispensation and impingement with said surface of said web, and means for reconditioning and recycling withdrawn gas to the first plenums of said heads and their drying gas dispensing openings.

10. In a machine of the character described having a treating zone through which a web of material is moved for drying, means for effecting accelerated drying treatment of the web with uniformity of web drying comprising a plurality of independently movable gas dispensing devices arranged contiguously in side by side relationship widthwise of the web, each said dispensing device including a head having a hollow interior, partitioning means subdividing the interior of each head into a pair of plenums and each head having a surface movable with it to selected independent spaced positions relative to the web, one of the plenums of each head having gas dispensing openings in its said movable surface and the other of the plenums of each head having gas withdrawing openings in its said movable surface adjacent the gas dispensing openings, means for movably supporting each head independently so that its surface may be independently positioned at the selected spaced positions relative to said web, means for independently moving each head on the supporting means for effecting the selected spaced positions of its surface relative to said web, a source of drying gas, a common delivery conduit for drying gas connected to said source, a separate conduit for each head connecting its first-named plenum to said common delivery conduit, valve means in each separate conduit for controlling the quantity of drying gas delivered to the latter plenum from

the common conduit independently of the quantities of gas delivered to like plenums of other heads and thereby providing independent control of the quantity of drying gas dispensed by each head to said web, a reservoir, a separate conduit connected to the other plenum of each head, a common return conduit connected to said reservoir and to each of the last-named separate conduits to effect return to said reservoir of gas withdrawn from the web via the gas withdrawing openings, means for recycling gas from said reservoir to said first-named common conduit, and means for indicating the position of each independent dispensing device and the surface of its head relative to said web.

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