United States Patent [19]

Loser

[11] **3,750,305**

[45] **Aug. 7, 1973**

[54] **WEB DRYER**

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[52] **U.S. Cl.** **34/56**, 34/155

[51] **Int. Cl.** **F26b 13/10**

[58] **Field of Search** 34/56, 152, 153, 34/155, 158, 160

[56] **References Cited**

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[57] **ABSTRACT**

A dryer for webs having freshly applied printed designs and coatings is disclosed. The dryer has an involute conduit formed of a plurality of runs disposed angularly with respect one to the others. The web is drawn through the conduit and exits from the conduit into a central cavity in which is disposed a receiving element for receiving the then dry web. Heated air is introduced into the conduit for drying the web and carrying off the volatile constitutents of the material applied to the web. When the receiving element is a take-up reel, a leader greater in length than the conduit is used to draw the leading edge of the web through the dryer. A photocell sensor determines the presence of a portion of the web to be dried and causes the take-up reel to be driven to draw the web through the dryer.

5 Claims, 6 Drawing Figures

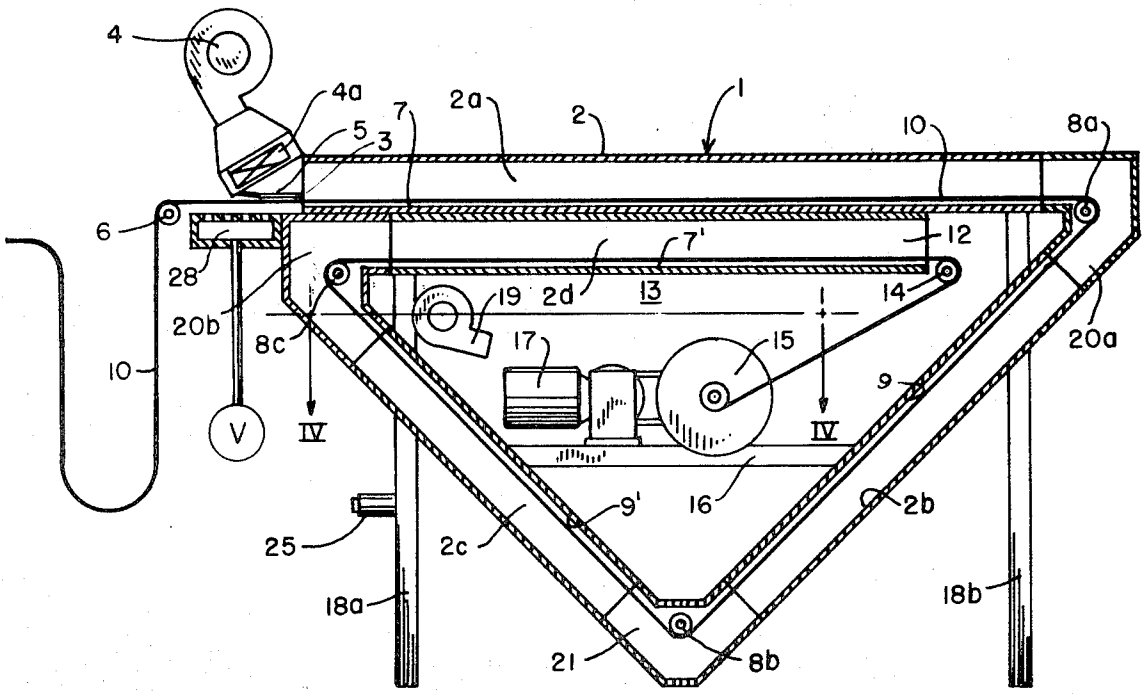
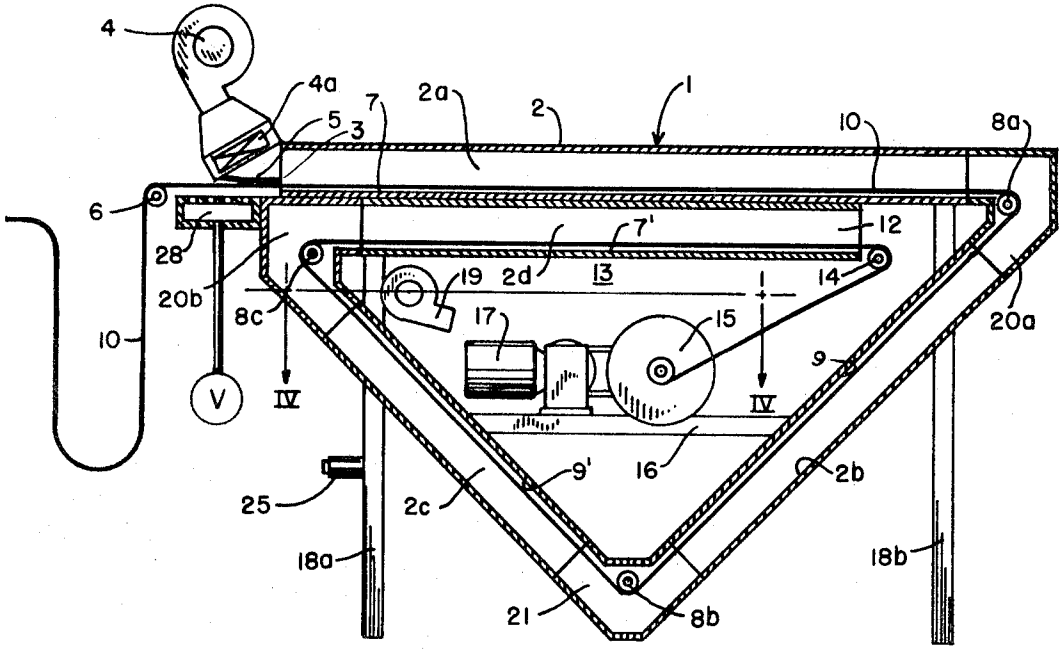


FIG. I



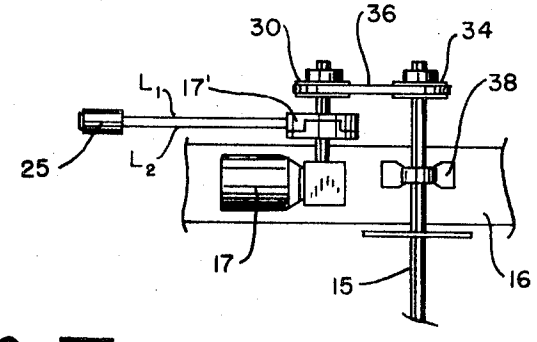


FIG. IV

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FIG. IIa

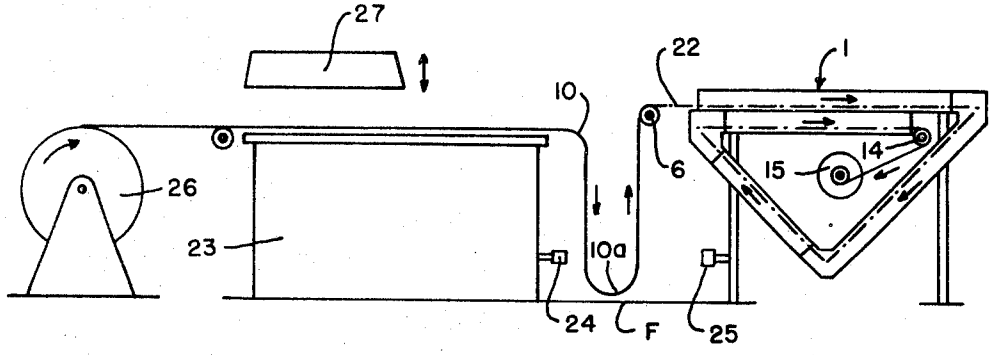


FIG. IIb

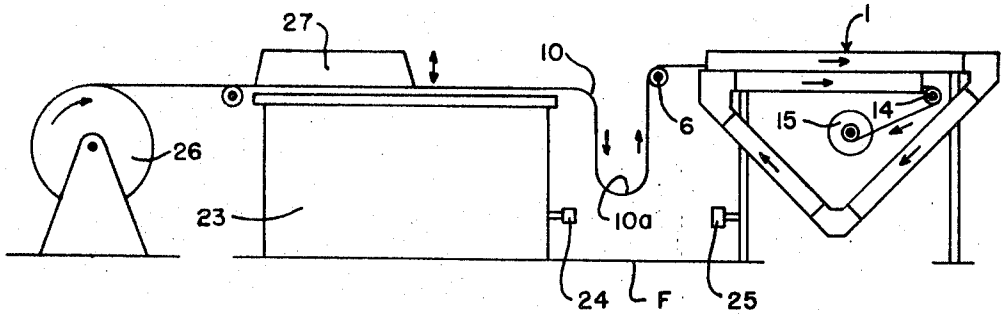
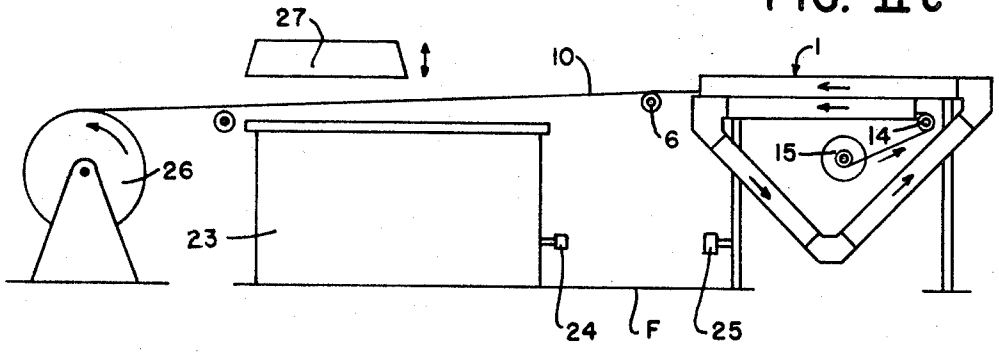


FIG. IIc



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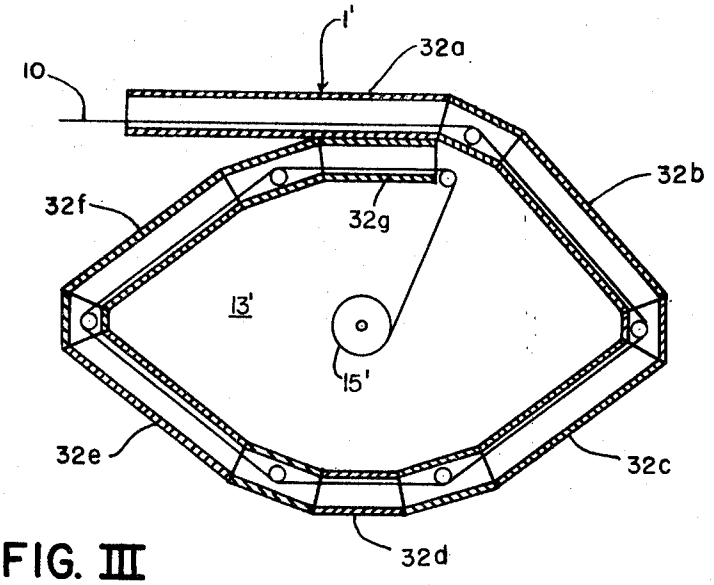

FIG. III

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WEB DRYER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to drying apparatus for webs which have had a design or coating of a settable material applied to one side thereof. More particularly, this invention relates to web dryers of the type in which the web is drawn in an involute path through the dryer, during which the web is exposed to a conditioned gaseous stream which dries the web and carries off the volatile constituents of the applied material. Drying apparatus of the type here described is particularly adapted for use with batch-type printing operations such as manual and semimanual silk screening.

2. Description of the Prior Art

In the production of such materials as wallpaper or the like where the pattern is multicolored, in almost all instances, the finished designs are formed by the serial application of each of the colors of the pattern to the web. That is, first one color of the design is applied to the entire web and then the succeeding colors of the design are applied in a like manner. It is also common to apply designs to the web in a discontinuous manner, leaving the width of at least one design between each discreet application of material to the web. The pattern is applied in this manner to avoid smudging of the edges of adjacent portions of the newly applied pattern by contact with the printing mechanism.

Between succeeding color application steps, it is necessary to dry the web thoroughly so that the previously applied coloring material is not smudged or otherwise defaced when the web is handled prior to or during the next color application step.

One way in which webs are dried is to hang or drape the web in racks to expose the wetted web freely to the ambient air to promote drying. This procedure requires the expenditure of labor costs to position the webs on the racks and also requires a large amount of floor space to be devoted to the drying area.

In order to obviate the disadvantages of the drying rack discussed above, it has been known to use web dryers that draw the web inwardly in an involuted path and which, during the transport of the web through the dryer, subject the web to conditioned air. These known prior art designs are of the cabinet type wherein the web is caused to move through the dryer over an involute array of driven rolls mounted in a surrounding cabinet. These designs require a very costly and trouble-prone drive system. Further, these designs do not support the web within a closed circuit and therefore require large and expensive fluid handling equipment for supplying drying air. These considerations have militated against acceptance of such dryers for limited production applications where the equipment cost could not be spread over high production volumes.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide a new and improved dryer for drying webs, which dryer is compatible with batch-type printing operations, less costly to purchase and maintain, has improved drying efficiency, is compact, and which can be constructed in accordance with uncomplicated sheet metal techniques.

Briefly, these and other objects of this invention are achieved by a dryer design incorporating a closed, generally air-impervious conduit comprised of a plurality of duct sections. The duct sections are arranged so that the web in its transport through the dryer follows an involute path. The conduit is provided with a device for effecting the drying of the web as it passes through the conduit. The dried portion of the web is received upon an element mounted in the interior of the involute path for storing or redirecting the dried portion of the web.

DESCRIPTION OF THE DRAWINGS

FIG. I is a side elevation of the preferred form of drying apparatus.

FIG. II*a* is a schematic illustration showing the start of the web take-up sequence.

FIG. II*b* is a schematic illustration of the web take-up sequence showing the position of the web loop when the take-up drive is de-energized.

FIG. II*c* is a schematic illustration showing the dried web being returned to the supply roll **26.**

FIG. III shows a second dryer embodiment having a hexagonal web path.

FIG. IV illustrates a typical take-up reel drive mechanism.

Referring now to FIG. I, which shows the preferred embodiment of the invention of dryer **1,** the dryer is composed of an involute conduit **2.** The consuit **2** is formed from duct sections **2***a*, **2***b*, **2***c* and **2***d*, joined in a manner to be hereinafter discussed. The duct sections **2***a*, **2***b*, **2***c* and **2***d* are of rectangular cross section, as it is ducts of this cross section which are most easily fabricated.

In the preferred embodiment, a first run of the conduit **2** is formed by a straight horizontal duct section **2***a*. One end of the cut section **2***a* is received in a joining member **20***a* which is generally in the nature of an elbow section. A second run is formed by straight duct section **2***b* which is received at one end in joining member **20***a* and at the other end in apex joining member **21.** As shown in FIG. I, the duct section **2***b* extends downwardly from and beneath duct section **2***a*. A third run is formed by straight duct section **2***c* which at one end is received in apex joining means **21.** Duct section **2***c* extends upwardly and at its other end is received in joining means or elbow **20***b*. A fourth run is formed by straight horizontal duct section **2***d* which at one end is received in the joining member **20***b*. The other end of duct section **2***d* terminates at exit opening **12** spaced from the joining means **20***a* and duct section **2***b*, as shown in FIG. I.

Thus, it can be seen that an involute passageway of generally triangular configuration is formed for the passage of web **10** therethrough. The duct sections **2***a*, **2***b*, **2***c* and **2***d* all include relatively flat, smooth supporting surfaces, such as surfaces **7, 7'** and **9, 9'** over which the web is transported. Further, the joints between the duct sections **2***a*, **2***b*, **2***c* and **2***d* and the joining members **20***a*, **20***b* and **21** are smooth and otherwise free of edges or surfaces which would snag or abrade the web. These joints are generally fluid-tight so that a stream of gas may be caused to course through the conduit for reasons to be herein later described. Joints having these attributes are known conventionally to those knowledgeable in the art of sheet metal fabrication and no detailed disclosure of these is necessary.

As can also be readily seen from FIG. I, the above described assembly defines in its central portion a large cavity **13.** Within this cavity **13** can be mounted ele-

ments necessary for the conditioning and handling of the web as will be later described.

At each point of direction change of the web in the dryer is placed a flanged roller to assist in such direction changes. Entrance roller **6** is placed adjacent the entrance **3** to the first run of the dryer formed by duct section **2***a*. Rollers **8***a*, **8***b* and **8***c* are contained in the joining members **20***a*, **21** and **20***b* respectively. Exit roller **14** is mounted adjacent the exit opening **12** of the fourth run of the dryer formed by duct section **2***d*. The rollers **6**, **8***a*, **8***b*, **8***c* and **14** are all freely rotatable.

Above the entrance **3** to the first run formed by duct section **2***a* is an induction unit for introducing a drying gas, such as heated air, into the conduit **2**. The induction unit **4** can be comprised of a conventional squirrel cage-type and housing, the outlet of which directs air onto the heating elements of an electrical resistance-type heater, designated as **4***a*, and thence into the conduit **2**. The induction unit **4** may include in its control circuit (not shown) a thermostat for maintain the drying air at a desired temperature and suitable safeguards to prevent the energization of the heater **4***a* before an adequate volume of air is supplied by the fan motor. Another source of heat energy may be a plurality of infrared lamps mounted in the conduit. While the induction unit has been shown positioned at the upstream end of the conduit **2**, thereby creating a current of drying gas which moves in the direction of travel of the web **10**, such an induction unit could equally well be placed at the downstream end of the conduit at opening **12**, thereby creating a flow of drying gas which is counter to the direction of travel of the web. Further, it is equally within the scope of a disclosed preferred embodiment to mount an exhaust unit at either end of the conduit to assist in or cause a flow of drying gas within the conduit. A baffle **5** is disposed in the entrace **3**. Baffle **5** is placed adjacent the entrance opening **3** to minimize the escape of drying gas therefrom.

Mounted on each side of the dryer on the ducts **2***b* and **2***c* is a horizontal support member, such as member **16**. Disposed between the support member **16** is a web-receiving element.

For purposes of the invention, the web-receiving element can be a flanged take-up reel **15**, as shown, or an obliquely disposed turning bar or roller or similar element which directs the dried portion of the web laterally outward of the cavity **13**. In the case where the web-receiving member is a take-up reel, a suitable drive means **17** is provided for driving the take-up reel. This drive means includes a motor, a gear reduction unit, and an electrically actuated magnetic clutch **17'** disposed between the gear reduction unit and the take-up reel. The drive means **17** is mounted exteriorly of the cavity **13** on one of the members **16**. The drive system for driving take-up reel **15** also includes drive pulley **30** mounted on the output shaft of clutch **17'**. Drive pulley **30** drives pulley **34** via belt **36**. The pulley **34** is fixedly mounted to an extension of the axial shaft of take-up reel **15**. The take-up reel **15** is journally mounted at each end to members **16** by bearings, such as bearing **38**.

Pairs of support elements **18***a* and **18***b* are disposed on opposite sides of the dryer to support the dryer in upright condition. These support members **18***a* and **18***b* can be constructed of angle stock and are secured to the conduit **2** by tack welding or bolts.

FIGS. IIa, IIb and IIc show the dryer **1** in the contemplated operating environment. The environment includes a printing table **23** which forms the supporting surface for the web **10** as it is undergoing a printing or coating operation. At one end of the table **23** is a supply reel **26** on which the web **10** is stored prior to the printing or coating operation. The element designated **27** schematically illustrates a silk screen frame or similar printing element which is capable of being moved veritcally into and out of engagement with the upper surface of the web.

Placed on a leg of the table **23** or adjacent the end of the table **23** is a light source **24** disposed above the floor F. Mounted to the dryer **1** is a photocell **25** which is positioned the same distance above the floor F as light source **24** and which is aligned therewith so that the beam from light source **24** will impinge on photocell **25**. The light source **24** and photocell **25** are of a type which is commonly commercially available and no additional description is believed necessary other than that the photocell is of a conventional type, i.e., one that changes its electrical properties, such as the resistance, in response to the impingement of light thereon. Photocell **25** forms the control element of the circuit (not shown) energizing the magnetic clutch **17'** of the drive means **17**. Lines L_1 and L_2 schematically represent the conductors connecting photocell **25** to magnetic clutch **17**. The photocell **25** and its accompanying circuitry are of a type which is commonly commerically available and the details thereof form no part of the invention herein disclosed. It suffices to describe the circuit in terms of its operation as follows: when there is no light from source **24** impinging on photocell **25**, the magnetic clutch of drive means **17** is actuated, causing the take-up reel **15** to be rotated. Conversely, when light falls upon the photocell **25**, the clutch **17'** is deactivated.

Alternatively, the element **17'** can be a combined magnetic clutch and brake unit. Such a unit operates in the same manner as described above except that when light impinges on photocell **25**, the clutch portion of the unit is deactivated and the brake portion is actuated. The output shaft of the unit **17'** is prevented from rotating and, therefore, the movement of the reel **15** and is drive system comprised of pulleys **30** and **34** and belt **36** is prevented. This arrangement eliminates the tendency of the take-up reel **15** to backwind when the drive system is idle and serves to keep the portion of the web **10** in the dryer taut.

As shown in FIG. IIa, dryer **1** also includes a carrier or leader element **22**. Element **22** is comprised of any strong flexible web of material, such as canvas or nylon, and is attached to one end to the spindle of take-up reel **15**. The length of the leader **22** is somewhat greater than the length of conduit **2** so that the free end of the leader can be drawn through the conduit to extend beyond the entrance opening **3**. To this free end of the leader **22** is secured the leading edge of the web **10**. This securing can be accomplished by one of many known methods, for instance, by sewing or taping the leading edge of web **10** to free end of the leader **22**. Leader **22** is provided so that at start-up the web can be drawn into the dryer without the need for manually threading the web through the dryer.

Mounted within the cavity **13** is a source of cool air such as cooling fan **19**. The stream of cool air issuing from fan **19** is directed toward take-up reel **15**. The

purpose of this stream of cold air is to give a final set to the material printed on the web **10** to lessen the likelihood that the printed matter will be marred as succeeding convolutions of the web are wound on the take-up reel.

While in the description of the preferred embodiment above, the conduit **2** has been described as having a generally triangular configuration, it is considered to be within the scope of the invention to utilize other similar involute configurations. For example, in FIG. III is shown another embodiment with a conduit having a hexagonal configuration, the conduit being formed of six straight duct sections **32***a*, **32***b*, **32***c*, **32***d*, **32***e*, **32***f* and **32***g*. It will be noted that this configuration also includes large central cavity **13'** in which can be mounted a web-receiving member such as take-up reel **15'**.

The operation of the dryer will next be described in connection with a typical printing or coating operation which the web undergoes prior to the time that it is dried.

At start-up, the web is contained on supply reel **26**. The leading edge of the web is drawn across the table **23** and is attached to the end of leader **22**. The frame **27** is brought into engagement with the upper surface of web **10** and the printing operation is completed. The frame **27** is then raised and the operator manually pushes the web across the surface of table **23** to position a new section web beneath the printing frame **27**.

When the web reaches the edge of the table **23**, it falls therefrom to form loop **10***a* between the edge of the table and the entrance to the dryer. The loop **10***a* of the web **10** interrupts the passage of light from light source **24** to photocell **25**, thereby changing the electrical characteristic of the photocell **25** and causing the actuation of the magnetic clutch **17'** upon actuation of the clutch **17'**, the take-up reel **15** is driven in a clockwise direction as shown in the drawing, thereby causing the web to advance through the dryer. This in turn causes a portion of the web forming loop **10***a* to be drawn into the dryer.

When the bottom of the loop **10***a* reaches a point above the light source **24** and cell **25**, as shown in FIG. II*b*, the magnetic clutch is deactuated and movement of the web through the dryer ceases. When the operator of the frame **27** has completed the printing operation and again advances the web across the table to form a large loop **10***a*, as in FIG. II*a*, the cycle is repeated.

FIG. II*c* shows the rewinding of the web onto supply reel **26** in preparation for an additional printing operation. At this time, the loop **10***a* either becomes very small or ceases to exist so that the web is spaced well above the light source **24** and photocell **25**, thereby precluding actuation of the clutch **17'**. With the clutch **17'** disengaged, the reel **15** is free to rotate in a counterclockwise direction as the web **10** is drawn off the reel.

It should be noted that the single most important design criteria for dryers of the type disclosed is that the side of the web which receives the applied pattern must not come into contact with any portion of the dryer until the material applied has been fully dried and set. In order to achieve this result, it is necessary to maintain the web end closely adjacent the flat surfaces **7**, **7'** and **9**, **9'**. This problem becomes especially critical when considered in the light of the operating environment heretofore described which, as will be remembered, is in many instances a batch-type operation. The problem arises partly from the use of ducts having small cross-sectional heights. From a study of FIG. I, it can be seen that the web, if untensioned, is sufficiently heavy, either by reason of the weight of the web itself, the weight of the material applied, or both acting in conjunction, that on the second and third runs through ducts **2***b* and **2***c*, the web **10** might hang in catenary fashion from the rollers **8***a* and **8***b* or **8***b* and **8***c*, thereby causing wet portions of the web **10** to come into contact with the interior surfaces of the duct, causing a smearing of the pattern to take place.

Of couse, one solution to this problem would be to tension the web. However, there are two factors militating against this solution. One is that the web in wetted form is capable of sustaining only very limited stress in tension. The other is that known mechanical tensioning schemes add cost and maintenance problems to the dryer unit.

Another solution to this problem would be to increase the cross-sectional height of the ducts. However, this would add to the material costs of fabricating the conduit, would require the use of air-handling equipment of greater capacity and, therefore, greater expense, and would reduce the overall compactness of the dryer.

The preferred embodiment of the disclosed invention solves the problem of web contact with the ducts without the need for increasing cross-sectional height thereof by a combination of features. The first consideration is that in the first run, the web is supported in a flat, horizontal position with its contact-sensitive surfaces free from engagement with inner surfaces of the duct. The second consideration is that in those runs where the contact-sensitive of the web is most likely to come in contact with the interior of the duct, namely the second and third runs forms by ducts **2***b* and **2***c*, the ducts are inclined with respect to the horizontal plane. This minimizes the distance by which the web **10** falls away from surfaces **9** and **9'**. As previously stated, this allows the use of ducts of lesser cross-sectional height.

It should also be noted that because the web stays in close proximity to the surfaces **9** and **9'**, the continuous stream of air passing through the conduit tends to urge the web against these surfaces. Further, it shall also be realized that the material feed-control system also aids in this regard. The loop which is maintained at all times immediately adjacent the dryer entrance causes, by reason of its weight, a slight back tension which tends to, but does not, draw the web out of the dryer. This back tension in turn causes the web **10** to be held more closely against the surfaces **7**, **7'** and **9**, **9'** during the period when the take-up reel is stationary.

One other manner of causing the web to be placed under light tension is to place a vacuum hold-down device, such as element **28**, at the entrance to the dryer. This may consist most simply of a plenum maintained under vacuum and in communication with an apertured plate. Such a device will cause the web to be pulled down upon the apertured plate and would create a drag on the web, thereby reducing the amount of slack of the web position in the dryer. This will tend to hold the web closer to the surfaces **7**, **7'** and **9**, **9'** and out of contact with parts of the dryer capable of defacing the web. Tensioning the web in this manner will also lessen the lateral shifting of the web within the duct **2** which causes the edges of the web to contact interior surfaces of the duct, causing damage to such edges.

An additional advantage arises from the fact that the first run is horizontally disposed. It must be remembered that the web is weakest in its wetted condition. The preferred embodiment lessens the likeihood that the web will be tore while in this condition by reason of the fact that the first run is horizontal and therefore the web is supported on the flat surface throughout this entire first run.

In addition, the ducts forming the runs of the conduit in the preferred dryer embodiment have been illustrated as being straight ducts of rectangular cross section. It should be realized that this duct configuration is one that is most easily and inexpensively fabricated and one which yields other advantages in terms of web support and ease of machine maintenance. It is within the scope of the present invention to employ duct cross sections other than that shown.

Finally, it should be realized that the primary comtemplated environment of the disclosed dryer is that of small volume and batch-type printing operations, such as silk screening. The features disclosed, such as the triangular involute conduit and the photocell control system allow the use of inexpensive air supplying and take-up roll driving equipment. It is these features that yield an inexpensive automatic dryer construction which can be used successfully with low volume batch-type printing operations. These features allow the contact-sensitive web to be passed through the dryer without defacement and consequent waste. However, it should be realized that the dryer disclosed, when operated in a continuous manner, has high speed drying capabilities. It is, therefore, also compatible for use with high volume production processes.

I claim:

1. Apparatus for drying a web having a wetted surface comprising a conduit formed of first, second and third substantially straight runs, the longitudinal axis of the runs arranged in a triangular array, the first run being generally horizontally disposed and including a web entrance, the second run extending angularly downwardly beneath the first run and the third run extending angularly upwardly from the end of the second run toward the first run, the angles of the longitudinal axis of each of the second and third runs with respect to a horizontal plane being such that the web is supported with the wetted surface thereof free from contact with the interior surfaces of the conduit as the web travels through the conduit, joining means for joining the first run to the second run and joining means for joining the second run to the third run, the intersection of the second run and third run being beneath the first run, a cavity formed within the triangular array of runs, receiving means mounted within the cavity for receiving the web, and means for introducing a drying gas into the conduit.

2. Apparatus according to claim **1** wherein the conduit includes a fourth run disposed beneath the first run and generally parallel thereto.

3. Apparatus for drying a web comprising, a closed involute conduit having a surface therein for supporting a web with one surface thereof free from contact with the interior surfaces of the conduit, the conduit having at least one vertical direction change therein; a cavity defined by the conduit; means for effecting drying of the web; and a reel disposed in the cavity for receiving a dried portion of the web; and a leader of a length greater than the length of the conduit attached to the reel.

4. Apparatus for drying a web comprising, a closed involute conduit having a surface therein for supporting a web with one surface thereof free from contact with the interior surfaces of the conduit, the conduit having at least one vertical direction change therein; a cavity defined by the conduit; means for effecting drying of the web; a reel disposed within the cavity; drive means for driving the reel; and control means responsive to the presence of portions of the web to be dried for actuating the drive means.

5. Apparatus according to claim **4** wherein the closed conduit includes a first substantially horizontal run having entry means at one end thereof for providing entry of the web into the conduit, and wherein the control means includes a photocell detector means position to detect the presence of portions of the web disposed below the entry means.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,750,305 Dated August 7, 1973

Inventor(s) Alois Loser

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 53, "to" should read --at--.

Column 6, line 34, insert --surface-- after "contact-sensitive".

Column 7, line 5, "tore"should be read --torn--.

Signed and sealed this 30th day of July 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334