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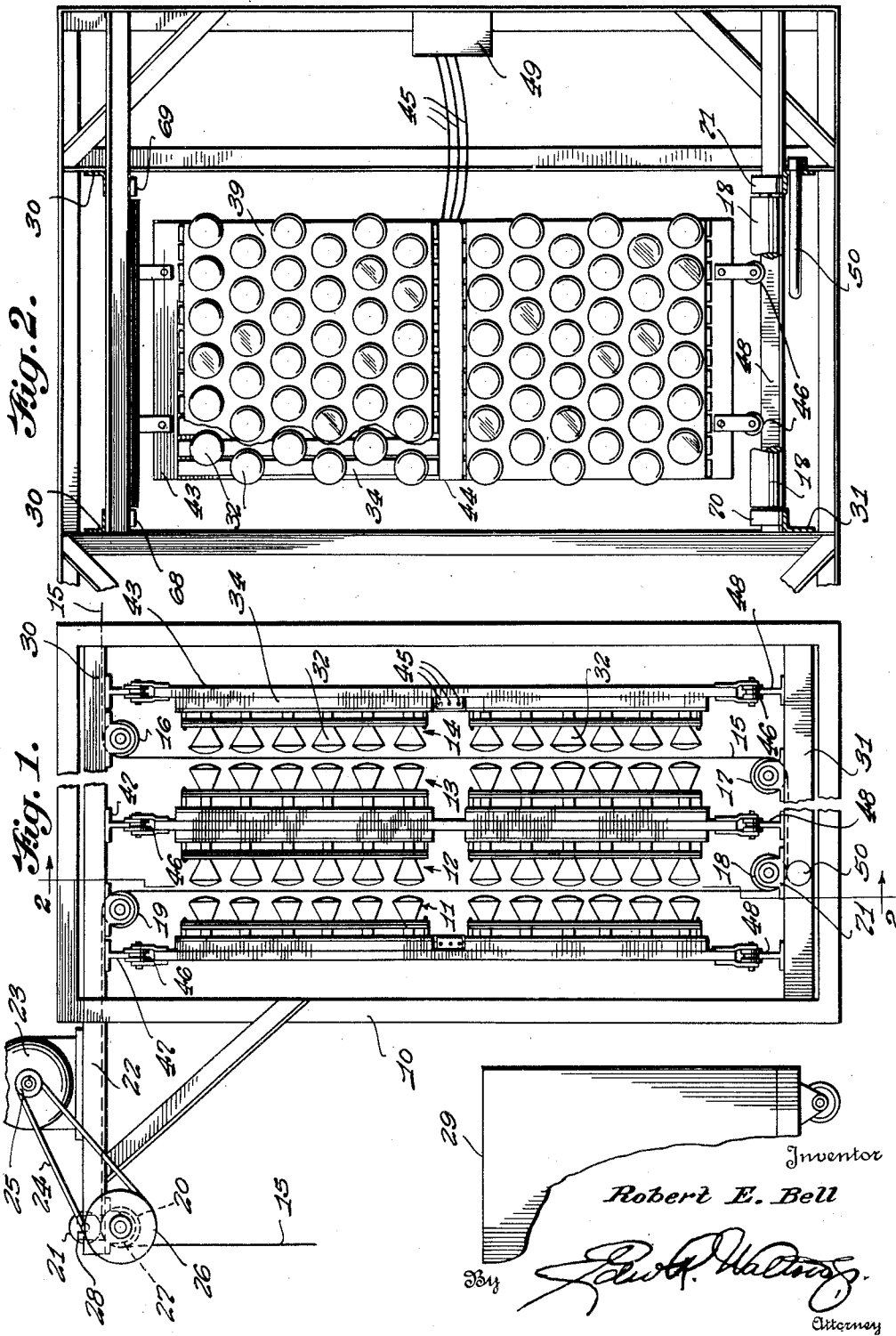
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2,308,239

DRYING MACHINE

Filed Nov. 8, 1940

2 Sheets-Sheet 1



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Fig. 5.

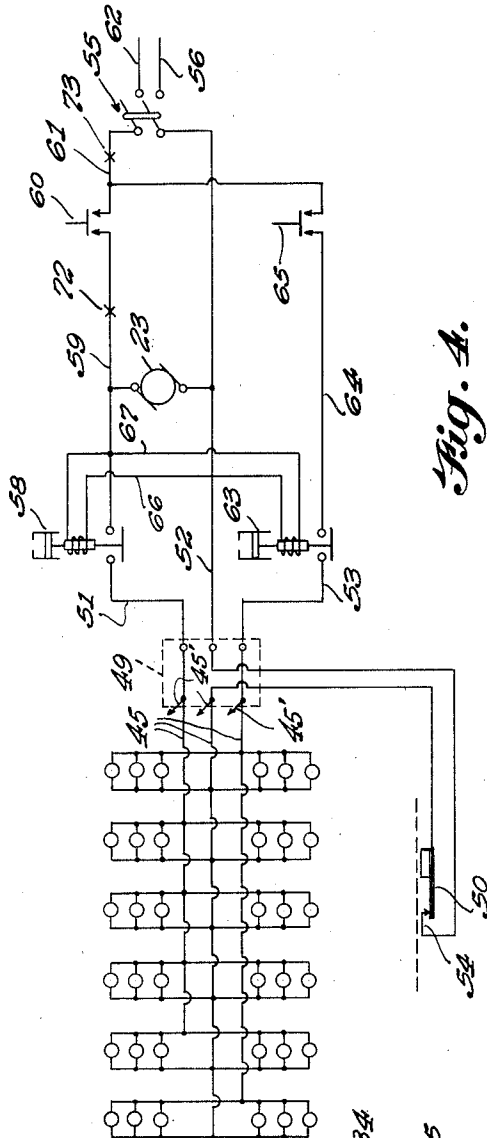


Fig. 4.

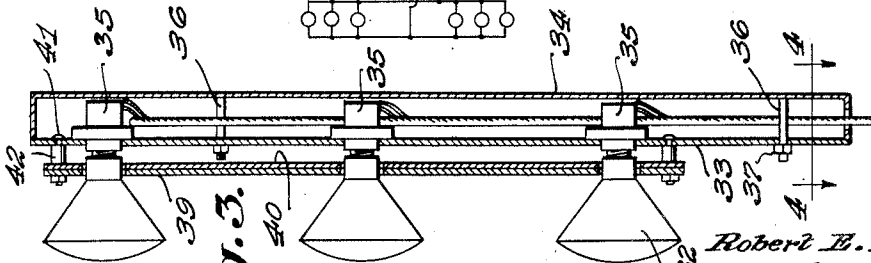


Fig. 3.

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DRYING MACHINE

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4 Claims. (Cl. 34-161)

The present invention relates in general to the art of drying and in particular to apparatus for and methods of continuously drying fabrics in web form and containing relatively large amounts of moisture.

Heretofore, in the drying of wet fabrics in web form a copious supply of heat has been considered essential in order to vaporize the large quantities of water present in a reasonable time allowing for the necessary waste of heat due to convection and waste radiation. In the interest of economy and efficiency the custom has therefore been to use some relatively cheap source of heat such as that derived directly from combustion and applied through the medium of drying cylinders in direct contact with the webbing, or large space heaters such as heating coils transmitting their heat to the fabric by convection through the medium of heated gases, dry steam or the like.

Where drying cylinders or rolls are used in contact with the cloth it is necessary to cover the rolls with cloth to avoid direct contact of the metal of the roll with the cloth which imparts an objectionable glaze and mottle to the cloth being treated. This greatly reduces efficiency and adds to the cost of operation and maintenance. In the use of space heaters, stray radiation and convection currents are a source of waste.

Electrical resistance heating has been applied through suitable mediums of convection for the heating of fabrics, paper pulp and the like, carried through the heat conveying medium on open conveyor belts, but this has been found to be costly in the use of electric current because of waste due to stray convection currents, stray radiation and the shielding of the work by the conveyor belt.

Because of such unavoidable wastes where convection is relied upon, electrical heating has been considered to be of prohibitive expense especially for the present purpose, that of rapid drying of fabrics in the web form containing a large amount of moisture such as one pound of water per square yard of ten or twelve ounce cotton.

Now I have discovered, notwithstanding the long and generally accepted belief in the greater economy of the use of large quantities of a cheap source of heat, cheap as compared to electrical heating, that I may accomplish the drying of fabric in web form not only with greater speed, but with greater economy, by electrical heating through the use of sealed drying lamps, of the infra-red type, applying the heat directly to the work by radiation in such manner that by far the

greater part of the energy radiated from the lamps is converted into heat substantially only upon striking the cloth to be heated. As long as there is moisture present substantially all heat dissipated is dissipated usefully in carrying off moisture and not wastefully as by stray convection currents and stray radiation. Through use of the apparatus and method here disclosed it is found that the greater cost of electrical heat units is offset both by the reduction of waste heat and reduction of the time of application, particularly the latter since time is a factor in the computation of the cost of electrical energy.

I have also discovered that through the use of drying lamps of the sealed beam, infra-red type, the cloth is dried with a softer textured finish and with clearer colors, where colored cloth is treated, than with the drying methods heretofore practiced.

It is therefore the main object of the present invention to provide an improved apparatus and method for the economical and rapid drying of fabrics in the web form, to a high degree of dryness or what is known as bone-dry, through the utilization of drying lamps, preferably of the infra-red type because of the high degree of penetration of such radiant energy especially with respect to wet objects.

Another and important object of the invention is the provision of means for the rapid drying of fabrics containing a high percentage of moisture which means shall occupy a minimum of space and be readily accessible as to all its parts.

Another object is the provision of a drying apparatus which shall be flexible in its adaptability to variations in the character of the work to be operated upon and which may be readily assembled or disassembled to a degree necessary to facilitate cleaning, replacement or repair of parts.

A further object is the provision of an electrical drying unit utilizing a bank of drying lamps and capable of being used interchangeably in varying multiples to constitute machines of various capacities.

Another object of the invention is the provision of an electrical drying machine for drying wet fabrics in the web form with minimum heat loss due to convection currents or radiation, and without the necessity for protective housing and elaborate heat insulation.

A further object of the invention is the provision of an automatic control for a machine of the above type for maintaining the temperatures

within a safe range and to correlate the control of the application of heat with the feeding of the work to the machine to prevent overheating of the work.

The above and other objects and advantages of the invention are attained in general by a novel cooperative relation and arrangement of parts, enabling the work to be passed through the machine in proper spaced relation to the drying lamps without the use of intervening supporting elements between the lamps and the work, whereby energy may be transmitted directly from the lamps to the work as radiant energy to be converted into heat in the work. Conservation of heat by substantial elimination of stray radiation is attended by the provision of a reflecting surface extending over the greater part of that space between the drying lamps which faces the work to, set up in effect a reverberation of radiant energy between the work and the exposed space between the lamps.

The object of cheapness in first cost installation and maintenance is attended by the utilization of standard parts in the fabrication of units which are made interchangeable for readiness of assembly, replacement and repair.

Various other objects and advantages of the invention will be apparent from a perusal of the following specification and the drawings accompanying the same.

In the drawings:

Fig. 1 is a side elevation of the drying machine loaded with the web of fabric being operated upon.

Fig. 2 is a vertical, transverse section taken on the line 2—2 of Fig. 1.

Fig. 3 is a vertical section through one of the lamp supporting, wire ducts taken on the line 3—3 of Fig. 2.

Fig. 4 is a horizontal section through one of the wiring ducts taken on the line 4—4 of Fig. 3 with the wiring omitted.

Fig. 5 is a schematic circuit diagram.

Referring to the drawings in detail, the machine comprises in general a main frame 10 in which is mounted a plurality of vertical banks 11, 12, 13 and 14 of drying lamps, the lamps of each bank being arranged with their faces substantially in a common vertical plane, the banks being arranged in pairs facing each other and spaced apart horizontally a slight distance to provide a vertical passageway for a web 15 of the fabric to be dried. The web is guided in vertical reaches through the passageways between adjacent pairs of lamp banks by means of holding and guide rolls 16, 17, 18 and 19 mounted at the top and bottom portions of the main frame 10 at points beyond the upper and lower limits of the lamp banks so as to support the vertical reaches of the fabric web between the lamps free of any supporting structure between the fabric and the lamps. The fabric is drawn into and out of the machine through its looped path within the machine by means of a driving roll 20 and nip roll 21 mounted at the discharge end of the machine on the extension frame member 22, and driven by a motor 23 through a belt 24 and pulleys 25 and 26. The driving roll 20 is mounted in suitable pillow block bearings 27 mounted on the frame extension 22, while the nip roll 21 is supported in half bearings 28 to permit vertical automatic adjustment of the nip roll to compensate for various thicknesses of material. From the feeding drive roll 20 the fabric web is

discharged into a suitable receiving truck 29 or otherwise stored as on a storage roll.

The supporting and guiding rolls 16 to 19 are mounted in anti-friction pillow block bearings 68 to 71, respectively, suitably secured to the top and bottom horizontal angle-iron frame members 31. Each of the lamp banks 11 to 14 is composed of the upper and lower rectangular groups arranged with the faces of the individual drying lamps 32 in a common substantially vertical plane. Each of these rectangular groups is built up of a plurality of vertical rows of lamps, each vertical row mounted on the cover 33 of a sheet metal duct 34 by means of lamp sockets 35 suitably secured to the cover as by means of bolts or screws. These sockets may be made of Bakelite or other suitable insulating material as is common practice and provided with the usual terminal screws not shown. An enlarged vertical section through one of these wiring ducts is shown in Figure 3 where it will be seen that a cover 33 is secured to the channel shaped duct 34 by means of anchor posts or studs 36 spot welded at one end to the back of the channel shaped duct on the inside and provided at the other end with a threaded extension arranged to project through the cover element 33 as to receive a fastening nut 37. Knockout holes 38 (Figs. 3 and 4) are provided at one end of each of the wiring ducts for entrance of the necessary conductors not shown. Mounted upon the front surface of each duct cover is a zinc reflector 39 chromium plated to enhance its reflecting quality and provided with a sheet asbestos backing 40 interposed between it and the front surface of the cover element 33, the reflector plate with its backing being spaced forwardly away from the duct and secured to the duct in such spaced relation by means of the bolts 41 and spacing collars 42. An important function of the reflector sheet 39 is to reflect back to the workpiece, or web 15, radiant energy emanating therefrom as by reflection or re-radiation and an important function of the asbestos backing is to insulate from the wiring duct any heat absorbed by the reflector plate thus forcing a large portion of such heat to be dissipated mainly in the direction of the work, there is thus produced a reverberatory effect between the workpiece and the reflector to prevent heat loss by stray radiation.

The pair of upper and lower rectangular groups of lamps forming a bank are each formed by the placement of several of the lamp carrying ducts 34 in vertical arrangement and side by side upon a mounting panel 43, in any suitable manner as by bolts or screws, not shown, the upper and lower groups of ducts being spaced apart vertically to permit of the insertion between them of a horizontally extending, manifold wiring duct 44 for the housing of a suitable group of bus wires supplying current to the lamps from a group of flexible leads 45. In the case of a double bank, such as the central bank (Fig. 1) formed by the banks 12 and 13, the wire ducts 34 are secured back to back on opposite sides of a common mounting panel.

To enable the banks of lamps to be moved edge-wise into and out of the machine between the vertical reaches of the web and free of the web and other remaining banks, for repair, replacement etc., the mounting plates 43 are provided above and below with flanged rollers 46 arranged to travel along transversely positioned guide rails 47 and 48 mounted across the top and bottom frame members 30 and 31 respectively. These

tracks 47 and 48 protrude on one side as shown at the right hand side of Figure 2. It will be understood, however, that where desired the tracks may protrude also on the other side to facilitate complete withdrawal of the bank after severance of the flexible leads 45. It will be noted that the ducts need not be removed from the mounting panel for repair, inasmuch as the lamp sockets are carried by the duct covers 33 readily removable by removal of the nuts 37. A suitable control box 49 is mounted upon the side of the frame as indicated in Figure 2 to which extend the flexible leads 45 which may be flexed upon withdrawal of a bank to the side of the machine, thus obviating the necessity of disconnecting the leads for replacement of lamps etc.

For controlling the energization of the drying lamps in response to variations in temperature of the web of fabric being dried, I provide a control thermostat 50 located in close proximity to the traveling web at a point in its travel intermediate its path of travel through the space between the lamp banks, but close to the end of such travel, and out of the path of the radiant beams from the lamps so as to be influenced substantially wholly by the heat of the traveling web. This point preferably is at the bottom of the machine so as to avoid undue heating of the thermostat by rising convection currents.

A preferred form of power supply and control circuit for the machine is shown in the schematic diagram of Fig. 5. While the machine is shown in the mechanical views as having twelve vertical rows of lamps in each bank, the circuit diagram shows but half this number, six rows, for the sake of clearness and simplicity of illustration. The purpose of the use of three flexible leads 45 is to permit the energization of either the entire bank of lamps or only a given number of vertical rows extending horizontally over less than the full width of the bank, to adjust the machine to different widths of cloth. The flexible leads 45 connect through a junction panel 49 to the lead-in wires 51, 52 and 53 to which latter the flexible leads from other panels are connected as indicated by the multiple connections 45'. The central bus wire 45 connects with the left hand common lead wire of the lamps of all of the vertical rows of the lamp banks, the upper bus wire connects with the right hand common lead wire of each of the four middle rows and the lower bus wire connects with the right hand common lead wire of each of the outer rows. The central bus wire is thus a common return for all the rows, while the upper bus wire is individual to the four central rows and the lower bus wire individual to the two outer rows. The central flexible lead 45 is connected through a junction panel 49 in common with the central leads 45' of other banks, to the common return supply wire 52 in series with the contacts 54 of the thermostat 50. The common return wire 52 extends on through the lower arm of the line switch 55 to the line wire 56 which with the line wire 62 constitutes the source of supply. The upper flexible lead 45 which is individual to the four central rows connects through the junction panel 49 to the supply wire 51 which is arranged to be connected through the contacts of a time relay 58, conductor 59, push button 60 and conductor 61 to the upper switch arm of the line switch 55 for connection with the line wire 62. The lower flexible lead 45, individual to the two outside rows is connected through the junction panel 49 to the lower supply wire 53 which connects through the contacts of

a time relay 63 to conductor 64 which connects through push button 65 to conductors 61 and thence through the upper arm of line switch 55 to line wire 62. The driving motor 23 is connected across the conductors 52 and 59 for control by the push button 60. Also connected across the wires 52 and 59, so as to be controlled in common with the motor 23, are the energizing circuits of the time relays 58 and 63 connected to the wires 52 and 59 by conductors 66 and 67 respectively. Suitable protective devices such as circuit breakers, fuses, etc., may be placed at the points 72 and 73 in the power supply circuit. It is to be understood that while the push buttons 60 and 65, here shown diagrammatically as simple push buttons may be of any known or other suitable kind of circuit closing and opening means capable of safely controlling the necessarily large volume of current, either directly or through suitable relay means. It will also be understood that while for the sake of simplicity the thermostat 50 is shown as a simple bi-metallic thermostat connected directly in the circuit, it too may be of any known or other suitable type capable of safely controlling the heavy current used, either directly or through suitable relay means. The timing relays 58 and 63 here indicated diagrammatically as dash-pot solenoid relays, are so shown by way of example only and may be of any other suitable form. It is also to be understood that while the push buttons and time relays are shown connected in the main conductors 51 and 53 so as to control all of the banks in common, there may instead be one such set for each bank. In practice the time relays 58 and 63 are adjusted to delay closure of their respective circuits for a given time period for a purpose explained below. The energizing circuits of these relays are connected in multiple with the circuit of the driving motor 23, so that period will begin only after closure of the motor circuit. The relays thus govern the time the lamps are to become energized after the driving motor starts so as to prevent overheating of the material. These relays also operate to automatically de-energize the lamps upon de-energization of the motor circuit. Where individual time relays are used for each bank of lamps they may be adjusted to time periods increasing in length from the discharging to the charging end of the machine so as to tend to equalize the time of exposure of work standing in the machine at the time of the starting of the motor, thus giving the portion of the work first to leave the machine an earlier start in exposure, its relative short travel through the machine being compensated for by slow movement of the motor during its acceleration to normal operating speed.

In operating upon a webbing of the full width for which the machine is designed all of the lamps of the different banks are energized by closure of both push buttons 60 and 65, while operating upon a web of lesser width only the central rows of lamps in each bank are energized to the exclusion of the end rows by closure of the push button 60 only.

Closure of the push button 60 completes the energizing circuit of the driving motor 23 over a path which may be traced from line conductor 62 to line switch 55, conductor 59, motor 23 and back over conductor 52 through switch 55 to line wire 56. Closure of this circuit also energizes the time relays 58 and 63 over the conductors 66 and 67 connected to conductors 52 and 59 in multiple with the motor 23. Energization of the motor 23 starts movement of the work through the ma-

chine which latter attains a normal predetermined speed after a given time interval and to which interval the time switches 58 and 63 are set to complete closure of the lamp circuits. Actuation of the time relay 58 thus closes the circuit of the four middle rows of lamps which circuit may be traced from the line conductor 62 over switch 55, push button 60, conductor 59, contacts of relay 58, conductor 50, uppermost flexible lead 45, to the right hand lead wires of the four middle rows of lamps and back over the left hand lead wires of said rows through the middle flexible lead 45, main common return supply wire 52 and switch 55 to line conductor 56. The time relay 63 is also actuated to close its contacts at the end of the predetermined time interval regardless of whether or not the push button 65 is closed, and assuming that the latter has been closed the outer rows of lamps in the bank will be energized over a circuit which may be traced from line wire 62, switch 55, conductor 61, push button 65, conductor 64, contacts of time relays 63, conductor 53, lower flexible lead 45 to the right hand lead wires of the outer rows of lamps and thence back over the left hand lead wires of those rows through the common return middle flexible lead 45, thermostat contact 54, common return supply lead 52 and switch 55 to line wire 56.

It will be seen from the above that inasmuch as the thermostat contacts 50 are included in series in the common return circuit 52 of all the lamps of all the banks, it will have control of all the lamps being used at any time whether the entire banks are energized or just the middle portions of each bank. Thus in operation should the work, at the point adjacent the thermostat, become heated to the predetermined maximum, say 240° F., the contact 54 of the thermostat 50 will open to de-energize all of the lamps in the circuit at that time. Also, if during operation the circuit of the motor 23 should be disconnected either at the push button 60 or by one of the safety devices such as 72 or 73, the relays 58 and 60 will become de-energized, opening the lamp circuits which they control.

The type of electric lamp preferred to be employed, is a reflector drying lamp having a relatively high percentage of infra-red radiation and provided with a sealed-in reflector. However, the greater the percentage of infra-red radiation in any lamp used, the greater is the economy in the use of electric power required for the work to be performed while resulting in quicker and more thorough drying of the fabric.

While I have thus shown and described a specific embodiment of my invention for the sake of disclosure, it is to be understood that the invention is not limited to such specific embodiment but contemplates all modifications and variants thereof as fall fairly within the scope of the appended claims.

What I claim is:

1. A drying machine comprising at least two opposed banks of drying lamps, means for supporting a web of fabric between the banks so

that the web is exposed on both sides directly to said lamps, each lamp bank comprising a multiple lamp support, lamp sockets carried by said support, a reflector panel mounted in front of and spaced from said support and provided with lamp-base openings registering with said sockets, and sealed-in-reflector drying lamps mounted in said sockets with their bases extending through the lamp-base openings.

2. In a drying machine, means for conveying a web through a looped path having a plurality of substantially parallel, vertical reaches, a guideway extending between said reaches, a mounting panel mounted on said guideway for edgewise movement in and out between said vertical reaches and banks of drying lamps mounted on opposite sides of said panel and arranged to direct radiant energy against the adjacent vertical reaches of the web.

3. In a drying machine, means for conveying a web through a looped path having a plurality of substantially parallel, vertical reaches, and a vertical lamp bank positioned between an adjacent pair of said reaches, said lamp bank comprising a vertical lamp support, a plurality of lamp sockets mounted on said support, a reflector plate backed by a layer of heat insulating material and mounted in front of the lamp support and spaced away therefrom to provide an open vertical space between the reflector plate on the one hand and the support and lamp sockets on the other hand, and a plurality of drying lamps mounted on said support with their bases extended through the reflector plate across the space between the plate and the support into engagement with the lamp sockets.

4. In a drying machine, means for conveying a web through a looped path having a plurality of substantially parallel, vertical reaches, a guideway extending between said reaches, a mounting panel mounted on said guideway through roller bearings for edgewise movement in and out between said vertical reaches, a plurality of channel-section, sheet-metal, wiring ducts secured to the mounting panel and arranged vertically side-by-side with their open sides outwardly facing toward one of the said vertical reaches, cover plates for the open sides, means for detachably securing the cover plates to their respective ducts, lamp sockets mounted within the wiring ducts on the said cover plates and facing outwardly through openings in the cover plates to receive a lamp base, a reflector plate having a backing of heat insulating material and mounted on said cover plate and spaced outwardly therefrom to provide a vertical air space between the heat insulated panel and the cover plate, said reflector plate being provided with lamp-base openings registering with said lamp sockets, and drying lamps arranged outwardly facing with their bases extended through the lamp base openings into engagement with said lamp sockets.

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