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Cahnman et al.

[11] **3,864,546**

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[54] **SYSTEM FOR IRRADIATING A DISCONTINUOUSLY MOVING WEB**

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[21] Appl. No.: **351,530**

[52] **U.S. Cl.** **219/354,** 34/48, 34/151, 219/345, 219/348, 219/388

[51] **Int. Cl.** **H05b 3/20**

[58] **Field of Search** 34/48, 49, 148, 151, 152; 219/345, 347, 348, 354, 358, 388, 405, 411

[56] **References Cited**

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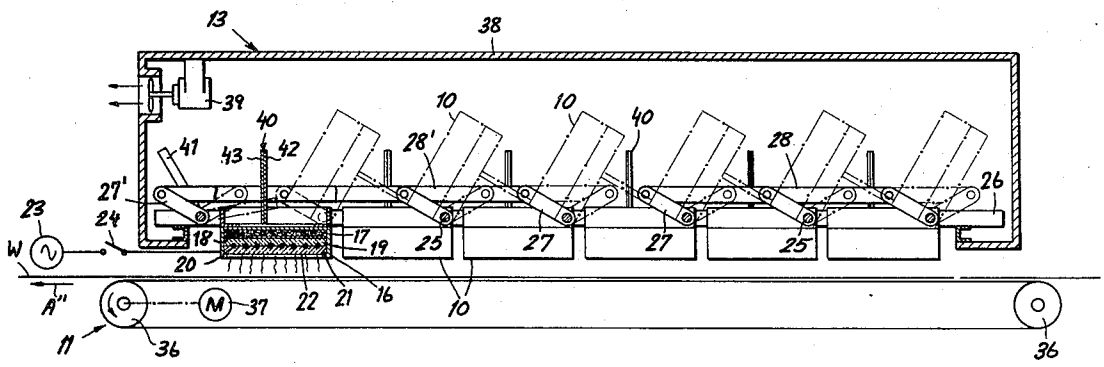
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[57] **ABSTRACT**

A plurality of elongated heater panels, preferably with fused-quartz radiating surfaces, are all arranged in a common plane facing downwardly onto a continuous web and are pivotal about respective axes extending transverse to the direction of displacement of the web. When the web stops, to prevent overheating the panels are pivoted up and directed away from the web, a shield on the back of each panel coming to rest on the lower edge of the radiating surface of the adjoining panel so as to prevent any radiation from falling on the web.

2 Claims, 3 Drawing Figures



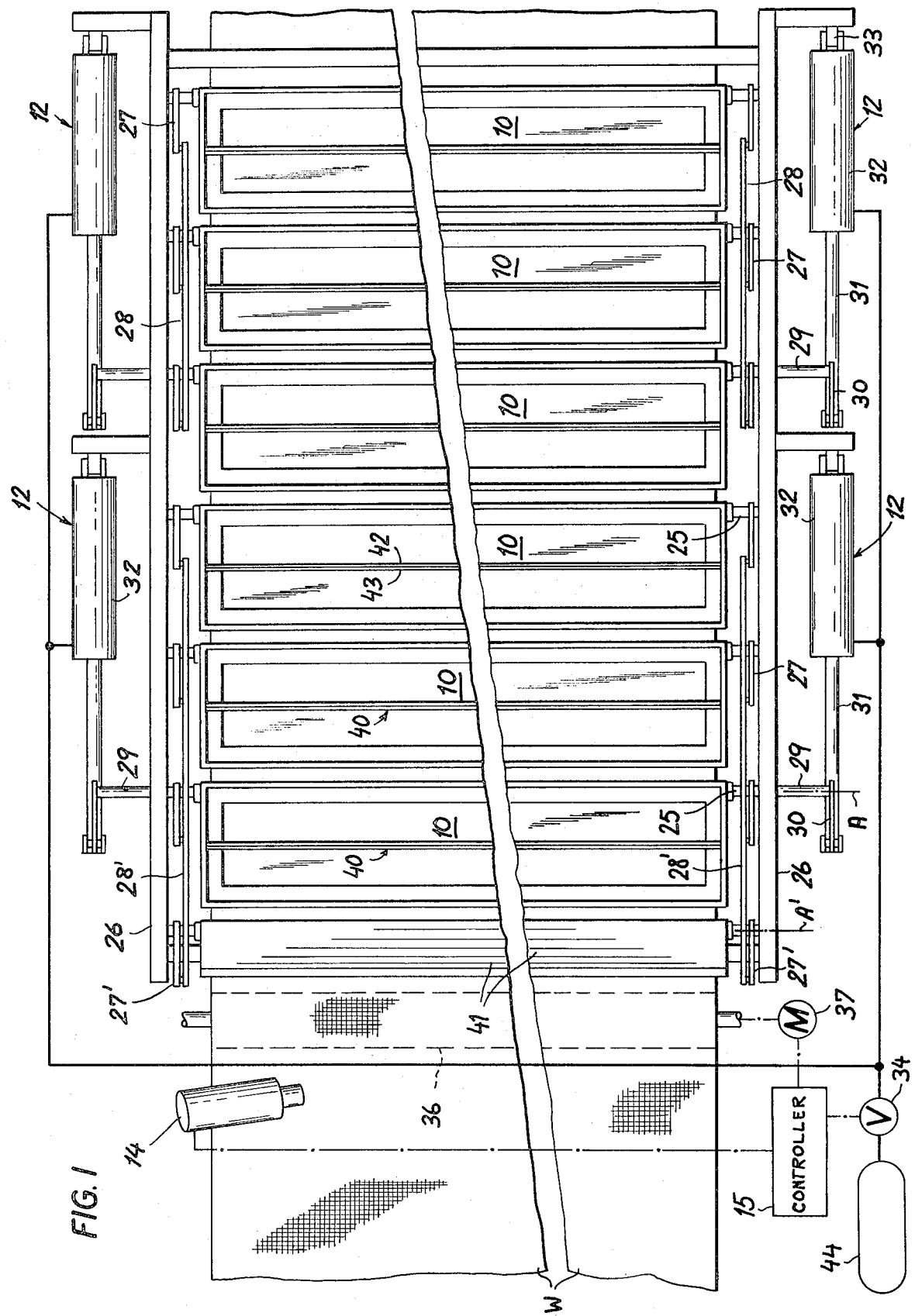

12
27
10
33
28
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31
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30
25
42
43
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26
A
A'
27'
37
34
36
41
14
15
CONTROLLER
44
W

FIG. 1

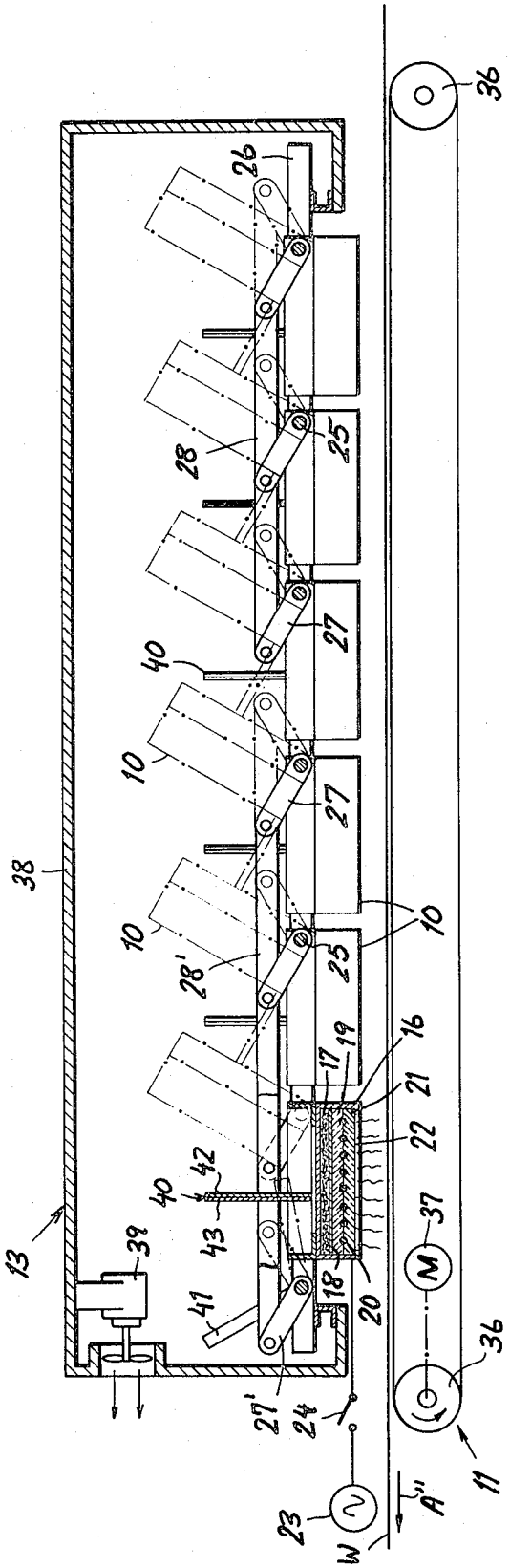

36
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28'
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42
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M
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41
18
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36
27'
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W
A"
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FIG. 2

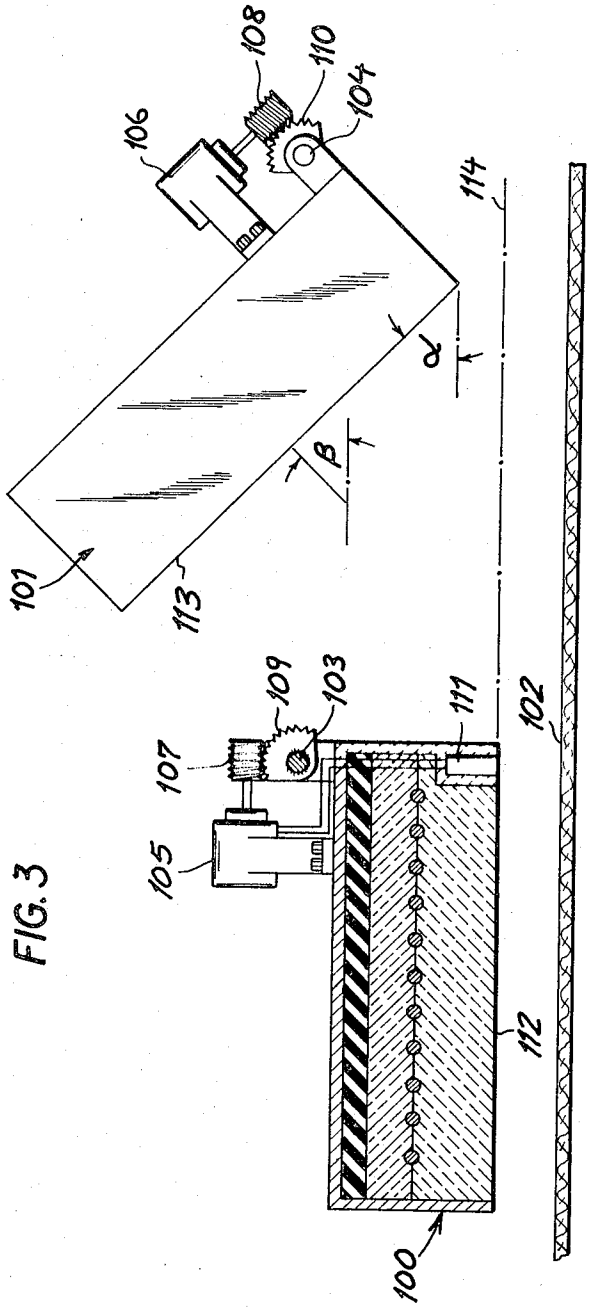


FIG. 3

SYSTEM FOR IRRADIATING A DISCONTINUOUSLY MOVING WEB

FIELD OF THE INVENTION

The present invention relates to a method of and an apparatus for irradiating a discontinuously moving web. More specifically this invention concerns a system for the controlled heat treatment of a textile.

BACKGROUND OF THE INVENTION

The use of infrared heaters in the treatment of textiles, paper, and the like has greatly simplified many systems wherein the web must be heated in order to be shrunk, dried, or otherwise treated. The use of quartz-panel heaters, sold under the trademark Solar Heater by Hugo N. Cahnman Associates, Inc., allows intense radiation of selected wavelength to be directed at such webs to bring them to the requisite temperature very rapidly. Such a system for bulking yarns is described in our copending patent application Ser. No. 306,159 filed Nov. 13, 1972.

Shutting off the current to the resistive wires imbedded in the quartz panels or other large-mass radiant heater is undesirable to prevent burning of the web when the latter stops because substantial heat is stored in the panels, preventing instant shutdown of the process.

OBJECTS OF THE INVENTION

It is therefore an object of the invention to provide an improved method of and apparatus for irradiating a moving web.

Another object of this invention is to provide a system for heat treating a discontinuously moving web wherein the problem of scorching is eliminated.

SUMMARY OF THE INVENTION

These objects are attained according to the present invention in a system wherein the irradiating panels are pivotal about axes parallel to the plane of displacement of the web, and means is provided to pivot these panels through an angle of 90° to 120° and face them away from the web should it stop or overheat. A sensor is provided at the downstream end of the heat-treatment station to sense either overheating or stopping of the web and to activate the pivoting devices immediately on sensing such condition. Emergency operator-controlled pivoting actuators are also provided.

According to another feature of this invention, a shield is provided which coacts with each panel so that when the panel is directed away from the surface it normally irradiates the shield comes into a position to block any radiation from reaching the web. Since such heating panels rely totally on radiant transmission of energy, the system according to the present invention completely cuts off the supply of radiant energy to the web. At the same time the panels are kept hot so that they can be swung back and used again immediately, once the web starts moving again. The current flow through the heaters in the panels may remain continuous for maximum service life of these units.

Our invention resides, to a large measure, in a system for the heat treatment of a flexible web, preferably of fabric, which comprises subjecting the web to radiant energy selected in accordance with the composition of the web from a plurality of panels extending parallel to one another and transversely to the direction of travel

of the web, sensing a parameter of the web affected by the heat treatment, and controlling the angle included between each panel and the plane of the web in accordance with the detected parameter. The invention is based upon our discovery that, especially when the web of fabric or like material is to be dried, heat set, texturized or otherwise modified by subjecting the same to thermal energy, and this thermal characteristic is selected in accordance with a characteristic of the material to be treated, it is not possible to regulate the heating effect simply by increasing or decreasing the current supplied to the heaters and yet maintain the quality of the treatment. At first blush it may be thought that the radiant heater may simply be turned on or turned off to provide the necessary overall heating effect, or the electrical ground supplied to the heater or electrical power may be increased or decreased in order to obtain the desired degree of heating. While this may be the case with ordinary radiant heaters, it has been found that such fluctuations in the consistency of radiant energy output of a panel type heater according to the present invention in which the radiant energy is passed through or emitted from a substantially planar surface of fused quartz, or other massive material varies the heating effectiveness to a detrimental degree.

Thus the present invention provides that, while the radiant heat output of this type of heater is maintained constant, the angle of incidence of this radiant energy, which may be represented as a homogeneous field propagated perpendicular to the heat emitting surface of the panel, is varied in accordance with the heating effectiveness. This is achieved by mounting each assembly of panels (the assemblies extending across the entire width of the fabric web) for pivotal movement about an axis parallel to the heat emitting surface and preferably parallel to a longitudinal edge of the panel when the heat emitting surface of each assembly of panels is elongated across the web and of a relatively small width in the direction of web travel.

Preferably, each assembly os panels is disposed adjacent another assembly so that when the respective panel faces are swung about their respective pivot axes into mutually parallel relationship, they are also parallel to the web. When a number of mutually parallel and closely spaced assemblies are provided, their pivotal axes may lie in a common plane parallel to the plane of the web or the transport means therefor so that a louver configuration is provided. The panel faces may thus be tilted from a position in which the panels are parallel to the web and, therefore, the angle of incidence, as defined above, is 90°, to an angle in which the panel faces are perpendicular to the web and the angle of incidence is substantially 0°. Most desirably, the angular displacement of the heater is a minimum of 120°. In a position in which the heaters have their emissive surfaces lying perpendicular to the web, a significant heating of the latter does occur and it should be noted that, when the system is tilted through 120° and the heat emitting surfaces generally face away from the web, at least 80 percent of the heating effect previously obtained is eliminated.

According to an important feature of the invention, a number of the panel assemblies are ganged for joint pivotal movement in parallel relationship, i.e., through a given angle by a common pivoting mechanism connected with a sensor responsive to a parameter of the

heat treatment of the web. In a special case, as indicated previously, the sensor may indicate termination of web displacement, whereupon the mechanism is energized to swing the panel assemblies into their minimum heating positions so that the system which caused the interruption may be corrected. The panel assemblies may be connected by articulation links, rack and pinion arrangements or other pivoting systems. Of course, a single sensor may be provided for each of the panel assemblies and each panel assembly may be subdivided into a pair of independently pivotal subassemblies under the control of a respective sensor or a sensor common to all or having a number of subassemblies.

The term "sensor" has been used herein to indicate that the device responds to a variable (parameter) of the heating treatment of the web and it should be noted that, with the system of the present invention, it is possible to obtain automatic process control of the quality of the production achieved in a simple manner. For example, when a textile is to be dried, the variable or parameter detected may be the moisture lost, moisture content (e.g., by weight), the density or the air permeability of the web. When the web is to be heat set and is a synthetic resin product, the weight or texture may be detected. In short, any process variable which is a function of the heating action may be detected and used to control the heaters. In the most general case, an optical pyrometer is employed. It has been found, in the heat setting of synthetic fibers, for example, that final temperatures may be maintained within 3°F at the output end of the arrangement.

It is essential to the present invention that the heater be of the emissive surface type wherein the energy-transmitting surface lies in a plane which is perpendicular to the plane of the web or the conveyor upon which the latter is disposed. In this case, the heater may be composed of a fused-quartz body of rectangular outline having one generally emissive planar face and formed along its other surface with a multiplicity of parallel grooves receiving resistive heating coils, wires or elements. The backs of the heaters may then be enclosed in a suitable housing, the spacing of the resistive-heating element being controlled so that the panel emits radiant energy at a uniform rate over substantially its entire surface area.

According to still another feature of the invention, the back of each panel-heater assembly is provided with an upstanding shield extending the entire length of the assembly. Upon rotation of each assembly about its aforementioned pivot axis, the shield substantially bridges the space between two assemblies and thereby prevents undesirable radiation from reaching the web.

DESCRIPTION OF THE DRAWING

The above and other objects, features, and advantages of the invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. **1** is a top view of the apparatus according to the present invention;

FIG. **2** is a longitudinal section through the apparatus of FIG. **1**; and

FIG. **3** is a diagram illustrating another embodiment of the invention.

SPECIFIC DESCRIPTION

As shown in the drawing the apparatus according to the invention comprises a plurality of like radiant panels **10** pivotal about respective axes A above a transport arrangement **11** which advances a fabric web W past the panels **10.** Drive units **12** serve to pivot the panels **10** and a hood arrangement **13** serves to carry off hot air. A detector **14** for determining how much the web W has been treated and if it is moving is connected through a controller **15** to the various drives in order to pivot the panels through 120° from the solid-line position of FIG. **2** to the dot-dash line position on stopping or breaking of the web W.

Each panel comprises a boxlike housing **16** open at one side and provided with a layer of wool-type insulation **17** covered by a reflector **18** over which a plurality of resistance wires **20** are arranged, sandwiched between a pair of quartz panels **19** and **21** so that the radiation of the wires is emitted from the lower face **22** of each panel **10.** The wires **20** are connected to a power source **23** through a switch **24.** The panel structure and its use is described in detail in *Plastics Technology* ("New Heat Source for Plastics Processing" by Louis Fisher, January 1963). Extending normally upwardly from the back of each housing **16** is a flat reflector **40** whose function is described below. Each reflector is formed of a fiber insulating board **42** covered with a stainless steel reflector **43.**

Each such radiating unit **10** is provided near one longitudinal edge with a pair of support pivot rods **25** journaled in longitudinal support beams **26** of the apparatus. Each pivot rod **25** is provided with a respective radially extending arm **27** whose free end is connected via a link **28** to at least one neighboring arm **27.** The panels are arranged in groups typically, of three with the central panel **10** having its pivot rods **25** extended as shown at **29.** An arm **30** on each of the extensions **29** is connected to a fork on the end of a piston rod **31** of a pneumatic or hydraulic cylinder **32** pivoted at **33** on the beam **26.** A solenoid valve **34** connected between a source **44** of compressed air is operated by the controller **15** and connected to an air-over-oil tank and directed to all of the cylinders **32** which constitute the drive elements **12** for pivoting the panels **10** about their axes A.

The web W is advanced in direction A'' by the drive arrangement **11** which comprises an endless belt **35** spanned over two rolls **36** one of which is driven by a motor **37** connected to the controller **15.** The drive **11** can simply be the output end of a loom, or a tenter device.

The air-aspirating arrangement **13** comprises a hood **38** above the panels **10** provided with an exhause fan **39** to keep air moving past these panels **10.** In this manner all of the heat transmitted from the panels **10** to the web is transmitted as radiation, no conduction is relied on at all.

Downstream from the entire apparatus is an optical pyrometer **14** trained on the web W as it emerges from beneath the panels **10.** This device monitors the temperature, so that should the temperature rise to above a predetermined safe limit for the material it emits a signal to the controller **15.** A line speed switch or other similar device also detects loss of motion provides a signal to the controller **15.**

In the extreme downstream end of the apparatus there is provided, pivotal about an axis A' parallel to the coplanar axes A a shield **41** which is pivoted by means of two arms **27'** connected through links **28'** to the nearby arms **27.** In this manner as the panels **10** are pivoted the shield **41** also is pivoted. This shield **41** is a two-part laminate as are the shields **40.**

When the sensor **14** detects an excessively high temperature in the web or the line-speed switch detects that the web is stopped, it signals the controller **15** which operates the valve **34** and pressurizes the cylinders **32.** This pivots all of the panels **10** and the shield **41** clockwise around their axes A and A' through arcs of approximately 120°, into the dot-dash positions shown in FIG. **2.** In this position the shield **40** of each panel **10,** except of course the furthest upstream panel, lies against the lower edge of the panel immediately upstream, so that none of the radiation of the panels falls on the web W; in fact it is all directed away from this panel and reflected up by a MARONITE (asbestos) board **43** of the reflectors **40.** Similarly the reflector **41** blocks radiation from the furthest downstream panel **10.**

The above-described apparatus is provided as part of a tentering frame. The web is a polyester fabric having a maximum absorption level of energy at approximately 3.3 microns so that the panels are set a 1,400°F to produce the required spectrum and achieve most efficient energy transfer. A unit having an overall length of 36 inches is found to be as effective as a conventional 80-foot tentering oven.

In FIG. **3** we show an arrangement in which each of the panel assemblies **100** and **101,** which extend across the full width of the fabric web **102,** is pivotally mounted on a shaft **103, 104** along one edge of the rectangular parallelepipedal structure and carries a servomotor **105, 106** whose worm **107, 108** meshes with a fixed gear sector **109, 110.** Each of the assemblies also carries an optical pyrometer or other sensor **111** which is mounted in the body of the heater and is connected in a servocontrol circuit with the motor **105** or **106** (see SERVOMECHANISM PRACTICE, McGRAW-HILL BOOK COMPANY, 1960).

A pyrometer may be set to swing the radiating faces **112, 113** out of a common plane **114** parallel to the web **102** through angles α so the incident angle of radiant energy is increased from 90° to the angle β. The heaters may be provided with shields as described in connection with FIGS. **1** and **2.**

We claim:

1. An apparatus for radiantly treating a discontinuously displaced web, said apparatus comprising:

a plurality of panels each having a radiation-emitting surface normally directed at said web at a location and pivoted about a respective axis;

means for detecting displacement of said web past said location;

means connected between said detecting means and said panels for pivoting each of said panels about said axis and directing said surface away from said web upon detection of an interruption in displacement of said web, said pivoting means being operatively connected to all of said panels; and

respective shields each displaceable into a position between a respective radiation-emitting surface and said web in the position of said panels wherein the surfaces are directed away from said web, at least one of said shields extending from the back of one of said panels generally perpendicularly thereto and being engageable with the panel immediately adjacent thereto when said panels are directed away from said web.

2. The apparatus defined in claim **1** wherein said panel is a fused quartz radiant flat-surface heater.

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