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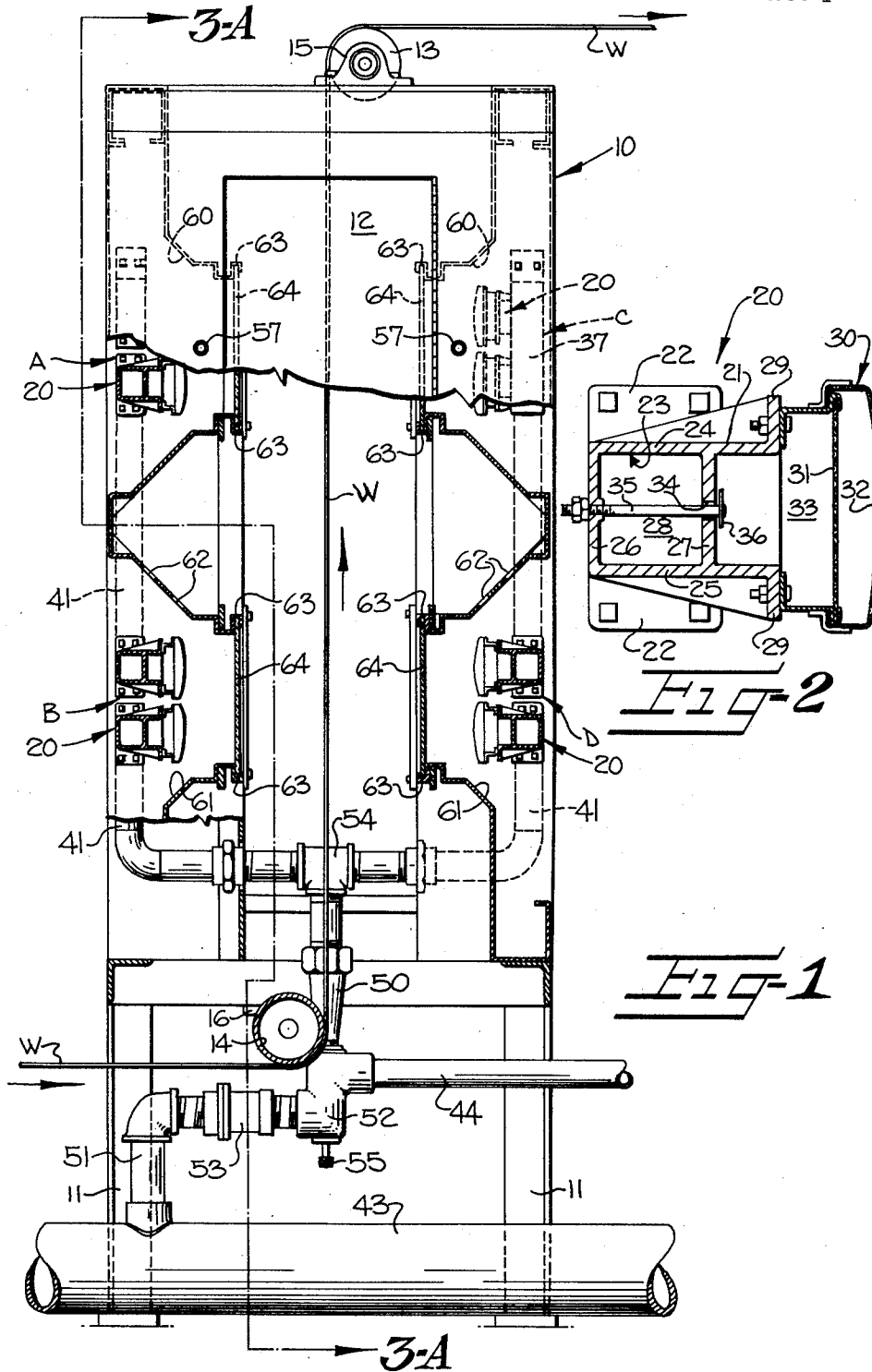
C. B. FETNER ETAL

3,150,864

APPARATUS FOR APPLYING HEAT TREATMENT TO WEB MATERIAL

Filed Aug. 9, 1962

3 Sheets-Sheet 1



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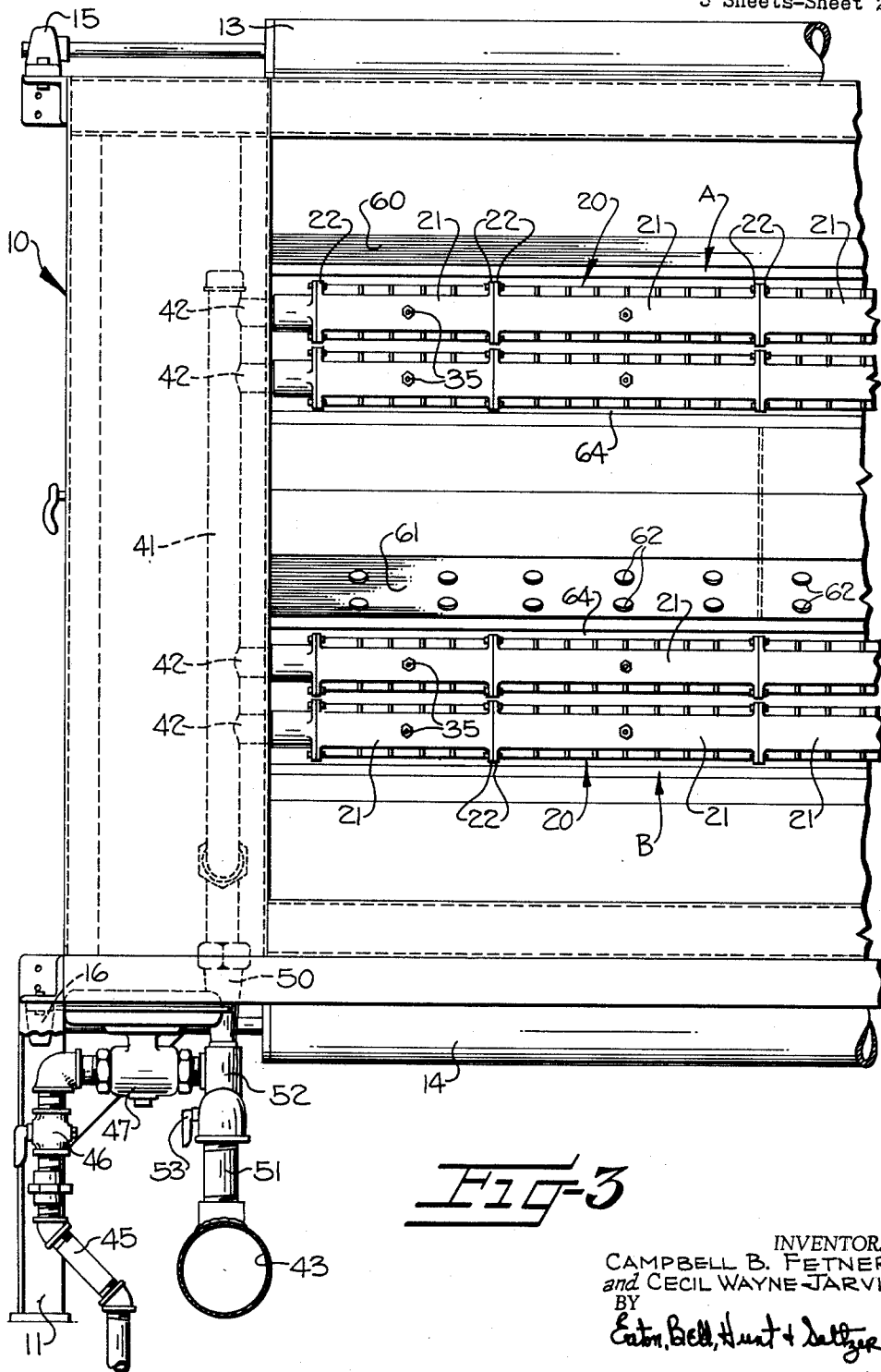
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3,150,864

APPARATUS FOR APPLYING HEAT TREATMENT TO WEB MATERIAL

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5 Claims. (Cl. 263-3)

The present invention relates to improvements in an apparatus for applying a heat treatment to web material, such as a textile fabric. More particularly, the improved apparatus is of a type useful for drying textile fabrics, which have been dyed or printed, in a manner producing dyed or printed fabric of superior quality. The apparatus is also capable of curing textile fabrics which have undergone resin impregnation in a fast and efficient manner.

A problem common to the dyeing and printing of textile fabrics is that of controlling color migration. Color migration is believed to be caused by the greater affinity for moisture exhibited by the dyestuff applied to the fabric as compared to the affinity of the dyestuff for the fabric itself. During a continuous drying operation in which dyed or printed fabric web material is being fed from a starting point in a substantially continuous manner for undergoing a heat treatment while the fabric is moving, an attempt must be made to maintain an even drying of the dyed or printed fabric to provide for even evaporation of moisture from the fabric which is necessary to control color migration in the drying operation. Proposals for applying fairly uniform heat distribution in a continuous drying operation across the surface areas of moving dyed or printed fabric webs have met with varying degrees of success. However, even the better proposals heretofore known characteristically permit a relatively wide tolerance range in the degree of heat maintained on the moving dyed or printed fabric web—a 20° F. tolerance range being typical. These proposals have included the drying of web material by radiant heat emanating from an electric bulb or from a gas burner. Electrically produced radiant heat has been generally preferred for a drying operation of this character because of the frequent occurrence of discolored areas on the dyed or printed fabric caused by combustion products produced from burning gas which have a tendency to dull the coloration of the dyestuff.

However, the fairly uniform distribution of the heat applied to the dyed or printed textile fabrics has not produced a completely satisfactory answer to the problem of controlling color migration during a drying operation. In the latter respect, the application of heat treatments to moving dyed or printed fabric webs by conventional procedures tends to concentrate the heat on the opposite surfaces of the fabric web to evaporate moisture therefrom. This surface evaporation of moisture is responsible for causing an irregular flow of moisture from the interior region of the fabric to the outer surfaces thereof, thereby unevenly drawing a portion of the dyestuff which has penetrated into the fabric to the surfaces thereof. This phenomenon known as color migration, if not properly controlled, leads to color concentrations on the fabric which dull the coloration imparted to the fabric by the dyestuff and cause the dyed or printed fabric after it has been dried to take on an outward appearance which may be described as lackluster or dingy.

The present invention therefore concerns an improved apparatus for applying a heat treatment to web material, such as a textile fabric, which is more effective in controlling color migration during the drying of a moving dyed or printed fabric web. To this end, radiant infrared heat

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is relied upon as the drying agent. Infrared radiation occurs over a wide range of wavelengths—extending from approximately 0.8 micron to 1000 microns. It has been determined that certain wavelength ranges of infrared radiation are readily absorbed by water, whereas others are not. By restricting the infrared radiation directed against the fabric to be dried to wavelength ranges lying within water absorption zones, we have found that the radiant heat penetrates through the fabric to be absorbed by the moisture therein for evenly evaporating the moisture on the opposite surfaces of the fabric and within the interior region thereof to effectively control color migration. Our invention accomplishes this purpose by providing an apparatus affording a primary source of radiant infrared heat emanating from gas burners located on opposite sides of the dyed or printed fabric web and having heat transmissive and filtering shield means disposed between the gas burners and each of the opposite surfaces of the fabric web to be dried. The shield means protects the fabric web against exposure to the products of combustion from the gas burners, while transmitting radiant heat to the fabric web from the burners in a particular wavelength range of infrared radiation lying within a water absorption zone. In addition to acting as a heat transmissive means, the shield means also filters out or absorbs some of the heat given off by the gas burners and in so doing is heated itself to become a secondary source of radiant infrared heat of less intensity than the primary source and in a different wavelength range lying within another water absorption zone of the infrared radiation spectrum—this secondary source of infrared radiation being directed against the fabric web and combining with the greater intensity of infrared radiation transmitted through the shield means from the gas burners to modulate and distribute the infrared radiant heat over the fabric web so as to penetrate throughout the thickness thereof in a uniform manner to be absorbed by the moisture therein. This technique of combining the infrared radiation from a primary source of radiant heat with the infrared radiation developed in a heat transmissive and filtering shield means disposed between the primary source of radiant heat and the fabric web to be dried has proved to be not only effective in reducing moisture flow from the interior region of the dyed or printed fabric web to its surfaces for controlling color migration and stopping color concentration of the dyestuff impregnated therein during a drying operation, but it actually appears to be responsible for developing or heightening the color of the dyestuff impregnated in the fabric to provide a brightened, lustrous coloration on the opposite surfaces of the fabric—thereby producing a finished dyed or printed fabric of superior quality compared to dyed or printed fabrics which have been dried by conventional apparatuses.

Accordingly, it is a primary object of this invention to provide an improved apparatus for drying a dyed or printed fabric web which substantially eliminates color concentration by controlling color migration of the dyestuff to the opposite surfaces of the fabric web during a drying operation in applying a heat treatment to the fabric web of infrared radiation in wavelength ranges lying within water absorption zones so that the radiant heat penetrates throughout the thickness of the fabric for evenly removing moisture therefrom.

It is another more specific object of this invention to provide an improved apparatus for drying a dyed or printed fabric web, wherein the apparatus comprises gas burners forming a primary source of radiant infrared heat in combination with heat transmissive and filtering shield means on each side of the fabric web with the shield means transmitting radiant heat to the fabric web from the burners in a predetermined wavelength range

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of infrared radiation lying within a water absorption zone, while absorbing some of the heat emanating from the burners to become a secondary source of radiant infrared heat directed to the fabric web—the secondary source of radiant infrared heat being in a different wavelength range and lying within another water absorption zone of the infrared radiation spectrum to modulate the more intense infrared radiation transmitted to the fabric web through the shield means from the burners comprising the primary source of radiant infrared heat. The complementary nature of the secondary source of radiant infrared heat provided by the shield means when added to the primary source of radiant infrared heat results in a greater development of the color of the dyestuff to produce a brightened, lustrous coloration on the dyed or printed fabric web following the drying operation.

Some of the objects of the invention having been stated, other objects will become apparent as the description proceeds, when taken in connection with the accompanying drawings in which—

FIGURE 1 is a side elevational view of the improved apparatus for applying a heat treatment to web material in accordance with the present invention, partially broken away and showing the assembly of the heating means in vertical section for purposes of clarity;

FIGURE 2 is an enlarged vertical sectional view of one of the burner elements illustrated in FIGURE 1;

FIGURE 3 is a fragmentary end elevational view of the improved apparatus for applying a heat treatment to web material, looking at the left-hand end of the apparatus as illustrated in FIGURE 1; and

FIGURE 3-A is a fragmentary view taken substantially along the line 3-A—3-A in FIGURE 1, being partially in end elevation and partially in vertical section, with parts shown in vertical section being broken away for purposes of clarity—FIGURE 3-A forming a continuation of the fragmentary end elevational view of FIGURE 3 to illustrate a complete end of the apparatus.

Referring more specifically to the drawings, the apparatus in accordance with the present invention comprises a housing 10 including end walls and side walls, the housing 10 being supported on a floor or other planar surface by pairs of legs 11, 11 located at the opposite sides thereof. The side walls of the housing 10 are provided with respective doors 12, 12 therein, the doors 12, 12 being hingedly mounted about one side thereof to the respective side wall corresponding thereto for pivotal movement between open and closed positions to provide access to the interior of the housing. The top and bottom of the housing 10 are open to permit web material W, such as textile fabric, which is to be subjected to a heat treatment to be fed through the housing 10 in a vertical path of travel intermediate the end walls thereof, as will be presently described.

In the latter connection, it will be observed that upper and lower web feed rolls 13, 14 are respectively mounted on the housing 10 so as to extend between the side walls thereof across the open top and open bottom of the housing 10. Suitable pairs of bearing blocks 15, 16 are provided on the housing 10 into which axles extending from opposite ends of the web feed rolls 13, 14 are journaled. The web material W is fed into the housing 10 through the open bottom thereof by being directed onto the lower feed roll 14, and the web material W then passes upwardly through the open top of the housing 10 on a vertical path of travel, being received by the upper feed roll 13 from where the web material W is directed away from the housing 10.

Heating means are arranged within the interior of the housing 10 so as to extend along the opposite end walls thereof in opposed relationship to the opposite surfaces of the web material W being fed through the housing 10. In this respect, the heating means comprises upper and lower banks or groups of horizontally extending heating elements 20 arranged along the interior surfaces of

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both end walls of the housing 10 so as to direct the major portion of heat generated thereby inwardly of the housing 10 toward the web material W. Thus, an upper bank A of heating elements 20 and a lower bank B of heating elements 20 are located along the interior surface of the left-hand end wall of the housing 10, as shown in FIGURE 1, while upper bank C and lower bank D are located along the interior surface of the right-hand end wall.

Since the arrangement of each of the upper and lower banks of heating elements 20 along both end walls of the housing 10 is the same, it will be understood that the following description of the upper bank A of heating elements 20 extending along the interior surface of the left-hand end wall of the housing 10 as illustrated in FIGURE 1 will also apply to the banks B, C, and D of heating elements 20. The upper bank A of heating elements 20 along the interior surface of the left-hand end wall includes first and second vertically spaced horizontal rows of heating elements 20 extending widthwise of the housing 10, each of the horizontal rows of heating elements 20 comprising a plurality of adjoining elongate gas burners 21. The opposite ends of the individual gas burners 21 are provided with lugs 22 which abut corresponding lugs 22 of adjoining gas burners 21, and the gas burners 21 are connected together by suitable fastener bolts extending through the opposed abutting lugs 22, 22 on adjacent gas burners 21.

Each of the gas burners 21, as shown in FIGURE 2, comprises an elongated horizontally extending burner housing 23. The burner housing 23 is tubular, being open at both ends, and includes top and bottom horizontally extending walls 24, 25, a vertical back wall 26 disposed adjacent to the end wall of the apparatus housing 10 corresponding thereto, and a vertical front wall 27 disposed inwardly of the back wall 26 with respect to the apparatus housing 10 to provide a fuel chamber 28 defined by the walls of the burner housing 23. It will be observed that the top and bottom walls 24, 25 extend inwardly beyond the front wall 27 of the burner housing 23 and terminate in vertical upstanding and depending flanges 29, 29 to which a burner screen assembly 30 is secured. The burner screen assembly 30 comprises an inner vertically disposed wire mesh screen 31, an outer generally vertically disposed wire mesh screen 32 having a convex curvature and being spaced inwardly of the apparatus housing 10 with respect to the inner screen 31, and suitable bracket members for mounting the screens 31, 32 on the flanges 29, 29 of the burner housing 23. The inner and outer screen 31, 32 are therefore arranged in spaced overlying relation to the front wall 27 of the burner housing 23. The inner screen 31 cooperates with the front wall 27, the inward extensions of the top and bottom walls 24, 25, and the bracket members mounting it on the flanges 29, 29 of the burner housing 23 to define a combustion chamber 33. A burner orifice 34 is formed in the front wall 27 of the burner housing 23, being centrally positioned therein with respect to the top and bottom walls 24, 25 and intermediate the ends of the burner housing 23, for providing communication between the fuel chamber 28 and the combustion chamber 33.

A rod 35 extends through the fuel chamber 28 and the burner orifice 34, the rod 35 having a flame baffle plate 36 on the end thereof projecting through the burner orifice 34 and being adjustably secured at its other end to the back wall 26 of the burner housing 23. Lengthwise adjustment of the rod 35 with respect to the burner housing 23 regulates the degree of restriction imposed on the burner orifice 34 by the flame baffle plate 36. The flame baffle plate 36 will ordinarily be adjusted to diffuse the ignited gases issuing from the burner orifice 34 so that the flame of the gas burner 21 will spread across the area of the inner screen 31 which serves as a burner grid. The inner screen or burner grid 31 is thereby heated to become a heat radiating surface and the heat

radiated therefrom combines with conducted heat and heat of convection from the flow of hot gases generated by the flame of the gas burner 21 to uniformly heat the outer screen 32 so that it becomes a heat radiating surface furnishing a primary source of radiant infrared heat directed inwardly of the apparatus housing 10. The inner screen or burner grid 31 and the outer screen 32 may be made of suitable heat-resistant mesh material, such as Nichrome mesh, the mesh of the inner screen or burner grid 31 being preferably more closely woven and of lighter weight than the mesh of the outer screen 32.

It will be appreciated that the fuel chambers 28 of the plurality of adjoining gas burners 21 in each of the several horizontal rows of heating elements 20 included in the banks A, B, C and D of heating elements 20 define a continuous fuel passageway extending the length of the row, since the burner housings 23 of the gas burners 21 in the row are open at both ends. The horizontal rows of heating elements 20 included in the upper and lower banks A, B of heating elements 20 along one end wall of the apparatus housing 10 are secured at one end thereof by means of respective brackets 37, 37 to a vertical support in the form of an angle-iron member 40 (FIGURE 3-A) projecting laterally inward of the end wall corresponding to the banks A, B of heating elements 20. The burner housings 23, 23 of the gas burners 21, 21 at one end of the first and second horizontal rows of heating elements 20 comprising each of the banks A, B of heating elements 20 are attached to the respective bracket 37 which serves as an end closure for the fuel passageways defined by the adjoining fuel chambers 28 of the gas burners 21 comprising the first and second horizontal rows of heating elements 20 in each of the banks A, B of heating elements 20. It will be understood that the horizontal rows of heating elements 20 included in the upper and lower banks C, D of heating elements 20 along the other end wall of the apparatus housing 10 are mounted within the apparatus housing 10 at one end thereof in a manner similar to that previously described in connection with the upper and lower banks A, B of heating elements 20.

As shown in FIGURE 1, a fuel manifold comprising a pair of branch manifolds 41, 41, is connected into a fuel supply piping system, as will be later described. The branch manifolds 41, 41 extend vertically within the housing 10 along the opposite end walls thereof and are connected to the burner housings 23 of the gas burners 21 at the other end of each of the first and second horizontal rows of heating elements 20 included in the upper and lower banks A, B, C and D of heating elements 20 by nozzles 42 (FIGURE 3) to provide communication between the branch manifolds 41, 41 and the fuel passageways defined by the adjoining fuel chambers 28 in each row of heating elements 20.

The fuel supply piping system includes an air line 43 extending below the housing 10 and communicating with a source of compressed air (not shown). A gas supply conduit 44 is disposed above the air line 43 (FIGURE 1) and is connected to a source of gas fuel (not shown) by a gas tap line 45 (FIGURE 3). The flow of gas from the source of gas fuel through the gas tap line 45 to the gas supply conduit 44 is controlled by a manually operable valve 46 in the gas tap line 45, and the pressure of the gas flowing through the gas tap line 45 is regulated by a pressure regulator 47 of the flexible diaphragm type which is also interposed in the gas tap line 45 adjacent to its connection with the gas supply conduit 44.

Compressed air from the air line 43 is admitted to a mixing chamber provided in a conical pipe fitting 50 through an air tap line 51 which extends from the air line 43 and is connected to the conical pipe fitting 50 by a pipe coupling 52. The air tap line 51 has a valve 53 therein for controlling the flow of compressed air into the mixing chamber provided in the conical pipe fitting 50. The outlet end of the gas supply conduit 44 is also

connected to the conical pipe fitting 50 by the pipe coupling 52. The mixing chamber in the conical pipe fitting 50 is in the form of a Venturi passageway. Thus, gas is drawn from the gas supply conduit 44 into the conical pipe fitting 50 and thereafter into the branch manifolds 41, 41 via a T-connector 54 joining the branch manifolds 41, 41 to the conical pipe fitting 50 in response to the vacuum created by the compressed air rushing through the pipe coupling 52 past the outlet end of the gas supply conduit 44 connected thereto to draw gas from the gas supply conduit 44 into the conical pipe fitting 50.

The valve 53 in the air tap line 51 may be manually or automatically operable to control the flow of compressed air through the pipe coupling 52 and past the outlet end of the gas supply conduit 44 for regulating the degree of the vacuum drawing gas from the gas supply conduit 44 into the conical fitting 50. It will be understood that the valve 53 may be adjusted to vary the degree of the vacuum. In the latter respect, the pressure regulator 47 is adjusted in accordance with the degree of vacuum induced by the flow of compressed air in the manner described to correspondingly raise or lower the gas pressure flowing from the source of gas fuel through the gas tap line 45 to the gas supply conduit 44 for thereby increasing or decreasing the gas drawn into the conical pipe fitting 50 from the gas supply conduit 44. Where the valve 53 is of an automatically operable type, it is preferably controlled by a mechanism relying upon a web temperature sensing means in the form of a radiation pyrometer trained on the surfaces of the web material W within the interior of the housing 10 (not shown). The radiation pyrometer senses the temperature of the web material W within the housing 10 and is responsible for adjusting the valve 53 to increase or decrease the flow of compressed air from the air tap line 51 through the pipe coupling 52 and past the outlet end of the gas supply conduit 44 to correspondingly heighten or lessen the vacuum which increases or decreases the pressure of the gas fuel passing into the gas supply conduit 44 by appropriate adjustment of the pressure regulator 47. In this manner, the temperature of the web material W within the housing 10 can be maintained at a predetermined magnitude.

For further regulating the gas-air fuel mixture supplied to the burners 21, the restriction of the Venturi passageway in the conical pipe fitting 50 may be adjusted by a manually operable flow adjuster 55, which extends outwardly of and below the pipe coupling 52, to increase or reduce the vacuum induced by the compressed air for increasing or reducing the amount of the gas-air fuel mixture drawn into the branch manifolds 41, 41 from the gas supply conduit 44 and the air tap line 51.

A burner flame detector 56 is located in horizontal alignment with each of the banks or groups A, B, C, D of heating elements 20, the burner flame detectors 56 being positioned adjacent a side wall of the apparatus housing 10 (FIGURE 3-A) and including inwardly projecting sensing tubes 57 which respectively terminate adjacent one of the ends of the banks or groups A, B, C, and D of heating elements 20. The burner flame detectors 56 sense the presence of ultra-violet light in the flames produced by the gas burners 21. Should the flames of the gas burners 21 in a particular bank or group of heating elements 20 be extinguished while gas is being supplied to the banks or groups A, B, C, and D of heating elements 20, this condition will be detected by the burner flame detector 56 associated therewith because of the absence of ultra-violet light due to the lack of flames from the gas burners 21. The burner flame detector 56 associated with the non-firing bank or group of heating elements 20 will then communicate this condition to a suitable valve means (not shown) in the gas supply conduit 44 to close the valve means for shutting off the flow of gas from the gas supply conduit 44 to the burners 21,

thereby averting a dangerous accumulation of gas in the apparatus housing 10.

Each of the upper and lower banks or groups A, B, C, and D of heating elements 20 are individually confined by generally inwardly convergent reflector casings—there being upper reflector casings 60, 60 corresponding to the upper banks A, C of heating elements 20 and lower reflector casings 61, 61 corresponding to the lower banks B, D of heating elements 20. A plurality of exhaust holes 62 are provided in the lower reflector casings 61, 61 above the lower banks B, D of heating elements 20, the exhaust holes 62 serving to dissipate products of combustion from the gas burners 21. The upper reflector casings 60, 60 similarly include exhaust holes (not shown) at appropriate locations therein above the upper banks A, C of heating elements 20 to allow products of combustion from the gas burners 21 to escape through the upper reflector casings 60, 60 and upwardly through the open top of the housing 10.

Each of the upper and lower reflector casings 60, 60 and 61, 61 converges inwardly to define a horizontally extending mouth disposed inwardly of the bank or group of heating elements 20 associated therewith. The upper and lower boundaries of each of the horizontally extending mouths are outlined by trackways 63, 63 provided in the respective reflector casing. Means are positioned in the mouths of the upper and lower reflector casings 60, 60 and 61, 61 to shield the web material W from direct exposure to the gas flames and the products of combustion from the individual gas burners 21, and to transmit radiant heat to the web material W from the burners 21 in a particular wavelength range of infrared radiation lying within a water absorption zone. Such means takes the form of a plurality of plate glass shields 64 which are slidably mounted along their upper and lower edges in the trackways 63 of respective reflector casings so as to cover the mouths thereof. While a plurality of glass shields 64 have been shown and described as covering each of the mouths, it will be understood that a continuous elongated glass plate extending across the entire length of each mouth may be suitably employed.

The plurality of glass shields 64 extend lengthwise across each of the banks or groups A, B, C, D of heating elements 20, being interposed between the heating elements 20 and the web material W on each side of the web material W as it is fed in a vertical path of travel through the apparatus housing 10. Thus, the glass shields 64 protect the web material W against direct exposure to the gas flames and the products of combustion from the gas burners 21, while transmitting radiant heat to the web material W from the burners 21 as described. Additionally, the glass shields 64 also filter out or absorb some of the heat given off by the gas burners 21 and become heated to an extent, wherein the glass shields 64 provide a secondary source of radiant infrared heat of less intensity than the primary source of radiant infrared heat emanating from the gas burners 21. This secondary source of radiant infrared heat from the glass shields 64 is transmitted to the web material W in a different wavelength range lying within another water absorption zone of the infrared radiation spectrum. It has been found that this secondary source of infrared radiation from the heated glass shields 64 combines with the greater intensity of infrared radiation transmitted through the glass shields 64 from the primary source of infrared radiation afforded by the gas burners 21 to modulate and distribute the infrared radiant heat over the web material W so that the radiated heat from the apparatus uniformly penetrates throughout the thickness of the web material W to be absorbed by the moisture therein.

In this manner, the apparatus accomplishes the drying of dyed or printed fabric web material in a superior fashion as compared to drying apparatuses heretofore used for this purpose by effectively controlling color migration of the dyestuff impregnated in the dyed or printed

fabric web material. This improved drying of dyed or printed fabric web material by the apparatus is accompanied by a greater development or heightening of the color of the dyestuff impregnated in the fabric web material which provides a brightened, lustrous coloration on the opposite surfaces of the fabric web material as compared to dyed or printed fabric web materials which have been dried by conventional procedures. It is believed that this brightened, lustrous coloration of the fabric web material after it has been dried by the apparatus in accordance with this invention is brought about by the evenly modulated and distributed infrared radiant heat applied to the fabric web material which is afforded by transmitting infrared radiation toward the fabric web material from primary and secondary sources of infrared radiation in different wavelength ranges and lying within water absorption zones of the infrared radiation spectrum.

By means of the present apparatus, printed or dyed fabric web material may be subjected to the maximum, practical amount of radiant heat lying within a water absorption range of the infrared radiation spectrum which can be safely employed without singeing or burning of the web material. In this respect, we have determined that the primary source of infrared radiation transmitted through the glass shields 64 from the gas burners 21 should have a wavelength of the order of 2.436 microns, this being the most effective wavelength of infrared radiation to be transmitted from the primary heat source to obtain fast and efficient evaporation of moisture from the web material W. 2.436 microns of infrared radiation lies within a water absorption zone of the infrared radiation spectrum and is that predominantly produced at a temperature of approximately 1,680° F. from the gas burners 21, or a radiation of approximately 36,000 B.t.u.'s/ft.²/hr.

The glass shields 64 may be made of a suitable heat-resistant material capable of transmitting radiant heat and filtering out or absorbing heat to become a heat radiating element, such as Feurex glass or Pyrex glass. By way of example, Feurex glass shields 64 having a thickness of ¼ inch by virtue of absorbing and filtering out certain heat from the gas burners 21 associated therewith may be heated to become a secondary source of infrared radiation transmitting radiant heat to the web material W having a wavelength ranging between 5 and 6 microns or within another water absorption range of the infrared radiation spectrum—5.1 microns being the approximate wavelength of infrared radiation obtained from the Feurex glass shields 64 and directed toward the web material W. 5.1 microns of infrared radiation is that predominantly produced at a temperature of approximately 563° F. or a radiation of approximately 1,889 B.t.u.'s/ft.²/hr. The Feurex glass shields 64 transmit approximately 83 percent of the radiant heat energy at 2.436 microns from the gas burners 21 associated therewith, the balance of the heat being absorbed or filtered out by the glass shields 64 in becoming a secondary source of radiant infrared heat.

Since the gas burners 21 in the upper and lower banks A, B, C, and D of heating elements 20 can be carefully regulated as to the amount of radiant infrared heat derived therefrom to be transmitted through the glass shields 64 toward the web material W by varying the amount of the gas-air fuel mixture admitted thereto through the fuel supply piping system in accordance with pyrometer readings of the temperature of the web material W within the apparatus, a much closer temperature tolerance range can be maintained with respect to the temperature of the web material than the 20° F. tolerance range typically accompanying the use of conventional drying apparatuses. In this connection, the heating means within the apparatus in accordance with the present invention can be controlled to produce a predetermined temperature on the web material being dried which is held within a tolerance range of only 5°–7° F.—thereby attesting to

the uniformity of the radiant heat applied to dyed or printed fabric web material by the instant apparatus.

From the standpoint of operating economies and strict control on the amount of heat radiated from the primary source of infrared radiation, gas burners are considered to be preferable as the primary source of infrared radiation in the improved apparatus. It should be understood, however, that it is within the spirit of the present invention to employ electrical heating means as the primary source of infrared radiation in conjunction with the glass shields 64 as the secondary source of infrared radiation.

The apparatus is also suitable in curing web material, such as a textile fabric, which has been treated with resins. In this respect, the resin impregnated in a fabric web material can be quickly cured by bringing the temperature of the web material up to the desired curing temperature through proper regulation of the radiant infrared heat emanating from the gas burners 21 with curing of the resin being accomplished in a fast and efficient manner.

While we have illustrated and described a single apparatus for applying a heat treatment to web material, it is contemplated that a plurality of these apparatuses may be suitably arranged in end-to-end relationship with a common fuel supply piping system for processing web material through a drying or curing operation as will appear more fully in our co-pending U.S. application, Serial No. 215,990, filed August 9, 1962.

In the drawings and specification there has been set forth a preferred embodiment of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for the purposes of limitation, the scope of the invention being defined in the claims.

We claim:

1. In an apparatus for applying a heat treatment to web material having a moisture content,

- (a) a heating means for radiating toward said web material infrared heat predominantly of wave lengths lying within a first water absorption zone at approximately 2.436 microns of the infrared radiation spectrum,
- (b) heat transmissive and absorptive shield means adapted to be interposed between said heating means and said web material
 - (b') for directly transmitting from said heating means to said web material a major portion of said infrared heat of wave lengths lying within said first water absorption zone and
 - (b'') for absorbing other of said infrared heat and itself radiating to said web material infrared heat predominantly of wave lengths lying within a second water absorption zone at approximately 5.1 microns of the infrared radiation spectrum.

2. In an apparatus for applying a heat treatment to web material having a moisture content,

- (a) heating means for radiating toward the opposite surfaces of said web material infrared heat predominantly of wave lengths lying within a first water absorption zone at approximately 2.436 microns of the infrared radiation spectrum,
- (b) heat transmissive and absorptive shield means adapted to be interposed between said heating means and said web material
 - (b') for directly transmitting from said heating means to the opposite surfaces of said web material a major portion of said infrared heat of wave lengths lying within said first water absorption zone and
 - (b'') for absorbing other of said infrared heat and thereby becoming heated, and for thereafter itself radiating to the opposite surfaces of said web material infrared heat predominantly of wave lengths lying within a second water ab-

sorption zone at approximately 5.1 microns of the infrared radiation spectrum.

3. In an apparatus for applying a heat treatment to a web of textile material and the like,

- (a) means for feeding said web along a predetermined path of travel,
- (b) heating means mounted adjacent said predetermined path of travel for radiating toward the opposite surfaces of said web fed therealong infrared heat predominantly of wave lengths lying within a first water absorption zone at approximately 2.436 microns of the infrared radiation spectrum,
- (c) heat transmissive and absorptive shield means adapted to be interposed between said heating means and said predetermined path of travel
 - (c') for directly transmitting from said heating means to the opposite surfaces of said web fed along said predetermined path a major portion of said infrared heat of wave lengths lying within said first water absorption zone and
 - (c'') for absorbing other of said infrared heat and thereby becoming heated, and for thereafter itself radiating to the opposite surfaces of said web fed along said predetermined path infrared heat predominantly of wave lengths lying within a second water absorption zone at approximately 5.1 microns of the infrared radiation spectrum.

4. In an apparatus for applying a heat treatment to a web of textile material and the like having a moisture content,

- (a) a housing having an open top,
- (b) means for feeding said web through said housing along a predetermined path of travel,
- (c) gas heating means mounted within said housing and adjacent opposite sides of said predetermined path of travel for radiating toward the opposite surfaces of said web fed through said housing infrared heat predominantly of wave lengths lying within a first water absorption zone at approximately 2.436 microns of the infrared radiation spectrum,
- (d) substantially planar heat transmissive and absorptive shield means mounted within said housing and adapted to be interposed between said heating means and said predetermined path of travel
 - (d') for directly transmitting from said heating means to the opposite surfaces of said web fed through said housing a major portion of said infrared heat of wave lengths lying within said first water absorption zone and
 - (d'') for absorbing other of said infrared heat and thereby becoming heated, and for thereafter itself radiating to the opposite surfaces of said web fed through said housing infrared heat predominantly of wave lengths lying within a second water absorption zone at approximately 5.1 microns of the infrared radiation spectrum.

5. In an apparatus for applying a heat treatment to a web of textile material and the like having a moisture content,

- (a) a housing having an open top and bottom, and a pair of substantially parallel vertical walls,
- (b) means disposed across the top and bottom of said housing for feeding said web along a substantially vertical straight path of travel through said housing between said vertical walls of said housing,
- (c) heating means mounted adjacent said path of travel for radiating toward the opposite surfaces of said web fed through said housing infrared heat predominantly of wave lengths lying within a first water absorption zone at approximately 2.436 microns of the infrared radiation spectrum,
- (d) said heating means comprising a plurality of gas burners mounted within said housing in substantially

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horizontally extending straight rows along said pair of vertical walls of said housing, at least one of said straight rows of said gas burners extending along each of said pair of vertical walls, and said gas burners being directly inwardly of said housing toward said path of travel for radiating said infrared heat in opposing directions toward the opposite surfaces of said web fed through said housing, (e) heat transmissive and absorptive shield means adapted to be interposed between said gas burners and said path of travel

(e') for directly transmitting from said gas burners to the opposite surfaces of said web fed through said housing a major portion of said infrared heat of wave lengths lying within said first water absorption zone and

(e'') for absorbing other of said infrared heat and thereby becoming heated, and for thereafter itself radiating to the opposite surfaces of web fed through said housing infrared heat predominantly of wave lengths lying within a second water absorption zone at approximately 5.1 microns of the infrared radiation spectrum,

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(f) said shield means comprising a plurality of substantially planar glass plates respectively associated with said gas burners along each of said pair of vertical walls of said housing and positioned inwardly of said gas burners corresponding thereto between said gas burners and the opposite surfaces of said web fed through said housing, said glass plates extending substantially horizontally in parallel relationship to the respective opposite surfaces of said web fed through said housing and covering all of said gas burners in said rows to protect the opposite surfaces of said web material from direct exposure to the flames and products of combustion from said gas burners.

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