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HEAT TREATMENT METHOD AND APPARATUS

Original Filed Feb. 19, 1934

Fig. 1.

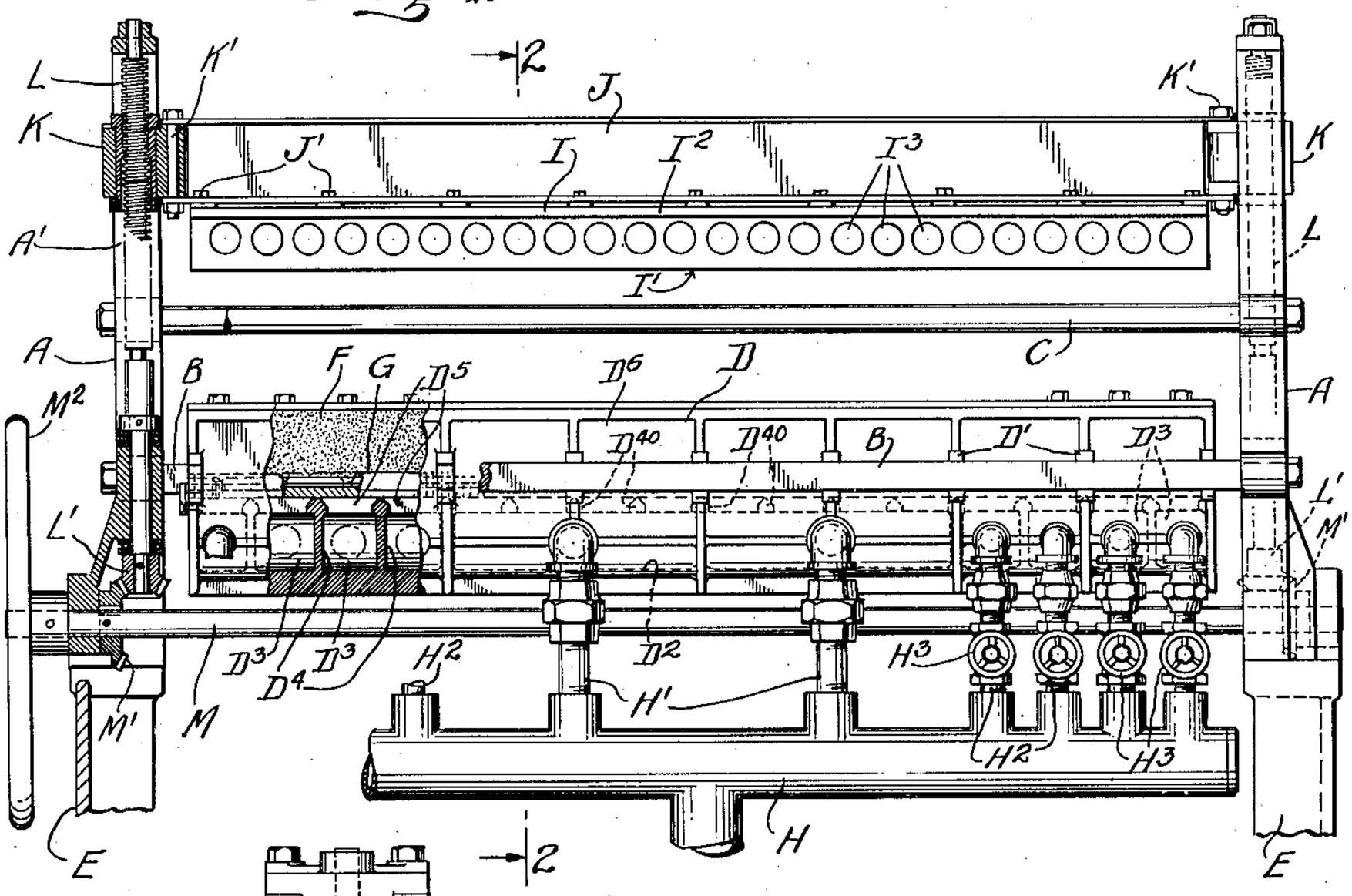


Fig. 2.

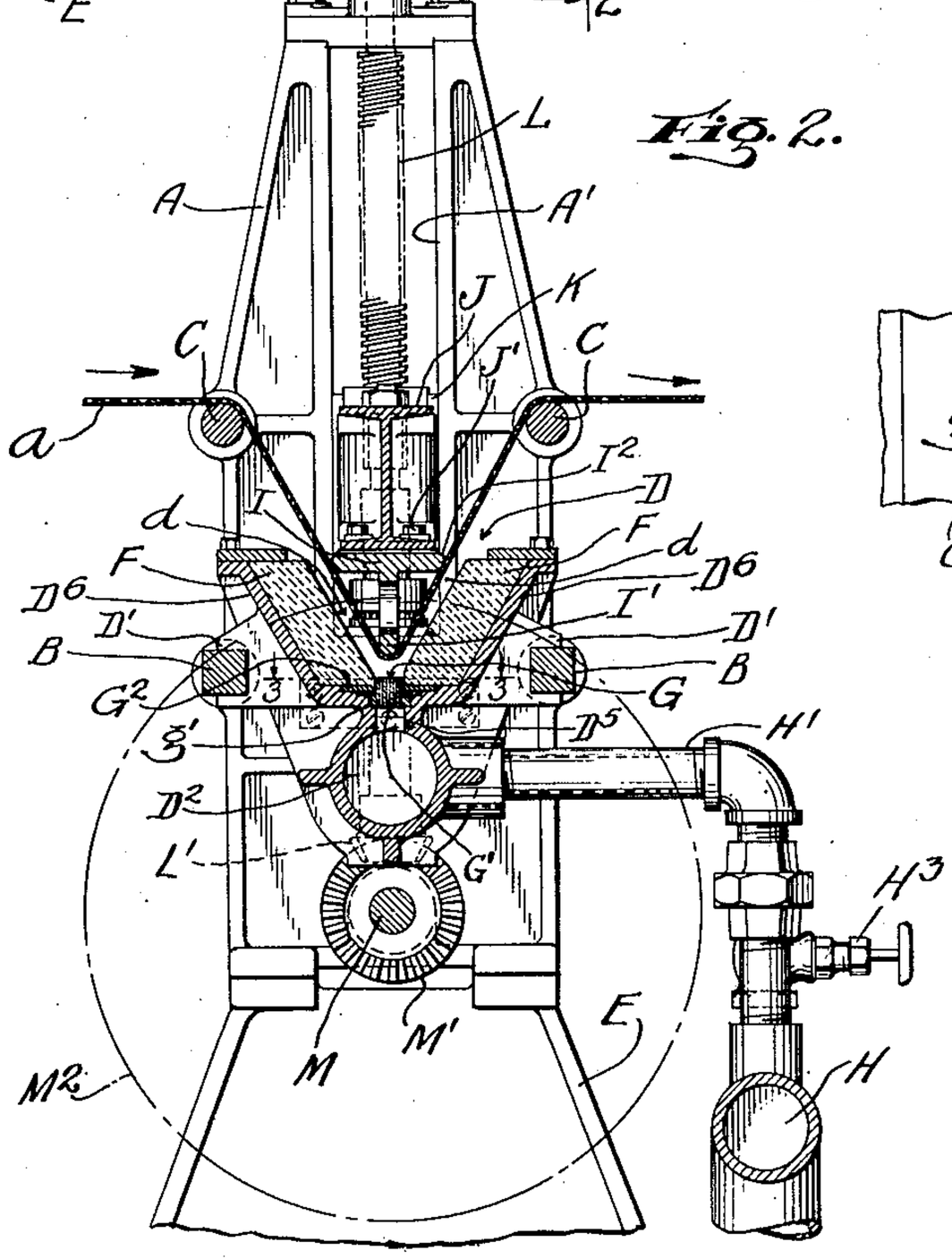
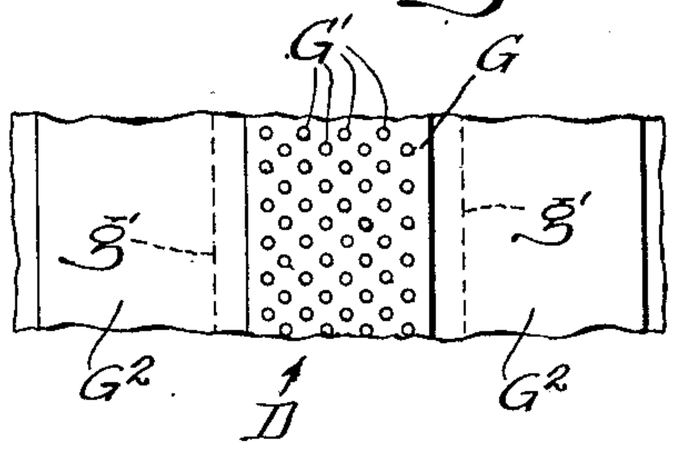


Fig. 3.



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HEAT TREATMENT METHOD AND APPARATUS

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10 Claims. (Cl. 26—3)

The general object of the present invention is to provide an improved method of and apparatus for subjecting a traveling web of cloth, paper, or analogous material to a heating action in a localized portion of the path of web travel. The embodiment of the invention illustrated and described in detail herein was primarily devised for use in singeing cloth, but is well adapted for use in drying paper webs and printed webs of paper or woven fabric, and in general, for subjecting such web material to a heating action analogous to that required for the above mentioned singeing and drying purposes.

The invention in its preferred form is characterized by the longitudinal movement of the web treated along a path including a loop portion defined by guides including a guide bar at the crown of the loop about which the web is looped and from the opposite sides of which the web loop limbs extend under tension, and by the subjection of the web loop to a heating action due to the combustion of gas, and preferably a combustible mixture of air and gas, adjacent but at the convex or outer side of the web loop crown and including in addition to the direct heating effect of the gas combustion, and the contact of the heating gas with the web loop, a radiation of heat to the outer side of one, or preferably both limbs of the web loop, from heat absorbing and radiating refractory material alongside of but spaced away from each limb to which heat is so radiated. When, as is ordinarily preferable, heat is so radiated to each limb of the web loop, the heat absorbing and radiating refractory material forms the oppositely inclined sides of an open ended trough like space which is formed in a heating element or burner structure, and in which the web loop is nested, so to speak. In the preferred embodiment of the invention, the bottom wall of said trough shaped space is formed with burner channels or orifices opening to said space from a subjacent gas supply chamber, and the heating element walls defining said trough shaped space and the web loop limbs collectively define a heating chamber which is V-shaped in cross section and from which the gaseous products of combustion issue at the edges of said chamber remote from its apex which extends longitudinally of the crown of the web loop.

More specific objects of the invention are to provide an apparatus for use in the practice of the above described method characterized by its mechanical and operating simplicity and effectiveness, and by features of construction and arrangement whereby the relative thermal expansion and contraction of its parts occurring under varying conditions of operation are accommodated, and by the features provided to accommodate the ready introduction of a material web into the apparatus, and by the features provided for the efficient handling of material webs of less widths than the maximum width which can be treated in the apparatus.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects obtained with its use, reference should be had to the accompanying drawing and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

Of the drawing:

Fig. 1 is a side elevation of an apparatus for subjecting a web to heat treatment, with parts of the apparatus broken away and shown in section.

Fig. 2 is a section on the line 2—2 of Fig. 1; and

Fig. 3 is a plan view of a portion of the burner structure of the apparatus.

The apparatus shown in the drawing was primarily devised and designed for singeing a cloth web *a*, as the latter is moved rapidly through the apparatus by web feeding means which may be of any suitable character and may be independent of the singeing apparatus proper and hence need not be illustrated herein, but the apparatus shown is adapted for use with little or no change in heating web material for drying and other purposes.

The stationary portions of the apparatus shown comprise vertical end frame members A connected by horizontal lower and upper cross frame members or bars B and C, respectively, and a heating element including a metallic burner body member D longitudinally disposed between the end frame members A. As shown, the burner body D is formed with slide bracket extensions D′ which are notched to receive the cross frame bars B by which the heating element is supported. The brackets D′ may slide on the bars B longitudinally of the latter as required to accommodate the relative longitudinal expansion of the bars and burner body D as their relative temperatures vary. As shown, the end frame members A are mounted on supporting pedestals E.

At its upper side the heating element is formed with a trough shaped heating space extending longitudinally of the burner body D and open at

its top and ends. The oppositely inclined side walls of said space are formed by slab like bodies F' of heat absorbing refractory material of relatively low heat conductivity, such as is commonly referred to as an insulating refractory material. The inner inclined faces of the bodies F' extend upward from a narrow horizontal bottom wall G formed with vertically disposed burner orifices or channels G' leading to the trough shaped heating space from a subjacent burner gas supply chamber. The latter, as shown, is divided by transverse web or division walls D^4 into a series of end to end compartments D^2 and D^3, whereby regulation of the distribution of heat to the heating space longitudinally of the latter is facilitated, and the supply of heat to the heating space may be restricted to such portion of the length of the latter as needs to be heated in handling a web of a width less than that of the maximum width which can be handled in the apparatus. As shown, the supply chamber compartment D^2 extends for about a quarter of the length of the heating element at each side of the center of the latter, and there are four similar compartments D^3 at each end of the compartment D^2.

In the arrangement shown, the compartment D^2 is supplied with gas, of preferably a combustible mixture of air and gas, through two branches H' from a distributing pipe H alongside the heating element and receiving gas, or a combustible mixture of gas and air, from a suitable source, not illustrated. Each of the compartments D^3 is connected to the pipe H through an individual branch pipe H^2 including a regulating and cut off valve H^3. As shown, the burner body D is formed with an end to end series of slots or openings D^5 at the upper sides of the compartments D^2 and D^3 through which gas may pass from the latter into the lower ends of corresponding orifices or burner channels G' in the wall G, there being one slot for each of the compartments D^3, and a plurality of such slots, separated by grid or tie bars D^{40}, for the compartment D^2. The use of the latter facilitates the formation of, and gives additional strength to the burner body casting. Each division wall D^4 and grid bar D^{40} has its upper portion beveled off to form a sharp corner edge engaging the under side of the wall G, so that it need obstruct flow through none of the channels G' which are suitably distributed to avoid any tendency to streaky action of the flame jets on the web of material treated. With all of the compartments D^2 and D^3 receiving gas, the channels G' are supplied with gas as they would be if the end to end slots D^5 were replaced by a single long slot.

As shown the wall G extends across the aligned slots D^5 and has edge portions suitably secured as by means of clamping plates G^2, against seat portions of the burner body D at the sides of said slots. The refractory slabs F' are shown as disposed with their lower portions alongside of, or in overlapping relation with an upper portion of the wall G and are supported by engagement with the clamping plates G^2 and suitably shaped portions of the burner body D, which comprises upper inclined portions D^6 at the outer sides of the body F' to the upper edges of which plates are detachably secured to clamp the bodies F' in place.

In the normal operative condition of the apparatus shown in Fig. 2, the web *a* is looped about a guide bar I which extends into the trough shaped space between the bodies F' and above the wall G. As shown, the guide bar I is of T-bar cross section, with its head flanges uppermost. The lower edge I' of the web or stem portion of the bar I defines and positions the crown of the web loop, and is smooth and rounded to facilitate the movement of the web over it. The two limbs of the web loop extend in normal operation under tension from the opposite sides of the edges I' and in substantial parallelism with the respectively adjacent faces of the refractory bodies F' to web guiding members which might be in the form of rollers, but as shown are formed by the non-rotatable cross frame members C. The latter are round and smooth to facilitate the movement of the web over them. As shown, the outer edges I^2 of the head flanges of the bar I are smooth and rounded and normally in position to contact with the limbs of the web loop extending between the bar edge I' and the web guides formed by the bars C.

In the operative condition of the apparatus illustrated in Fig. 2, the bodies F', wall G and the limbs of the web loop extending about the guide bar edge I' form the walls of a heating chamber *d* which extends longitudinally of the burner body D for the full width of the web *a*, and which is V shaped in cross section, and which is open to the atmosphere at its ends and at its upper edges which are at the level of the tops of the refractory bodies F'. To permit of adjustment in the thickness of the chamber *d*, and particularly of the portion of the latter between the crown of the web loop and the plate G, provisions are advantageously made for the vertical adjustment of the guide bar I. In the construction shown, the vertical adjustment provisions for the bar I are adapted to move the latter from the operative position shown in Fig. 2, into the inoperative position shown in Fig. 1, wherein the edge I' of the bar I is well above the level of the tops of the bars C. The relative positions of the bars C and I shown in Fig. 1, facilitates the initial introduction of the web into the apparatus. With the web *a* extending horizontally between the bars C as it may with the apparatus adjusted as shown in Fig. 1, all risk of injuriously heating the web while it is being introduced into the apparatus, or when the web travel is interrupted for any cause is avoided.

The means shown for supporting the guide bar I and giving the latter its vertical adjustments comprise a supporting bar J directly above the bar I and shown as in the form of an I-beam, from which the guide bar I is suspended by bolts J^1 distributed along the length of the beam and extending through openings in the bottom flange of the latter and in the head flanges of the bar I. Provisions are advantageously made, as by a suitable enlargement of said openings, to permit longitudinal thermal expansion and contraction of the bar I relative to the beam J. The bar I should be made of metal adapted to withstand the considerable temperatures to which it is subjected in operation. To suitably minimize any tendency of the bar I to warp as a result of thermal stresses to which it is subjected, and to minimize the transfer of heat by conduction from its bottom edge I^1 to its head, and the consequent transfer of heat from the bar I to the beam J, a multiplicity of large openings I^3 are advantageously formed in the web or stem portion of the bar I.

The means shown for vertically adjusting the beam J and thereby the bar I include non-rotatable nut members K connected to ends of the beam J and formed each with a vertical threaded

passage through which extends the threaded portion of a corresponding adjusting and supporting shaft L journalled in the corresponding end frame member A, and movable rotatably, but not axially, relative to the latter. At its lower end each shaft L carries a beveled gear L', meshing with a corresponding beveled gear M' secured to a horizontal shaft M below the burner body D and suitably journalled in the end frame member A. The shaft M may be rotated as required to raise and lower the threaded members K and thereby the beam J and guide bar I manually or by any suitable power mechanism. As shown, the shaft M is provided at one end with a hand wheel M^2 for the manual rotation of the shaft. Advantageously the members K are guided in their vertical movements by the engagement of suitably shaped guiding surfaces of those members with guideways A' formed for the purpose in the end frame members A, and the connections K' between the members K and the ends of the beam J are adapted to permit of some longitudinal expansion and contraction of the beam J without corresponding movements of separation and approach of the two members K.

In the contemplated mode of use of the apparatus, the latter is adjusted into the general position shown in Fig. 2 and heat is supplied by the heating element, and the web *a* is advanced at respective rates suitable for the particular condition of operation. The form of the apparatus and its contemplated mode of use permit of a rate of web feed substantially higher than has heretofore been customary or is practically possible with previously known web singeing machines.

For any web heat treating operation, it is in general essential that the effective heating action on the web should be augmented and diminished as the speed of web travel is increased and diminished. With the apparatus disclosed, the intensity of the heating effect impressed on the web may be varied by varying the composition or pressure of the gas or air gas mixture supplied to the compartments D^2 and D^3, and may also be varied somewhat by adjustment of the guide bar I toward and away from the heating element. The heating action due to combustion, which occurs mainly in the space between the crown of the web loop and the wall G, and due to contact of the heating gases with the web loop, is supplemented to a substantial degree in the arrangement shown, by heat radiated against the extended web loop limbs from the extended heat absorbing and radiating inner faces of the bodies F.

In singeing cloth the effectiveness of the singeing operation is augmented by the opening of the woven fabric as the latter bends sharply about the edge I' of the guide bar I. This bending of the web when under suitable tension tends to move the loose ends of fibers away from the outer side of the web and toward the adjacent portions of the heating element. When it is desirable to singe both sides of a cloth web, that result may be secured by passing the web in series through two singeing devices of the kind shown in such fashion that one device operated on one side, and the other on the opposite side of the web, or the web may be passed twice through the single device shown so as to singe one side during one passage, and to singe the other side during the second passage of the web through the apparatus. The movement of the web under tension over the edges I' and I^2 of the guide bar I, and particularly over the more highly heated edges I' subjects the web to a desirable ironing action.

For many uses it is convenient to dispose the heating element horizontally and so that the web loop extends downward into the space between the refractory block bodies F as illustrated, but, as will be apparent, this disposition of the parts may be altered as conditions make desirable. The essential operating characteristics of the apparatus shown would not be modified by adjustment of the apparatus to bring its heating element into vertical or inclined position, or to bring the guide bars C below the level of the heating element.

While in accordance with the provisions of the statutes, I have illustrated and described the best form of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be in the form of the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. Apparatus for subjecting a traveling web to a localized heating effect, comprising a heating element formed with a trough shaped space, and relatively cool guiding means separate from and out of contact with said heating element for causing the web treated to move along a path including a loop portion extending into said space with the crown of the web loop parallel and adjacent to but spaced away from the bottom of said space and with the limbs of the web loop alongside and spaced away from the side walls of said loop, said heating element comprising fuel burner orifices opening to said space adjacent the bottom of the latter, and comprising portions forming the side walls of said space consisting of refractory material of relatively poor heat conductivity.

2. Apparatus for subjecting a traveling web to a localized heating effect, comprising a heating element formed with a trough shaped space, relatively cool guiding means separate from and out of contact with said heating element for causing the web treated to move along a path including a loop portion extending into said space with the crown of the web loop parallel and adjacent to but spaced away from the bottom of said space and with the limbs of the web loop alongside and spaced away from the side walls of said loop, and means for burning a combustible gaseous mixture into the portion of said space at the outer side of the web loop, said element comprising portions forming the side walls of said space consisting of refractory material of relatively poor heat conductivity.

3. Apparatus for subjecting a traveling web to a localized heating effect comprising a heating element formed with a trough shaped heating space, guiding means for causing the web treated to move along a path including a loop portion extending into said space with the crown of the web loop parallel and adjacent to the bottom of said space, said guiding means comprising a guiding bar movable toward and away from the bottom of said space between positions within and without the latter, and cooperating guiding members

outside of said space and at opposite sides of the path of movement of said guiding bar.

4. Apparatus for subjecting a traveling web to a localized heating effect comprising a heating element formed with a trough shaped heating space, guiding means for causing the web treated to move along a path including a loop portion extending into said space with the crown of the web loop parallel and adjacent to the bottom of said space, said guiding means comprising a guiding bar movable toward and away from the bottom of said space between positions within and without the latter and cooperating members outside of said space and between which said guiding bar passes in moving between said positions.

5. Apparatus for subjecting a traveling web to a localized heating effect comprising a heating element formed with a trough shaped space, and web relatively cool guiding means for causing the web treated to move along a path out of contact with said element and including a loop portion extending into space with the crown of the web loop parallel and adjacent to but spaced away from the bottom of said space and with the limbs of the web loop alongside and spaced away from the side walls of said space, and means for generating combustion heat within the portion of said space between the bottom of the latter and the crown of the web, the portions of said element forming the side walls of said space being formed of refractory material of poor heat conductivity.

6. Apparatus for subjecting a traveling web to a localized heating effect, comprising a heating element formed with a trough shaped heating space, and guiding means for causing the web treated to move along a path including a loop portion extending into said space with the crown of the web loop parallel and adjacent to, but spaced away from the bottom of said space, and including a guide bar having a portion defining said web crown, said bar being cut away to minimize heat conduction and the tendency of said bar to warp under thermal stresses.

7. Apparatus for subjecting a traveling web to a localized heating effect, comprising a heating element formed with a trough shaped heating space, guiding means for causing the web treated to move along a path including a loop portion extending into said space with the crown of the web loop parallel and adjacent to, but spaced away from the bottom of said space, and including a guide bar about which said loop extends and engaging the inner side of the crown portion of said loop, and supporting means for said guide bar comprising a beam parallel to said bar and to which the latter is connected by means permitting the longitudinal expansion and contraction of said bar relative to said beam.

8. Apparatus for subjecting a traveling web to a localized heating effect comprising a framework including spaced apart end frame members, a heating element supported by said framework and longitudinally disposed between said end frames and formed with a trough shaped space web, guiding means for causing the web treated to move along a path including a loop portion extending into said space with the crown of the web loop parallel and adjacent to the bottom of said space, said guiding means comprising a guide bar, means mounted in said end frames for moving said bar toward and away from the bottom of said space between positions, respectively, within and out of said space, and cross frame members at the opposite sides of the path of movement of said guiding bar forming web guides between which and said bar the limbs of said loop extend when said bar is within said space, and between which said web may extend without flexure when said bar is in a position out of said space.

9. In apparatus of the character described, a heating element comprising an elongated gas supply chamber and a wall portion at one side thereof formed of refractory material with burner orifices extending through it from said chamber to the side of said wall portion remote from the chamber, and refractory walls parallel to the length of the chamber and extending away from the last mentioned side of said wall portion and spaced apart and having their opposing faces oppositely inclined to form the side walls of a trough shaped combustion space of which said wall portion forms the bottom wall, and means for guiding a travelling web along a path including oppositely inclined portions respectively adjacent said side walls and spaced away from the latter and defining the side of said combustion space directly opposed to the side thereof formed by said side walls.

10. Apparatus for subjecting a travelling web to a localized heating effect comprising in combination a burner portion of refractory ceramic material, normally cooperating with the web to form a shallow combustion space alongside of and having one side formed by a longitudinal section of the web and having said refractory material at its opposite side, means for burning fuel in said space to thereby heat said refractory material to incandescence, and means for moving said web and portion apart to substantially increase the distance between them and thereby substantially reduce the transmission of heat to the web from said incandescent refractory material.

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