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E. KIENTLE ET AL

2,220,928

METHOD OF AND APPARATUS FOR PRODUCING AND UTILIZING RADIANT HEAT

Filed May 22, 1937

5 Sheets-Sheet 1

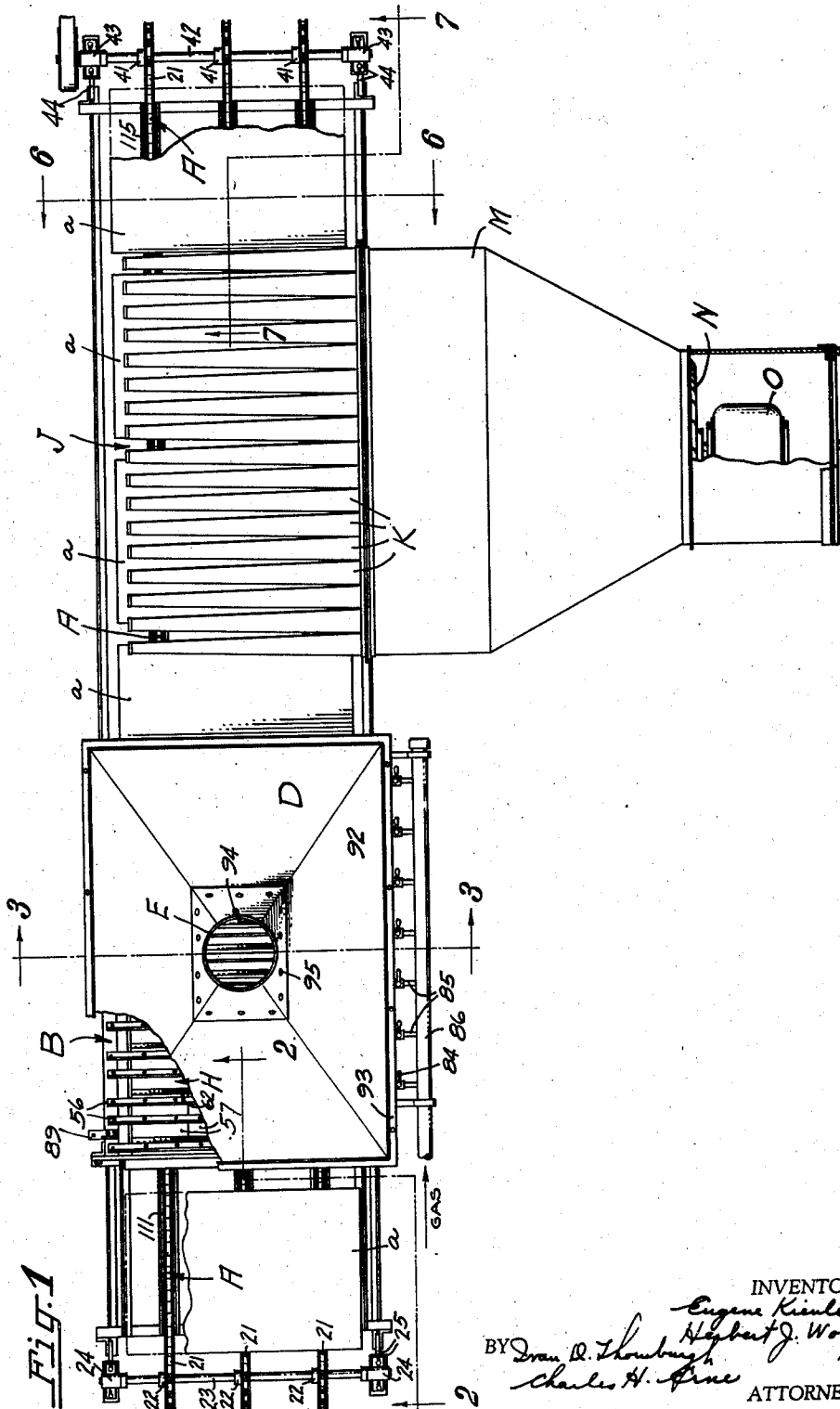


Fig. 1

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5 Sheets-Sheet 2

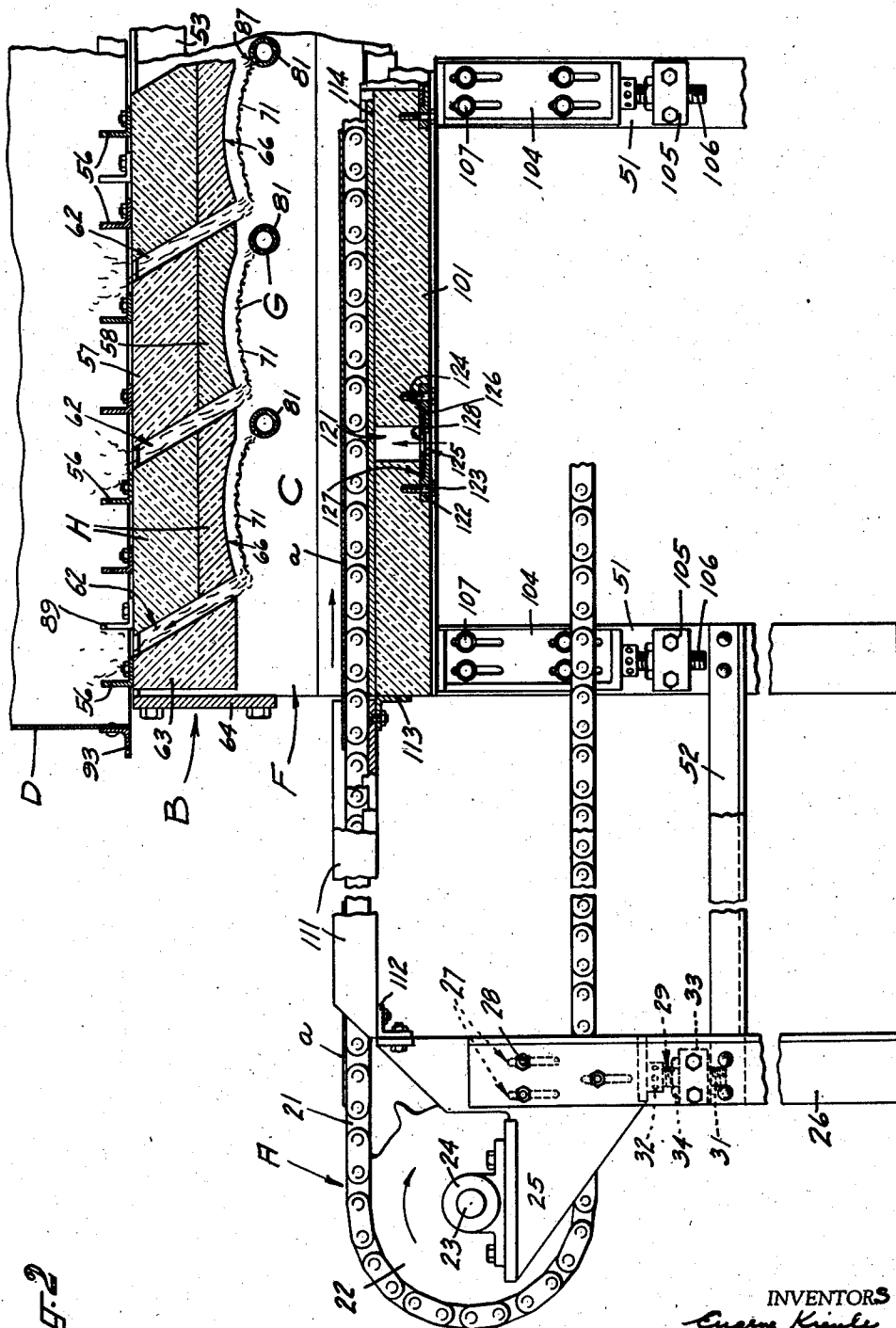


Fig. 2

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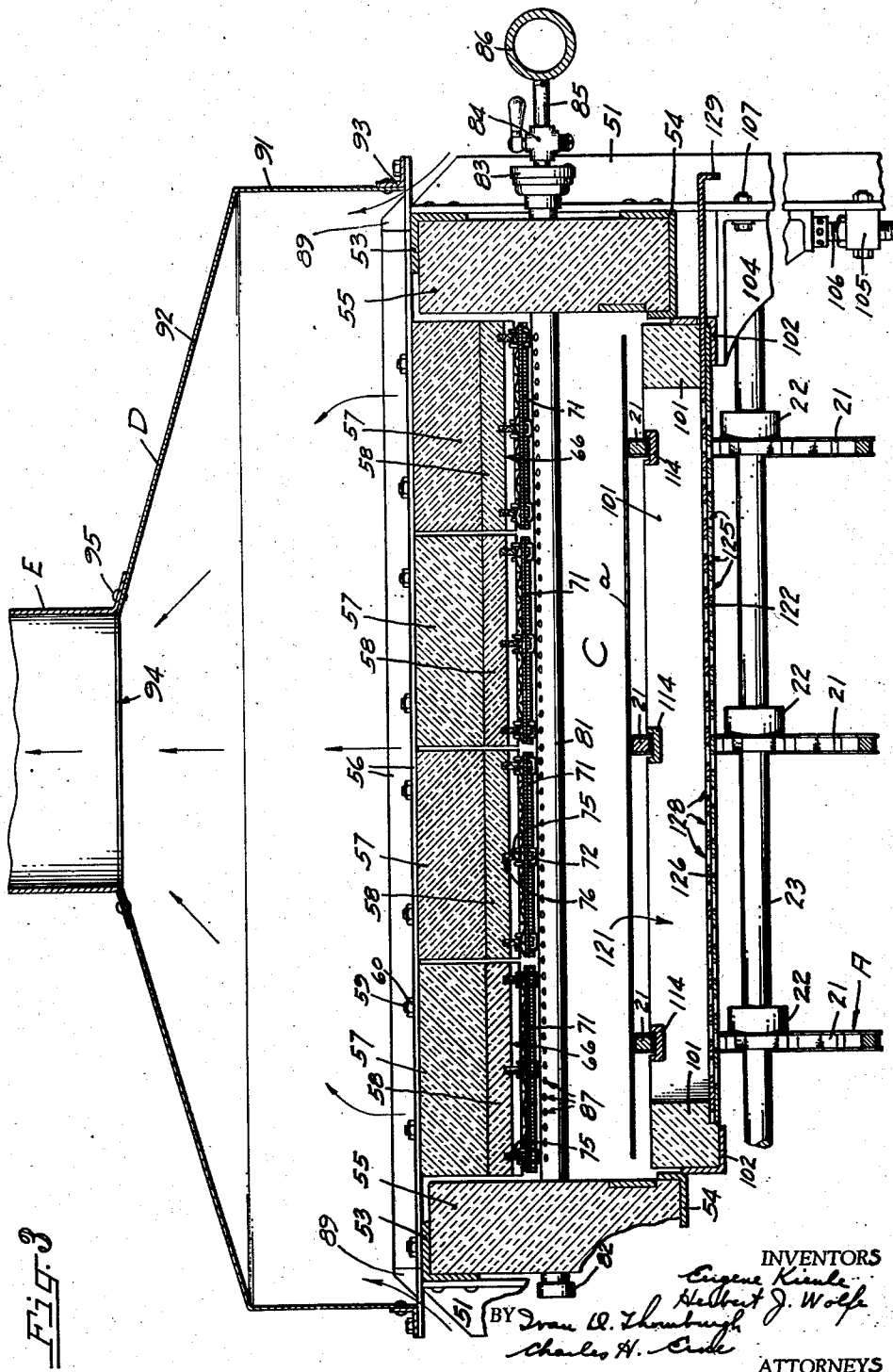
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Fig. 4

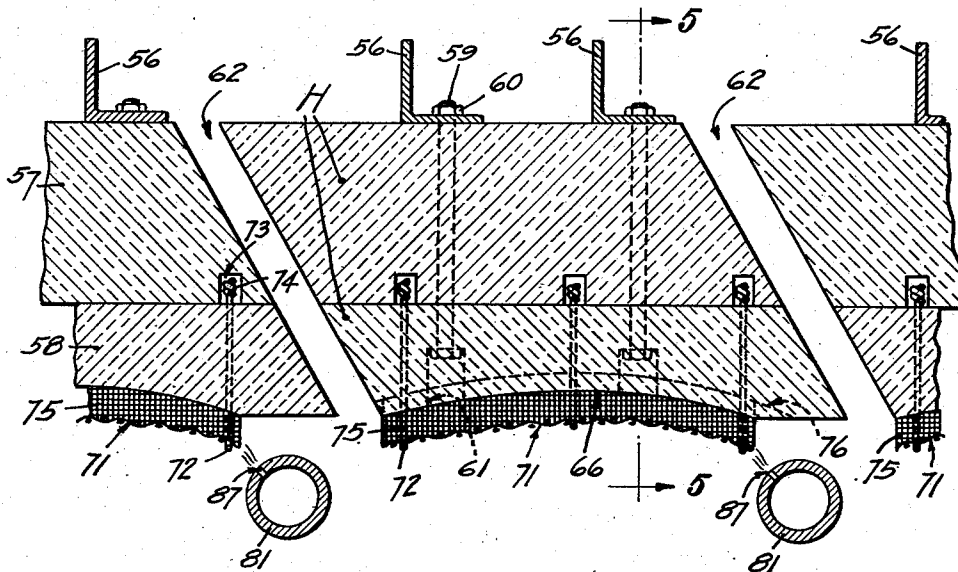
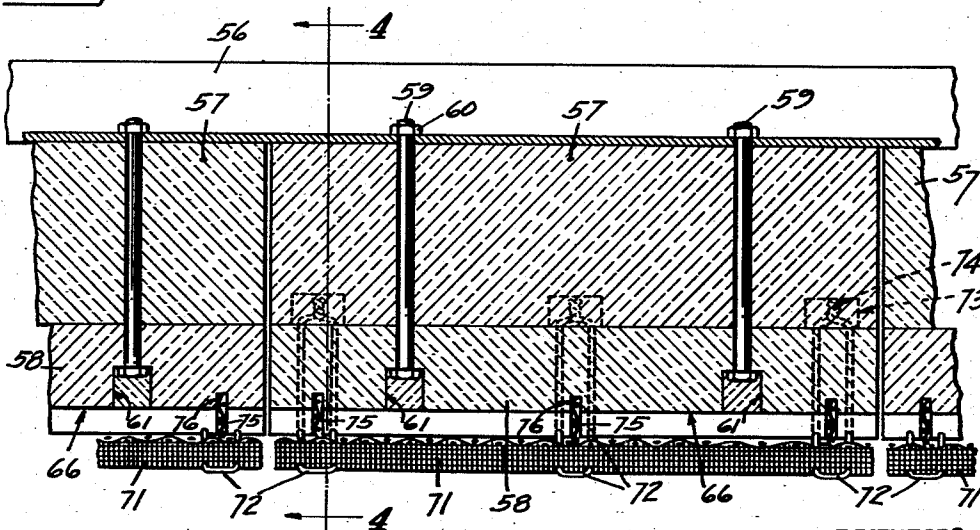


Fig. 5



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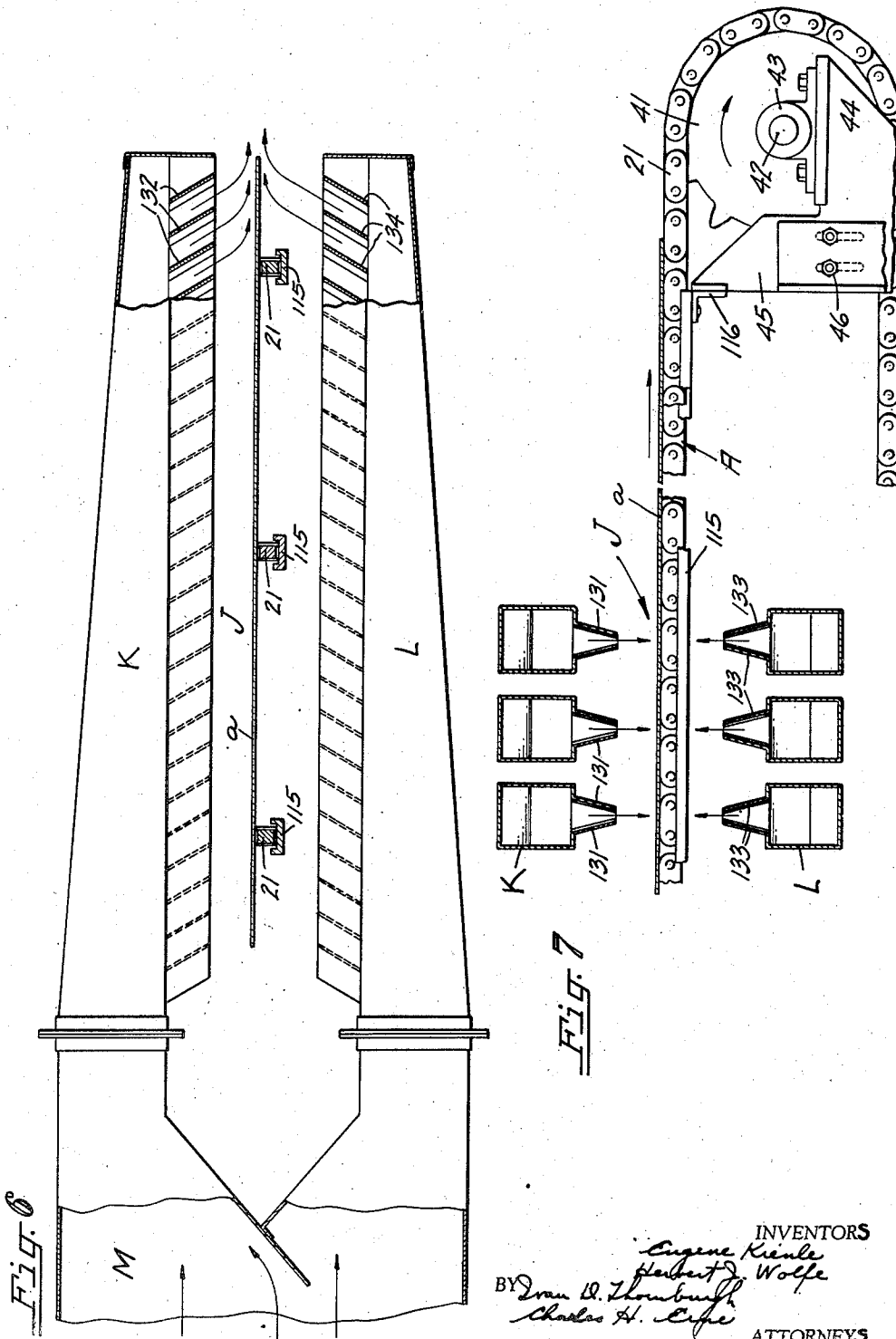
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UNITED STATES PATENT OFFICE

2,220,928

METHOD OF AND APPARATUS FOR PRODUCING AND UTILIZING RADIANT HEAT

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Application May 22, 1937, Serial No. 144,278

14 Claims. (Cl. 34—12)

The present invention relates to the drying of a surface coating material of that class of enamel, varnish, lacquer or printing ink which depends for drying upon evaporation of a solvent, and the invention has particular reference to the presentation of the coated surface to a particular type of radiant heat of high temperature which is capable of drying the coating in a relatively short time.

The present invention contemplates the use for drying purposes of a radiant heat having a high temperature, the heat waves of which are projected and concentrated to form an effective drying zone, and the coated stock having surfaces to be dried, is presented to such a zone for only that length of time which is necessary to properly dry the surface, this being a matter of but a few seconds. Where the coated surfaces are of such a nature as to be improved by rapid cooling, such a cooling step may be immediately performed and this too, if desirable, may be considered as a part of the inventive thought.

The invention also contemplates an improved form of drying apparatus wherein there is created a highly effectively radiant drying heat to which the coated stock is presented in an effective manner to obtain full drying results with a minimum of drying time.

One highly adaptable use of the invention is found in the can making field wherein tin plate or other metallic sheet material having one or more surfaces enameled, lithographed or otherwise coated is passed through a drying oven in which radiant heat is maintained so that the coated surface or surfaces are quickly dried and since such a use involves sheets which naturally retain the heat, these sheets are immediately subjected to a cooling operation and a fully dried sheet is obtained which can be stacked or otherwise handled without fear of scratching of the coated surface the total drying taking place in a remarkably short time.

An object of the present invention is the provision of a quick drying method for enameled, varnished, lacquered, lithographed or printed surfaces or the like wherein the surface is presented to the drying action of radiant heat such as by passage of the surface through the heat.

A further object is the provision of a method of quickly evaporating a solvent from a coating material which has previously been applied on the surface of metallic sheets, such evaporation being brought about by the action of properly applied radiant heat.

Another object is the provision of a method of

drying which includes producing a uniformly concentrated radiant heat for use as a drying medium for coated surfaces and subjecting the coated surfaces to a zone of the concentrated heat and then subjecting the heated surfaces to a zone of cooling air to render the dried surface scratch and smear proof and to permit immediate stacking of the sheets or to allow for any other handling operations which might be desirable therewith.

A still further object is the provision of an apparatus for drying coated stock having an oven formed with a partially enclosed drying chamber, a concentrated zone of radiant heat being produced in the chamber by open flames, the burned gases from the products of combustion escaping through suitable openings in the oven and the coated stock being introduced into and removed from the concentrated heat zone by way of other oven openings.

Yet another object is the provision of such an apparatus wherein the heat drying zone of the oven is produced by incandescence of heat resisting elements, part of the heat waves radiated from the heat producing elements being reflected back and joined with other heat waves by means of a ceramic arch construction so that the heat concentration in the drying zone is more uniform and more effective for drying the coated stock presented thereto.

Another object is the provision of an apparatus of the character described having a concentrated cooling zone adjacent the drying oven provided by properly directed cooling blasts of air or other cooling media.

Numerous other objects and advantages of the invention will be apparent as it is better understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment thereof.

Referring to the drawings:

Figure 1 is a plan view with parts broken away of a sheet drying apparatus embodying the present invention, the view illustrating the passage of sheets from the left to the right during which travel the sheets traverse first a drying oven and thence a cooling unit;

Fig. 2 is an enlarged fragmentary view showing a side elevation of the forward end of the conveyor adapted to pass sheets through the drying and cooling steps of the method and showing a longitudinal section of the forward end of the drying oven as viewed along the broken line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional view on an enlarged scale taken through the drying oven substantially along the section line 3—3 in Fig. 1, parts being broken away;

5 Figs. 4 and 5 are enlarged fragmentary sectional details of parts of the drying oven, Fig. 4 showing the fragment of a longitudinal section through the oven such as would be viewed along the line 4—4 in Fig. 5, and Fig. 5 being a fragmentary transverse section taken through the oven at the position indicated by the section line 5—5 in Fig. 4;

10 Fig. 6 is an enlarged transverse sectional view taken substantially along the line 6—6 in Fig. 1 and showing the cooling section of the apparatus in elevation with parts being broken away; and

15 Fig. 7 is an enlarged longitudinal sectional view taken substantially along the broken line 7—7 in Fig. 1 and showing the discharge end of the cooling section and the discharge end of the sheet conveyor.

20 The apparatus which is illustrated in the drawings as a preferred embodiment of the present invention is built to handle sheets of tin plate or the like which have been coated on one surface and it is the function of the present machine to dry the coating and condition the sheets for subsequent handling. This apparatus is particularly adapted to the can making art, this being shown as an exemplification of the method steps and as an exemplification of those parts of the apparatus required for consummating the process of the invention.

25 The coated sheets indicated by the letter *a* (Figs. 1 and 2) are adapted to be carried in a horizontal position with their coated surfaces at the top and by means of a horizontally operating conveyor chain A or equivalent device. This device passes the sheets, first through a drying oven (indicated broadly by the letter B) which oven encloses a drying chamber C (see also Fig. 3). This chamber is located beneath a hood D which connects with a chimney or flue pipe E. By means of this flue pipe the gases caused by combustion are vented from the chamber C and pass out and away from the apparatus.

30 Upon first entering the chamber C a sheet *a* passes through an entrance opening F (Fig. 2) and beneath heat producing elements broadly indicated by the letter G. The heat is a radiant heat and is concentrated within the chamber C by the combination of direct radiation of heat waves from the heating elements G and reflected heat rays which have been directed downwardly from the surface of a ceramic arch structure broadly indicated by the letter H.

35 During the time that the sheet is passing beneath the heating elements and through the concentrated heat zone of the drying oven in the chamber C, the volatile solvents contained in the coating upon the upper surface of the sheet are evaporated, this action drying the coating. The sheet is then passed out of the chamber C through an exit opening and continues on its travel. For lithographed or coated tin plate the drying time in which the sheet passing through the oven B is subjected to the concentrated heat is a matter of four or five seconds which is comparable as to drying results with twenty or more minutes of drying time according to usual oven drying.

40 The sheet then comes into a cooling chamber J (Fig. 6). The cooling chamber J through which the sheet passes is preferably supplied with

45 blasts of cooled air or other cooling medium which is directed against both the upper surface and the lower surface of the sheet as by passage through a series of upper air manifolds K and a series of lower manifolds L. These connect with an air chamber M in which a constant circulation of air is maintained by means of a blower N or other suitable air propelling or circulating device which may be operated by a motor O.

50 The passage through the cooling chamber J in the case of drying lithographed or coated tin plate requires some four or five seconds after which the sheet leaving the chamber and still moving with the conveyor A is in condition to be stacked or otherwise handled without fear of marring or scratching the dried coated surface.

55 The enameled, varnished, lacquered or printed surfaces exemplified in this adaptation of the invention by the coated sheet *a* may be of any suitable surface covering material which depends for drying upon evaporation of a solvent. An example of a varnish adaptable for application to the surface of a sheet of tin plate will now be given although it will be obvious that other kinds of coatings can be used on other kinds of surfaces or on the same tin plate surface if desired.

60 To obtain such a varnish coating two pounds of synthetic resin of the modified phenolic type may be mixed in a suitable kettle with 8 ounces of China-wood oil or oiticica oil. The mixture is then cooked at from 500° to 600° F. for a period of time which may be from thirty minutes to one hour depending upon the exact materials used. This cooked mixture is then removed from the fire and allowed to cool down to from 300° to 400° F.

65 While stirring the cooked mixture the following ingredients are next added: 2 pounds of turpentine or a substitute therefor, ½ ounce of cobalt drier and 4 ounces of plasticizer such, for example, as di-butyl phthalate. When the additional ingredients are supplied and the mixture is complete the resulting varnish is allowed to cool to room temperature. The cooled product can thereafter be applied to the sheet in any suitable manner as by a coating roller.

70 This example of one form of coating depends upon evaporation of the solvents within the mixture and when the coated stock is subjected to radiant heat within the chamber C of the apparatus herein shown, will be fully dried within four or five seconds. As already mentioned the sheet may be further treated as by cooling and substantially the same cooling time will be found adequate. These heating and cooling steps make the dried and coated sheet suitable for handling in usual can manufacturing practices or in any other desired manner as the case may be.

75 Referring more in detail to the drawings and to the parts which make up the apparatus shown therein, the operating conveyor chain A comprises three individual endless chain units 21 (Figs. 1 and 2) which extend throughout the entire length of the apparatus. At the entrance end of the machine the conveyor chains pass over sprockets 22 which are carried on a horizontal shaft 23 journaled in bearings 24. Each bearing is mounted on a bracket 25.

Each bracket 25 may be held in fixed position on an upright support 26, the bracket being formed with slots 27 which are used for clamping bolts 28 carried in the upper end of the up-

right 26. In order to obtain an accurate position for the brackets 25 so that the upper runs of the conveyor chains 21 are in a predetermined horizontal position, an adjusting screw device 29 may be used for each bracket.

The screw device 29 comprises a threaded member 31 which is formed with a head 32 on which the lower part of each bracket 25 rests. The head 32 may be formed with radially disposed slots or bores to provide for easy application of a spanner wrench. The threaded member 31 has threaded connection with a bracket 33 which is bolted to the upright 26. By turning the member 31 within its threaded seat 33 bracket 25 may be raised or lowered to suit the desired conditions. When in adjusted position the device is locked in place by a locknut 34 threaded on the member 31. The clamping bolts 28 are then made secure.

At the exit end of the machine the chains 21 operate over sprockets 41 (Figs. 1 and 7) which are mounted on a drive shaft 42. Shaft 42 is journaled in bearings 43 which are of the same construction as bearings 24 and the former are mounted upon brackets 44 which correspond in use and design to the brackets 25. Brackets 44 are adjustably connected with upright supports 45, corresponding to the supports 26. The same type of adjusting device 29 may be used for obtaining an accurate vertical position of the upper run of the chains 21 at the exit end of the apparatus. Such adjustment is suggested in Fig. 7 which illustrates a slotted arrangement generally indicated by the numeral 46. This corresponds to the slot and bolt constructions 27, 28.

The upper runs of chains 21 are retained in a straight line of travel extending from the upright support 26 at the entrance end to the upright support 45 at the exit end. The guides for performing this work consist of a number of channel bar sections disposed end to end to provide for the extended travel of each of the chains. These channel sections will be referred to more in detail as the description proceeds.

The oven B is mounted upon upright supports 51 (Figs. 2 and 3). The first set of supports 51 near the entrance end of the oven may be tied in by angle irons 52 with the supports 26 to form a more rigid structure. In a similar manner the various supports 51 may be tied together with each other and at the exit end of the machine with the support 45.

Oven B is formed as a box-like affair open at the ends and as part of such a structure the supports 51 carry horizontally disposed angle irons 53 which are at the top of the oven. Channel irons 54 are also secured to the supports, the irons 54 being spaced beneath and adjacent the bottom of the oven. Both irons 53 and 54 extend the full distance along the sides of the oven and directly carry the side walls. These walls consist of blocks 55 of heat resisting or ceramic material.

Angle irons 56 extend transversely of the oven their ends resting upon and carried by the angle irons 53. The irons 56 provide support for the ceiling members. Ceramic or heat resisting blocks 57 compose a part of the ceiling, these being a part of the ceramic arch structure H. There are a number of individual blocks 57 (Fig. 3) being arranged in rows and the rows extending across the width of the oven and between the side walls blocks 55.

Each block 57 carries a ceramic arch or unit 58 (Figs. 3, 4 and 5) which is also a part of the

ceramic arch structure H. Bolts 59 are used to support the parts 57, 58 and to also tie these parts together, the bolts extending vertically through both block and arch and through the angle irons 56. The upper threaded end of each bolt is held in fixed position by a nut 60. The heads of the bolts, which are at the bottom, are counter-sunk in pockets 61 formed in the under surface of the arch units 58. These pockets 61 are preferably filled with a ceramic cement which protects the bolt heads against the intense heat.

Longitudinally viewed, as in Figs. 2 and 4, there are a considerable number of rows of blocks 57 and the two end walls of each block are angularly disposed and opposite faces of adjacent blocks are spaced apart as shown so that slots 62 are formed. The two end walls of the associated arch units 58 are correspondingly disposed at an angle and provide for extension of the walls of the slots 62.

At the forward end of the oven a row of end blocks 63 is carried by one of the angle irons 56 and the inner face of each end block in the row is also angularly disposed to maintain an end slot 62. At the ends of the oven the side blocks 55 are tied together by metal plates 64 (the forward end appearing in Fig. 2) so that the sides and top block structure constitutes a single rigid unit.

The lower face of each ceramic arch 58 is a curved surface 66, this curve being a parabolic curve so designed to provide for the proper concentration of heat in the chamber C. The exact curve depends upon the type of burner used to produce the heat of the chamber C the function of the surface being to properly reflect the heat waves striking the surface and to concentrate them in a heating zone of great effectiveness and uniformity for the purposes previously set forth.

A curved nichrome screen 71 (Figs. 2, 4 and 5) or other suitable heat resisting and heat radiating member is provided for each ceramic arch 58 and is located in spaced relation to and below the arched surface. This screen member is also shaped to a parabolic curve corresponding to the curve of the surface 66. Each screen is held in its spaced position by nichrome wire loops 72 which pass through and engage below the screen and which extend up and through openings formed in the ceramic arch 58. The two legs of each wire are brought together at the top and within a space 73 formed in block 57 and are twisted as at 74. This is above the upper surface of the arch member 58.

Side screen spacer sections 75 are interposed between the arch unit 58 and the nichrome screen 71, these sections being located centrally of the legs of the wire loops 72. The upper edge of each screen section 75 is anchored in a longitudinal slot 76. This construction holds the screens 71 in exact spaced position relative to the lower surface of the corresponding ceramic arch unit 58.

The screens 71 are adapted to be heated to incandescence and for this purpose the drawings illustrate one form of heating which will be described by way of illustration. Electrical resistance can be used if desired but where this is done changes must be made in the shape of both the screen and the reflecting surface of the ceramic arch units. An open flame, as best illustrated in Figs. 2, 3 and 4, is found to be best adapted for the parabolic shape of screen and arch.

Gas burners 81 may be used. In the present embodiment these burners consist of pipes which

extend across the oven adjacent one end of each nichrome screen 71, each pipe passing through the side wall blocks 55. One end of the pipe 81 is closed as by a cap 82, this being outside of the oven. The other end of the pipe also outside of the oven, carries an air mixing member 83 and a hand operated valve 84, the end of the pipe being connected by a nipple 85 with a gas manifold 86. Gas is preferably supplied under pressure in any suitable manner the valve 84 of each burner constituting means for setting the gas discharge to control the size of flame.

Each pipe 81 is provided with a series of perforations 87 and these constitute the orifices from which the gas when ignited flows as an open flame against the edge of its associated screen 71. By reason of the parabolic curved structure of the screen 71 the flame when properly adjusted causes the entire screen to become and to keep incandescent. The maintenance of uniform incandescence is in part at least a function of the reflected surfaces 66 of the ceramic arch units 58.

In other words with the nichrome screens 71 of the oven B operating at capacity and under full incandescence the resulting heat waves are partially radiated downwardly from the screen and in addition the waves which are radiated upwardly are reflected downwardly. The reflected waves of heat passing through the screen mingle with the direct radiated heat waves and this provides a uniformly heated zone within the chamber C which is highly effective for drying enameled, printed, lithographed or otherwise coated surfaces. It is the association, in the case of gas open flames, of the curved nichrome screens 71 and the reflecting surfaces 66 that provide the desired concentrated uniform radiant heat for producing the evaporating characteristics previously referred to.

During the operation of the oven not only are the screen units 71 heated to incandescence but also the ceramic arch units 58. The gases resulting from combustion flow from the far end of each screen unit and pass up through the adjoining slot 62. The angular arrangement of the walls of the slot minimizes resistance of elimination of the gases of combustion and prevents congestion of the same. The gases pass from the top of the slots and up into the hood D.

Angle irons 89 are located across the top of the oven and are extended at their ends beyond the supporting angle irons 53 on which they rest. These extended ends support vertical side walls 91 (Fig. 3) forming skirt portions for adjoining conical top walls 92 of the hood D. Connecting angle irons 93 are used to secure the bottom edges of the walls 91 to the supporting angle irons 56. The top hood walls 92 are traversed with a discharge opening 94 and the chimney or flue pipe E is bolted thereto as at 95. The gases resulting from the combustion within the chamber C are thus directed out and away from the machine by way of the hood and chimney.

Expansion takes place in the screen parts 71, 75 and supporting wires 72 when heated and in lesser degree the ceramic blocks and arches may also undergo expansion. By reason of the loose or spaced construction of the various block units 51, 58 and the individual character of each ceramic arch H, these parts are free to expand without distortion or restriction and without adversely influencing the drying effect of the oven.

The description of the interior of the oven B thus far has particularly covered the side walls

and the ceiling. Consideration will now be given to the floor construction which provides for substantial closing off of the bottom of the chamber C and the oven to complete its box-like tunnel effect.

For this purpose a suitable floor plate or block 101 (Figs. 2 and 3) may be adjustably carried by the uprights 51. This block or plate may be made of any suitable fire clay or similar material which is not greatly affected by heat. Along the sides of the oven the floor plate rests upon angle irons 102. These irons are carried by suitable brackets 104 which are adapted to be raised and lowered. By such adjustment the floor plate may be brought into the desired horizontal plane in order to so locate the upper run of the chains 21 that the coated sheets *a* carried by the chains will be at a proper distance from the incandescent screens 71 and from the reflecting surfaces of the ceramic arch unit H.

Each bracket 104 like the bracket 25 is adapted to rest upon a screw device 105 which is identical in construction and operation to the screw device 29. By turning of a threaded member 106 of the device the bracket 104 and all parts carried thereby are raised or lowered. When the different brackets 104 have been properly positioned each is locked in place by clamping bolts 107.

The guides for holding the upper run of each chain 21 in the proper horizontal path of travel and which have been briefly mentioned heretofore may now be considered in detail. The upper run of each chain 21 in that region where it passes from the sprocket 22, is guided by a channel bar 111 which is secured at one end to the upright support 26, an angle iron 112 being used for this connection. The opposite end of the channel bar is carried on an angle iron 113 which connects it rigidly to the floor block 101 of the oven. Channel bars 114 are carried by the floor block and these provide tracks for the upper run of the chains during passage through the oven B. The channel bars 114 correspond in their guiding action and match with the channel bars 111 so that an extended horizontal track results.

In a similar manner other channel bars indicated by numeral 115 (Fig. 7) extend from an anchorage in the floor block at the exit end of the oven to the end uprights 45. They are secured in position on the uprights 45 by angle irons 116. The channel bars 115 match up with the oven channels and guide the chains through the cooling section of the apparatus.

The floor block or plate 101 is slotted at intervals as indicated by the numeral 121 (Figs. 2 and 3) and these slots are utilized for the entrance of secondary air which is allowed to enter the bottom of the chamber C during the operation of the oven B. Provision is made for controlling in amount this secondary air.

For this purpose there are provided a plurality of lower plates 122 which are held in fixed position within the floor 101 by bolts 123. Each plate 121 is set into a groove 124 formed in the lower surface of the floor plate these grooves extending throughout the length of the slots 121. Draft holes 125 are formed in the plate 122 and when opened provide for the entrance of air through the slots 121 into the chamber C.

The amount of air entering into the chamber is controlled by a sliding damper plate 126 which rests on the lower plate 122 and has longitudinal movement within a groove 127 formed in the plate. The damper plate 126 is also perforated, 75

holes 128 being cut therethrough and these holes correspond in size to the holes 125.

In one position of the sliding damper plate its holes 128 are aligned with the holes 125 and at such a time the full amount of secondary air is available for the chamber. In other positions of the slide damper its holes may be partially or entirely closed. This provides for a flexible control of secondary air entering into the oven. One end of each plate 126 extends out and beyond the supporting angle iron 102 where it is turned down in a hand grip 129.

The sheets *a* after passage through the oven C, during which time their coated surfaces are subjected to the action of the radiant heat provided by the heat producing elements G, move out of the discharge opening of the oven and come immediately into the cooling chamber J (Figs. 1, 6 and 7). Both surfaces of the sheet are then subjected to air blasts. These blasts may be created by the blower N and the air currents will pass from the chamber M into the upper and lower manifolds K, L.

The manifold K is formed as a rectangular box-like tube which may be of tin or other like sheet material and provision is made for projecting the air as it issues from the manifold so that it strikes the surface of the sheet *a* at an angle. Each manifold K is open at the bottom for substantially its entire length and the discharge opening is outlined by tapered side walls 131. Partition plates 132 are disposed in spaced relation between the walls 131 and are located in angular position as best shown in Fig. 6. The side plates 131 and the partition plates 132 cooperate to provide discharge nozzles for the air which is thereby caused to blow against the upper surface of the sheet striking it at an angle the air passing off at one side of the sheet.

In a similar manner the manifold L is open at the top for substantially its entire length and a discharge nozzle is formed by tapered side walls 133 and partition plates 134. The latter are disposed in spaced relation between the walls 133 and are located in angular position as best shown in Fig. 6. The air issuing from the discharge is thus caused to blow against the under surface of the sheet and to pass off laterally.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the form, construction, and arrangement of parts of the apparatus mentioned herein and in the steps and their order of accomplishment of the process described herein, without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the apparatus and process hereinbefore described being merely a preferred embodiment thereof.

We claim:

1. The method of drying coated surfaces which comprises producing a zone of uniformly distributed radiant heat of high temperature having increased drying action by projecting an open flame in a lateral direction against one edge of an arched heat resisting foraminous material to render it uniformly incandescent, reflecting the heat radiation from one side of and back through the material so that the reflected heat waves combine with the directly radiated heat waves from the opposite side thus creating a concentrated effective heating zone, and thence passing the coated surfaces through said heating zone.

2. The method of drying coated surfaces which comprises producing a heat zone of uniformly distributed radiant heat of high temperature by impinging open flames in a lateral direction along one edge of a curved nichrome screen of single thickness in position to render the entire screen uniformly incandescent, reflecting the heat passing from the upper surface of the screen by utilization of an adjacent arched face so that the reflected heat waves pass back through the screen where they mingle with the direct heat waves radiated from the lower surface of the screen, and thence presenting the coated surfaces to the combined heat waves to dry the same.

3. The method of drying coated surfaces which comprises producing a radiant heat of high temperature having increased drying action by projecting an open flame laterally against one edge of an arched screen of single thickness and constructed of heat resisting material, the curve of the arch being such as to insure uniform incandescence of the screen and at the same time reflecting radiation of the heat from one side back through the screen so that the reflected heat waves combine with those directly radiated thus producing a concentrated effective heating zone, and thence presenting the coated surfaces within the heating zone and directly exposing the same to said incandescent screen.

4. In an apparatus for drying enameled, varnished, lacquered or printed metallic sheets, the combination of a heating oven enclosing a heat drying chamber, arch curved heat radiating members formed of metallic heat resisting material mounted within said oven, means applied to one edge of said curved heat radiating members for heating said members to uniform incandescence, a conveyor having movement through said oven for conveying the sheets to be dried with a coated surface of the sheet spaced below and exposed to said incandescent heat radiating members, and means for varying the vertical distance between said conveyor and said heat radiating members.

5. In an apparatus for drying enameled, varnished, lacquered or printed surfaces, the combination of a heating oven enclosing a heat drying chamber, heat radiating members formed of heat resisting material mounted in said oven and spaced below the top wall thereof, a conveyor having movement within said chamber for carrying the surfaces to be dried beneath said heat radiating members, means for heating to and maintaining said members in incandescence, the heat from said heating means being projected into the space between said heat radiating members and the top wall of said chamber, and heat reflecting elements also located within said chamber and spaced above said heat radiating members for reflecting a part of the heat waves radiated from the latter so that the reflected heat waves combine with other heat waves directly radiated from said members to provide a drying zone in said chamber through which the said surfaces to be dried are passed by said conveyor.

6. In an apparatus for heat treating and drying enameled, varnished, lacquered or printed surfaces and including means for cooling said heated surfaces, the combination of a casing for enclosing a heat drying chamber, heat radiating members formed of heat resisting metallic material mounted in said casing, means for heating to and maintaining said members in incandescence, heat reflecting elements formed of ceramic material also located within said chamber and

spaced above said heat radiating members for reflecting downwardly through said members a part of the heat waves radiated from the latter so that the reflected heat waves and the directly radiated heat waves combine to provide a drying zone within said chamber of concentrated uniformly distributed heat of high temperature through which said surfaces to be dried are passed by said conveyor, and a conveyor having movement within said chamber for carrying the surfaces to be dried adjacent said heat radiating members.

7. In an apparatus for drying enameled, varnished, lacquered or printed metallic sheets, the combination of a heating oven enclosing a heat drying chamber, a metallic heat resisting foraminous arch mounted within said oven with its concave surface at the bottom, gas flame means for heating said arch to incandescence, a ceramic reflecting arch mounted directly above and spaced from said foraminous arch and having its concave surface at the bottom and parallel to the said foraminous arch and adapted to reflect the heat waves radiated upwardly from the incandescent foraminous arch back to and through the latter, thus assisting in maintaining a uniform incandescence thereof, the reflected heat waves passing through said foraminous arch together with the direct downwardly radiated waves therefrom providing a concentrated zone of radiant heat, and a conveyor having movement through said drying chamber for passing the coated sheets through said concentrated heat zone and under said foraminous arch.

8. In an apparatus for drying enameled, varnished, lacquered or printed metallic sheets, the combination of a heating oven enclosing a heat drying chamber, a series of metallic heat resisting foraminous arch sections mounted within said oven and spaced from each other and from the top of said chamber to form a foraminous arched row, means for directing an open flame into the spaces between said arch sections and the top of said chamber for heating the row of said arch sections to incandescence to provide a concentrated zone of radiant heat, and a conveyor having movement through said oven for conveying the sheets to be dried through the concentrated zone of radiant heat with the coated surfaces exposed to said incandescent arch.

9. In an apparatus for drying enameled, varnished, lacquered or printed surfaces, the combination of a heating oven enclosing a heat drying chamber, heat radiating members formed of a series of heat resisting foraminous arch sections mounted within said chamber and spaced alongside forming a foraminous arched row, means for heating and maintaining said arched row in incandescence, heat reflecting elements formed of a series of spaced reflecting arch sections also located within said chamber and spaced adjacent said heat radiating members and also spaced from each other and forming a corresponding arch row for reflecting the heat waves radiated from said foraminous arch which strike its arched reflecting surface, the reflected heat waves passing through said foraminous arch and combining with heat waves directly radiated from the opposite side of said heat radiating members, and a conveyor for passing the surface to be dried through said heat drying chamber and in position to present the same to the combined direct and reflected heat waves thereof.

10. In an apparatus for drying enameled, varnished, lacquered or printed surfaces, the com-

bination of a heating oven enclosing a heat drying chamber, heat radiating members formed of a plurality of heat resisting foraminous arch sections mounted in said chamber, certain sections being arranged in rows with spaces therebetween, open flame means for heating and maintaining said members in incandescence the flames of which are applied to one side of each row, arched heat reflecting elements also located in spaced rows within said chamber, each row corresponding to but spaced from its associated row of heat radiating members so that gases resulting from combustion escape from said chamber by way of the spaces between the rows of said heat radiating members and said reflecting elements, the latter reflecting a part of the heat waves radiated from said heat radiating members so that the same pass back through said foraminous arch and combine with the other heat waves directly radiated from said foraminous arch, and a conveyor for passing the surface to be dried through said heat drying chamber while exposed to the direct and reflected heat waves of the chamber.

11. The method of producing a radiant heat of high temperature and treating articles by means of an arcuate heating zone defined by and disposed between a curved refractory heat reflecting surface and a correspondingly curved foraminous metallic member spaced vertically from said reflecting surface, which method consists in projecting an open flame into said zone and directly against said curved refractory reflecting surface to completely and uniformly heat said foraminous member to incandescence in part by reflected heat from said surface, said curved refractory surface intercepting and reflecting the heat rays radiated from the top of said foraminous member back through the latter so that the reflected rays combine with other directly radiated heat rays from said member, and subjecting articles to be treated to the influence of said reflected and directly radiated heat rays passing downwardly from said zone while moving said articles past and relative to said heating zone.

12. The method of producing a radiant heat of high temperature and treating articles by means of a plurality of arcuate heating zones defined by and disposed between a plurality of horizontally spaced curved refractory heat reflecting surfaces and a plurality of correspondingly curved foraminous screen members each spaced vertically from a said reflecting surface, which method consists in projecting an open flame into each of said zones and directly against said curved refractory reflecting surface to completely and uniformly heat said adjacent screen member to incandescence in part by reflected heat from said surface, each of said curved refractory surfaces intercepting and reflecting the heat rays radiated from the top of said screen member back through the latter so that the reflected rays combine with other directly radiated heat rays from said screen member, conveying articles to be heat treated adjacent said screen member so as to subject said articles to direct and reflected heat from said zone, and controlling the proximity of the path of travel of said articles in respect to said incandescent screen member.

13. In an apparatus for producing and utilizing a radiant heat of high temperature, the combination of an oven having a top wall formed of refractory material having a curved parabolic heat reflecting surface, an arch member formed of perforate metal curved to conform to the curvature of said refractory wall surface and spaced

vertically therefrom to define an arcuate space therebetween, means for projecting a heating flame into said space to impinge against said curved refractory wall to completely and uniformly heat said screen member to incandescence in part by reflected heat from said wall, said curved refractory wall intercepting and reflecting the heat rays radiated from the top of said screen member back through the latter so that the reflected rays combine with other directly radiated heat waves from said screen member, and means for moving work to be heat treated past and relative to said heating flame projecting means.

14. In an apparatus for producing and utilizing a radiant heat of high temperature, the combination of an oven having a top wall formed of refractory material having a plurality of curved parabolic heat reflecting surfaces, a plurality of foraminous screen members each curved to conform to the curvature of said refractory wall surfaces and spaced vertically therefrom to define a plurality of arcuate spaces therebetween, means for projecting a heating flame into each of said

spaces to impinge against said curved refractory wall at one end of said screen member to completely and uniformly heat said screen member to incandescence in part by reflected heat from said wall, said curved refractory wall intercepting and reflecting the heat rays radiated from the top of said screen member back through the latter so that the reflected rays combine with other directly radiated heat waves from said screen member, means communicating with said space at the opposite end of said screen member for carrying away gases of combustion, a conveyor disposed beneath and spaced from said screen members for presenting articles to be heat treated to said mingled radiated and reflected heat waves from said space between said screen member and said curved refractory wall, and means for vertically adjusting said conveyor relative to said screen members to vary the intensity of heat imparted to the articles to be treated.

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