Dec. 24, 1957 E. A. ALBRIGHT 2,817,506

OVEN CONSTRUCTION

Filed July 23, 1954 4 Sheets-Sheet 1

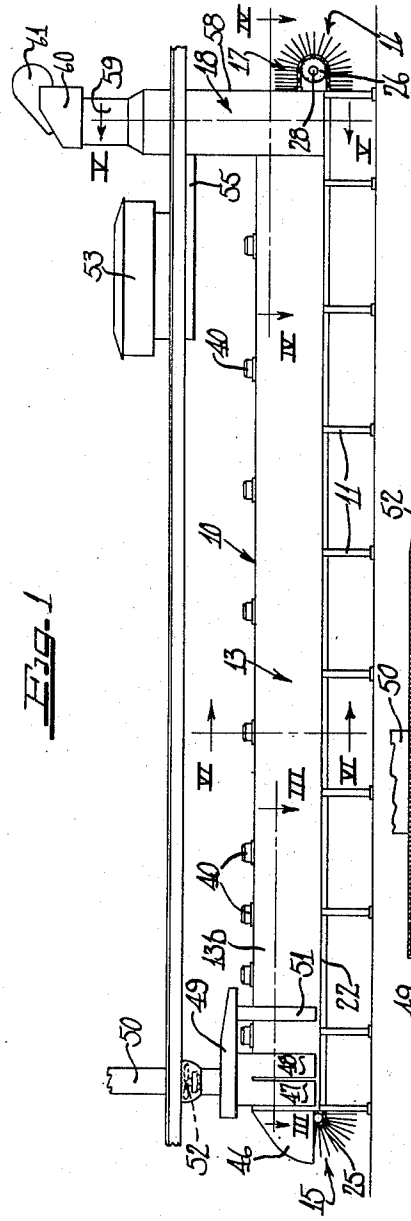


Fig. 1

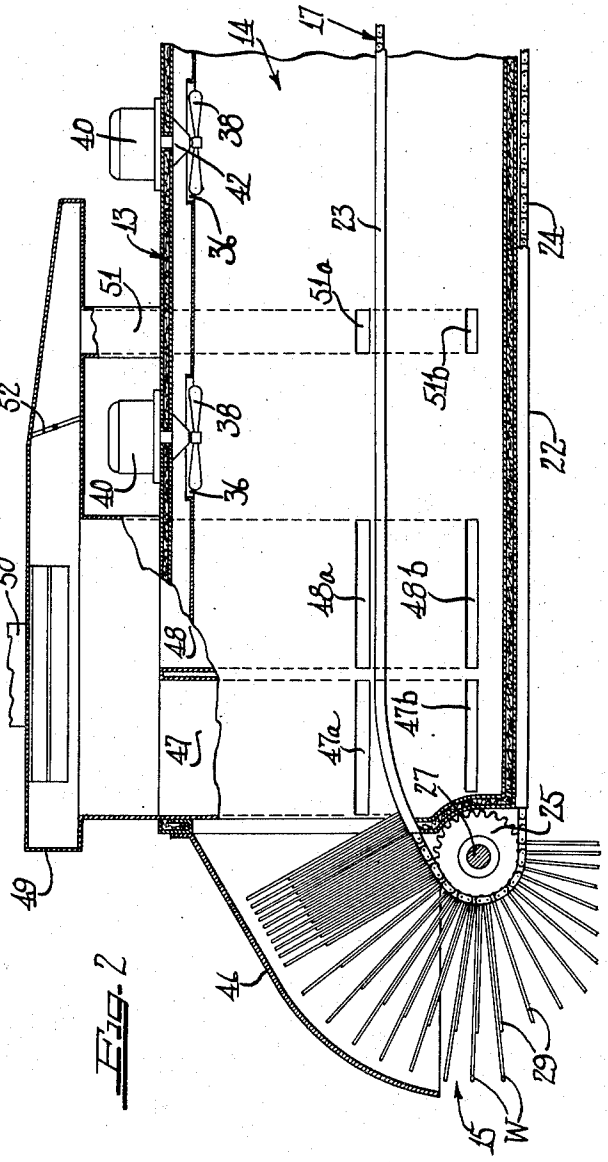


Fig. 2

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Dec. 24, 1957 E. A. ALBRIGHT 2,817,506

OVEN CONSTRUCTION

Filed July 23, 1954 4 Sheets-Sheet 2

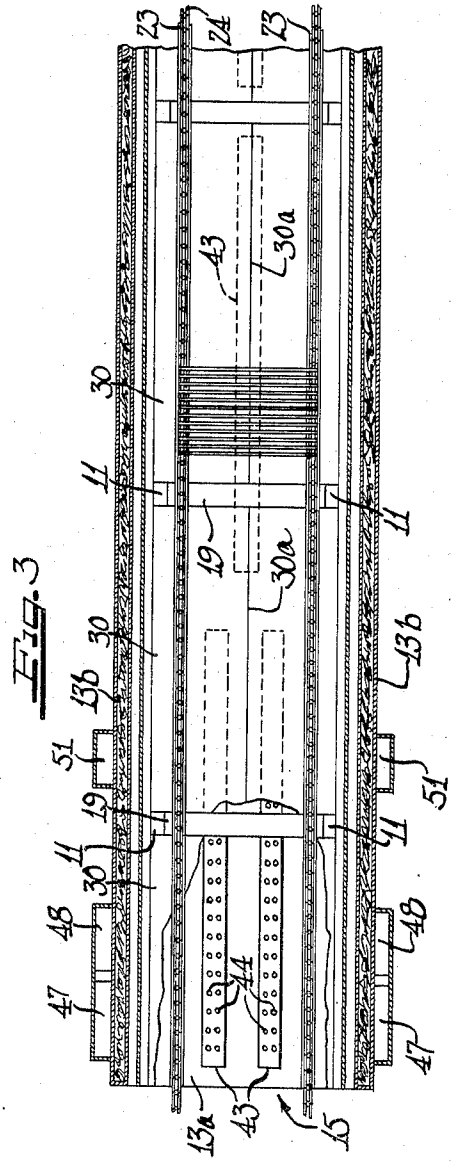


Fig. 3

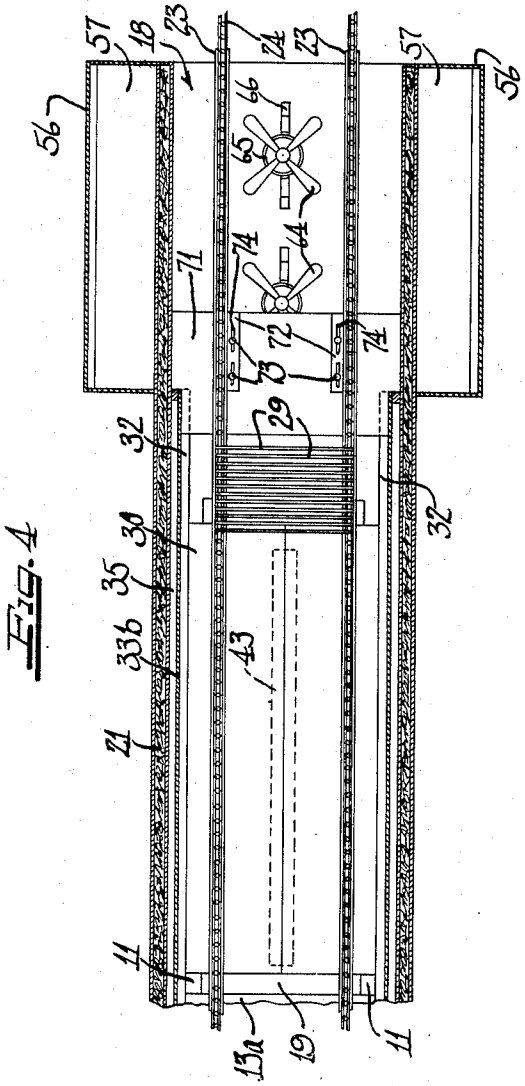


Fig. 4

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Dec. 24, 1957 E. A. ALBRIGHT 2,817,506

OVEN CONSTRUCTION

Filed July 23, 1954 4 Sheets-Sheet 3

Fig. 5

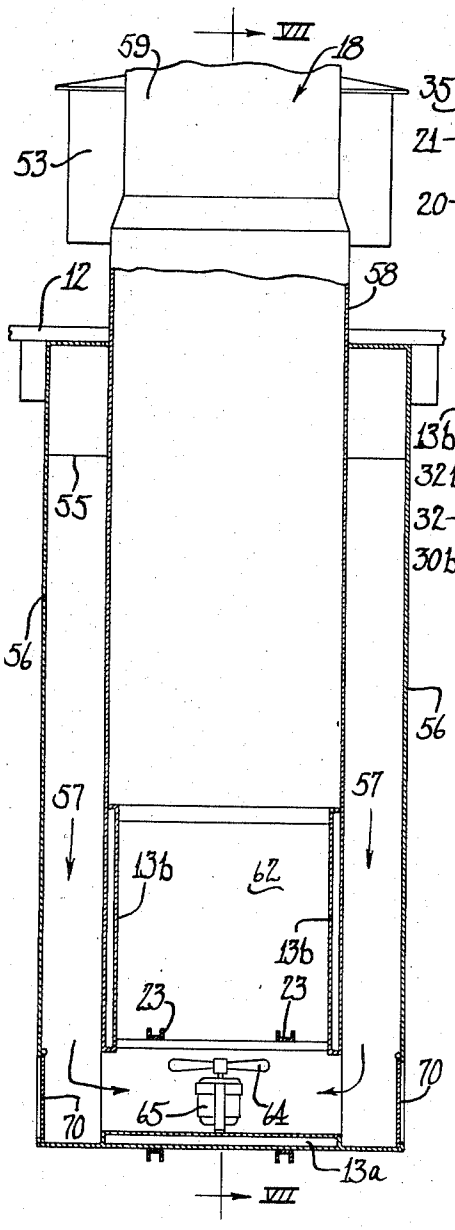
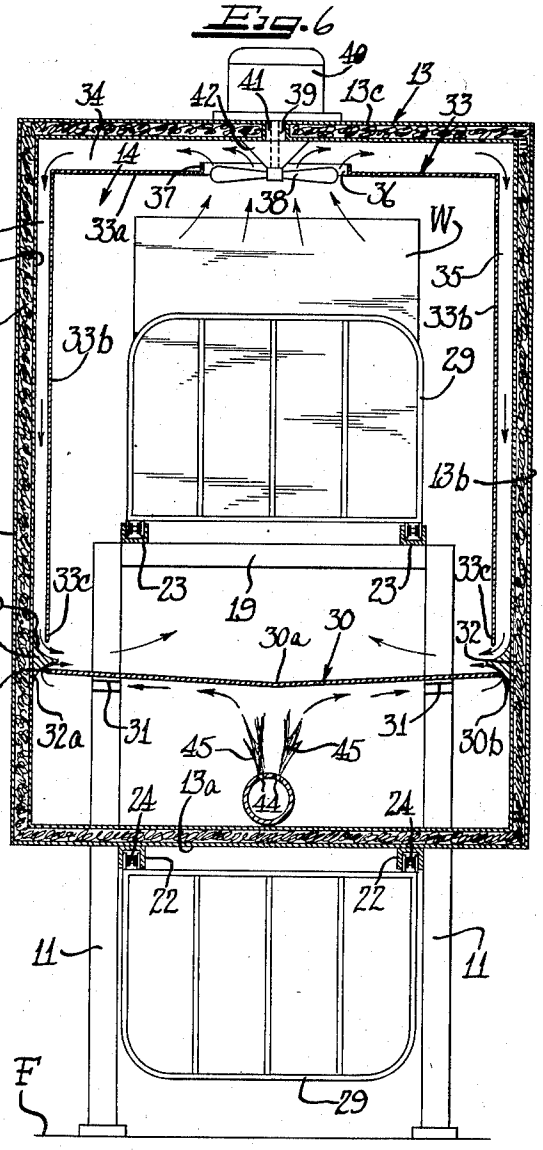


Fig. 6



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Dec. 24, 1957 E. A. ALBRIGHT 2,817,506

OVEN CONSTRUCTION

Filed July 23, 1954 4 Sheets-Sheet 4

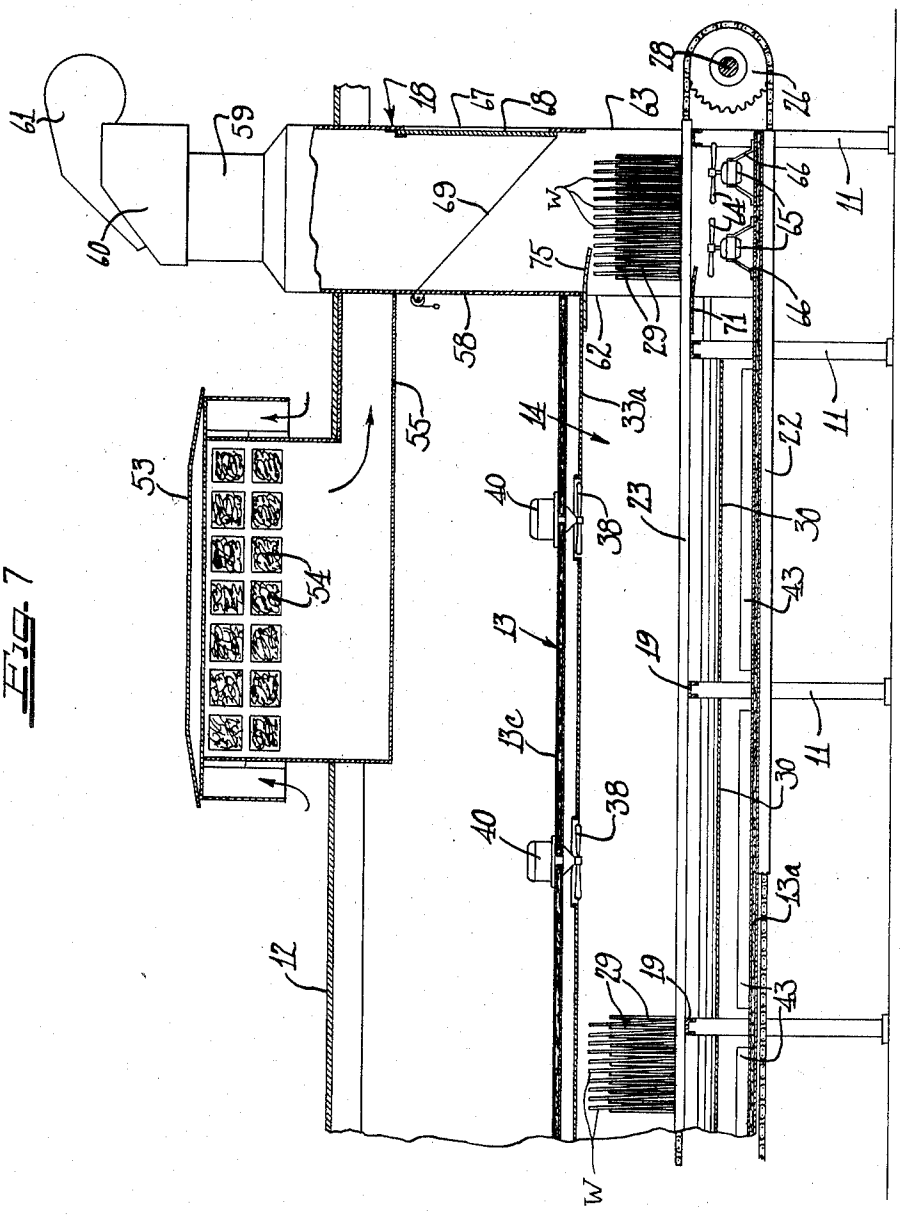


Fig. 7

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United States Patent Office

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2,817,506

OVEN CONSTRUCTION

Edward A. Albright, Brownsville, Tex.

Application July 23, 1954, Serial No. 445,253

15 Claims. (Cl. 263—8)

This invention relates to ovens having efficient air circulating fans in the top thereof cooperating with burners in the bottom thereof to eliminate localized hot spots without interfering with passage of work through the oven. Specifically, this invention relates to improvements in baking or drying ovens of the elongated tunnel type having a work conveyor extending through the entire length thereof wherein air for heating and drying is circulated through the tunnel in counter-current relation to the movement of the work and is transversely spiraled by overhead fans as it advances longitudinally.

The invention will hereinafter be specifically described as embodied in a baking oven for drying and baking coatings on metal plates or sheets such as enameled, varnished, lacquered, or otherwise wet coated steel sheets advanced through the oven on a conveyor. Heretofore, such ovens had air circulating fans positioned where they did not effectively eliminate "hot spots" or, as in the case of the oven disclosed in my Patent No. 2,129,634, had the fans positioned where they might damage the work or become damaged by the work in the event of misalignment or unseating of work pieces from the conveyor.

According to the present invention, an elongated drying oven or tunnel is equipped with a heat-radiating bottom pan. Burners are disposed along the length of the tunnel beneath this pan and a work conveyor has its upper active run through the tunnel above the pan. Air at the discharge end of the tunnel is divided into upper and lower streams respectively passing over and under the pan. Fans are positioned in the roof or top of the tunnel at spaced intervals and transversely circulate the air advancing through the tunnel above the pan. The fans receive the air above the work and circulate this air along both sides of the tunnel, preferably through passages around the tunnel discharging at the sides of the tunnel just above the pan. The air passing through the tunnel beneath the pan together with the products of combustion from the burners, is circulated around the sides of the pan to merge with the air issuing from the bottoms of the passages above the pan. This air, of course, is heated and co-mingles with the air from the top of the tunnel. In addition, the pan is heated by radiation from the burners and the air issuing from the bottoms of the air circulating passages above the pan, will also be heated by radiation as it passes over the pan. In this manner, the air moving from the work discharge to the work inlet end of the tunnel is transversely circulated as it advances so that spiral currents are formed. These currents pass between the work pieces being dried. The work conveyor is equipped with holders which maintain the work pieces in spaced relation so that the air paths between the work pieces are not blocked.

In the ovens of the present invention, therefore, it is impossible for the work pieces to contact moving fan blades nor is it possible for the fan motors to be burned or overheated by the burners. The location of the fans

in the top of the tunnel enhances air circulation without increasing the power input to the fans because the natural convection currents of the heated air are utilized.

It is then an important object of this invention to provide an efficient baking or drying oven of the type having air flowing counter-current to the direction of movement of the work therethrough wherein this air is transversely circulated over a heated bottom pan and is drawn upwardly around the work after passing over this pan.

Another object of this invention is to provide a drying tunnel with overhead fans for circulating drying air in spiral paths around the work pieces advancing through the tunnel while simultaneously drawing products of combustion therewith from burners in the bottom of the tunnel.

A still further object of the invention is to provide a drying oven of the type having an air-cooled tower at the discharge end thereof wherein some of the air from this tower is directed into separate paths above and below a heat-radiating pan in the oven and wherein overhead fans circulate the air from both paths to create spiral air currents flowing over the work pieces in the oven.

Another object of this invention is to provide an oven construction with out of the way overhead circulating fan units which will not contact work advanced through the oven and will not form exterior obstructions.

A still further object of this invention is to provide an improved drying method wherein upper and lower longitudinally flowing air currents are transversely circulated as they advance and are admixed during this transverse circulation to be blended and passed over the work that is being dried.

A still further object of this invention is to provide a drying tunnel having a work conveyor extending therethrough with overhead fans which effectively circulate air advancing through the tunnel around the work carried by the conveyor without any possibility of the work coming in contact with the fans.

Other and further objects of this invention will be apparent to those skilled in the art from the following detailed description of the annexed sheets of drawings which, by way of a preferred embodiment only, illustrate one of the ovens of this invention.

On the drawings:

Figure 1 is a somewhat diagrammatic side elevational view of a drying or baking oven construction according to this invention.

Figure 2 is an enlarged fragmentary longitudinal vertical cross-sectional view, with parts in elevation, of the inlet end of the oven construction.

Figure 3 is a fragmentary horizontal cross-sectional view taken along the line III—III of Figure 1.

Figure 4 is a fragmentary horizontal cross-sectional view taken along the line IV—IV of Figure 1.

Figure 5 is a vertical cross-sectional view, with parts in end elevation, taken along the line V—V of Figure 1.

Figure 6 is a transverse vertical cross-sectional view taken along the line VI—VI of Figure 1.

Figure 7 is a fragmentary vertical longitudinal cross-sectional view, with parts in side elevation, taken along the line VII—VII of Figure 5.

As shown on the drawings:

The oven construction **10** of this invention, as shown in Figure 1, is mounted on a plurality of vertical legs **11** at longitudinally spaced intervals along the length of the oven. The top of the oven **10** is spaced beneath the roof **12** of a building in which the oven operates.

The oven **10** includes a generally rectangular longitudinally elongated body **13** defining a horizontal tunnel

14 having a work inlet end 15 and a work discharge end 16 with a work conveyor 17 projecting beyond the ends 15 and 16 and extending through the tunnel 14 for conveying work pieces W such as lithographed steel plates. A cooling tower 18 is provided at the end 16 of the tunnel and receives the work conveyor therethrough.

As shown in Figure 6, the supporting legs 11 for the oven construction 10, are provided in transversely aligned pairs and extend through the bottom wall 13*a* of the body 13 to support horizontal cross-beams 19 in the tunnel 14. The body 13 has vertical side walls 13*b* and a horizontal top wall 13*c*. These walls are lined with insulation 20 and an inner metal liner 21. Channel-like conveyor tracks 22 are mounted under the bottom wall 13*a* and extend longitudinally in transversely spaced parallel relation along the entire length of the body 13 and under the cooling tower 18. Similar channel-like tracks 23 are supported in the tunnel 14 on the cross-beams 19. Endless conveyor chains 24 ride in the tracks 22 and 23 and are trained around sprocket wheels 25 and 26 at the ends 15 and 16 respectively, of the oven construction. These sprocket wheels are mounted on transverse cross-shafts 27 and 28 respectively, and one of the cross-shafts can be driven by a motor (not shown) to advance the upper run of chains through the tracks 23.

The chains carry racks 29 which extend transversely between the chains and are mounted on chain links in such a manner as to radiate from the chains in right angular relation therewith so as to form horizontal supports for the work pieces as the chains travel around the sprocket wheels 25 and provide vertical upright supports or separators for the work pieces as the chains travel horizontally through the drying tunnel 14 and cooling tower 18 and downwardly depending work discharge means as the chains travel over the sprockets 26.

As shown in Figure 6, the legs 11 support the bottom wall 13*a* of the body 13 sufficiently above the floor line F to accommodate the racks 29 under the body as they are advanced along their under-run to the inlet end of the tunnel. The cross-beams carried by these legs 11 support the tracks 23 at a level in the tunnel 14 so that the racks 29 will be centrally located in the tunnel and work pieces W can project above and laterally beyond the racks without engaging the walls of the tunnel.

The legs 11 also support bottom plates 30 on brackets such as 31 carried by the legs. The bottom plates 30 are separated at the cross-beams 19 so that brackets 31 on opposite sides of the legs will support a pair of plates 30 on each side of each leg. The plates 30 are longitudinally bent so as to have a depressed central portion 30*a*. The longitudinal side edges 30*b* of the plates 30 as best shown in Figure 6, are spaced inwardly from the liner 21 of the side walls 13*b*. Baffles 32 are carried by the side walls 13*b* and project inwardly into the tunnel 14 from the liner 21 to overlie the edges 30*b* of the plates 30. These baffles 32 have arcuate concave bottom faces 32*a* for directing air and gases from under the plates to flow across the tops of the plates as shown by the arrows in Figure 6.

An inner open-bottomed sheet metal duct member 33 is mounted in the tunnel 14 above the plates 30 and in spaced relation from the liner 21 along the sides and top wall of the body 13. The duct 33 has a horizontal top wall 33*a* and depending vertical side walls 33*b* in spaced parallel relation respectively, with the horizontal top 13*c* and the vertical sides 13*b* of the body 13 thereby defining with the liner 21, a top horizontal passage 34 and a pair of vertical side passages 35 at the outer ends of the top passage 34 in full communication therewith. The bottom ends 33*c* of the side walls 33*b* are spaced above the baffles 32. These baffles also have arcuate concave top faces 32*b* underlying the passages 35 for directing air issuing from the bottoms of the passages 35 inwardly over the plates 30 as also shown by arrows in Figure 6.

At spaced intervals along the longitudinal length of the duct member 33, the top wall 33*a* thereof is centrally apertured to provide circular inlet openings 36 connecting the top of the drying tunnel 14 with the passage 34. These central openings 36 are preferably surrounded by an upstanding circular flange or collar 37. A fan 38 is mounted in each opening 36 and is at least partly surrounded by the flange or collar 37. Each fan 38 is supported on a motor shaft 39 depending from an electric motor 40 mounted on the top wall 13*c* of the body 13. As illustrated in Figure 6, the shaft 39 extends freely through an opening 41 in the top wall 13*c*. The motor 40 drives the fan so as to draw air and gases upwardly through the tunnel 14 and discharge the air laterally through the passage 34 equally to both side passages 35. For assisting the fan in directing the air laterally outward through the passage 34, a frusto-conical baffle 42 surrounds the shaft 39 and is carried by the top wall 13*c*. The air is forced downwardly through the passages 35 to flow over the top faces of the baffles 32 and across the top faces of the plates 30 where it will again rise to be circulated between the work pieces on the conveyor.

As shown in Figures 3, 4, and 7, burner pipes 43 are mounted on the bototm wall 13*a* of the body 13 and extend longitudinally in the body under the plates 30. As shown in Figure 3, a pair of burner pipes 43 is mounted in spaced parallel relation at the inlet end 15 and extend completely under the first plate 30 and under about half of the next adjacent plate 30. This side-by-side arrangement of burner pipes provides added heating capacity at the inlet end of the tunnel and pipes 43 beyond the first pair of pipes are positioned directly under the depressed center 30*a* of the plates 30 and may be slightly spaced longitudinally from each other. Gas is supplied to each burner pipe 43 and issues from double rows of holes 44 along the length of each pipe to provide flames 45 issuing from the top of each pipe on each side of the top center line thereof. As best shown in Figure 6, these flames 45 are directed upwardly and heat the air under the plates 30 to create currents of air which will flow laterally outward from the depressed centers of the plates to the edges 30*b* thereof. These gases and heated air will then be drawn across the bottom faces 32*a* of the baffles 32 to co-mingle with the air from the passages 35 and flow therewith over the tops of the plates 30.

As shown in Figure 4, the last burner pipe 43 terminates under the last bottom plate 30 slightly in advance of the cooling tower 18.

As shown in Figures 1 and 2, the inlet 15 has a hood 46 projecting from the body 13 to receive the racks and work pieces as they enter the oven and to trap air which would otherwise flow out of the inlet. The hood 46 opens downwardly and its open bottom is below the tracks 23. As the racks 29 are raised around the sprockets 26 into substantially horizontal positions under the hood 46, the work pieces are fed onto the top faces of the racks thereby charging the work conveyor. Side ducts 47 and 48 extend vertically along the side walls 13*b* of the body 13 immediately adjacent the hood 46 for discharging wet air from the tunnel. These ducts empty into a header duct 49 over the top of the oven and this header duct discharges to a stack 50 on the roof 12. The header 49 also connects with a third set of vertical ducts 51 along the side walls 13*b* of the body 13 but spaced downstream in the tunnel from the duct 48. A damper 52 in the header controls the flow of air through the ducts 51.

As shown in Figure 3, the ducts 47, 48 and 51, extend on both sides 13*b* of the body 13. These ducts are connected at their tops through the header 49 which overlies the body 13, as shown in Figures 1 and 2. Each duct has an inlet opening 47*a*, 48*a* and 51*a* respectively, at a level just above the tracks 23 so as to receive air from the tunnel portion 14 above the plates 30. Each duct also has a second inlet opening 47*b*, 48*b* and 51*b* respectively, below the plates 30 to receive air from the bottom portion of

the tunnel 14. An exhaust fan 52 is provided in the stack 50 to induce the discharge of the wet air through the ducts.

As shown in Figures 1, 5, and 7, the roof 12 supports an air inlet filter 53 above the top thereof. Air enters this filter as shown by arrows in Figure 7, to flow through filtering elements 54 into an inlet duct 55 under the roof. This inlet duct 55 discharges into vertical ducts 56 on the sides of the cooling tower 18 as shown in Figure 5. Inlet air passes downwardly through the passages 57 provided by these ducts 56 to be discharged into the bottom of the cooling tower. The cooling tower 18 comprises a vertical housing 58 extending through the roof 12 and discharging to a stack 59 having a swivel top 60 controlled by a vane 61. The housing 58, as shown in Figure 7, has an inlet opening 62 in the front wall thereof aligned with the discharge end of the oven body 13 and also has a discharge opening 63 through the back wall thereof. As explained hereinabove, the tracks 23 extend through the tower 18 so that work from the tunnel 14 passes directly through the housing 58 before issuing out of the discharge opening 63 of the tower.

A pair of horizontal fans 64 is provided in the bottom of the housing 58. Each fan 64 has an electric motor 65 mounted on brackets 66 carried by the bottom wall of the tower which, in effect, is an extension of the bottom wall 13*a* of the body 13. The fans 64 receive air from the bottoms of the passageways 57 as shown in Figure 5, and discharge this air upwardly through the work advancing thereover on the tracks 23. As shown in Figure 4, fans 64 are mounted centrally between the tracks 23 and are spaced longitudinally to efficiently draw the air downwardly through the passages 57 and discharge it upwardly between the work pieces through the housing 58 and into the stack 59.

As shown in Figure 7, the rear wall of the housing 58 has an opening 67 above the opening 63. This opening is closed by a door 68 which is controlled by a cable 69 so that it can be partially or completely opened to direct air from the tower through the opening 67 into the building under the roof 12. Since this air is heated by contact with the work pieces issuing from the drying tunnel, the hot air can be used to heat the building when desired.

As shown in Figure 5, damper doors 70 are provided at the bottoms of the ducts 56 to feed room air to the fans 64 as desired.

A first horizontal adjustable baffle 71, as best shown in Figures 4 and 7, is carried under the tracks 23 to project through the inlet opening 62 into the cooling tower, partially above the first fan 64. This baffle 71 is suitably suspended from brackets 72 on the tracks 23 by bolts or other fasteners 73 extending through elongated slots 74 in the brackets. The baffle can thereby be shifted for overlying the fan 64 as desired to control the amount of air from the fan that is to be trapped by the baffle. This trapped air is diretced under the adjacent bottom plate 30 to flow along the bottom of the oven and supply air to the burners for combustion.

As shown in Figure 7, a second horizontal adjustable baffle 75 is supported by the duct wall 33*a* of the oven and extends through the inlet opening 62 of the cooling tower 18 to overlie the work on the conveyor. This baffle 75 projects further into the cooling tower than the baffle 71 so as to trap a portion of the air stream from the first fan 64 that is not trapped by the bottom baffle 71. The air trapped by the baffle 75 is directed under the baffle into the tunnel 14 above the plates 30 for supplying the air to be circulated by the fans 38 in the upper portion of the tunnel.

It will be noted from Figure 1 that the top fans and their motors 40, are positioned at equally spaced intervals from the cooling tower 18 except at the inlet end of the body 13 where four closely spaced fans are provided. The extra fan capacity at the inlet end is for the purpose of increasing air circulation in the area where most of the evaporation takes place. In this manner, the wet air is quickly discharged to the stack 50.

Operation

In operation of the oven construction of this invention, work is fed to the conveyor racks 29 as they assume horizontal positions under the hood 46 at the inlet end of the oven body 13. The conveyor advances the work through the drying tunnel 14 along a substantially horizontal path. The conveyor also advances the work through the cooling tower 18 at the discharge end of the oven. The conveyor projects beyond the cooling tower so that the work is readily discharged in this projected zone of the conveyor. The particularly illustrated conveyor construction is used for lithographed sheet metal plates to form metal labels, bottle caps, metal containers, and the like. These sheets are easily fed into and discharged from the illustrated racks and the coatings will not be damaged by the racks since, by feeding sheets on the racks with their coated faces uppermost, the coated sheet faces will not engage the rack surfaces.

Air is supplied to the oven from a filter 53 through ducts which open in the bottom of the cooling tower at the discharge end of the oven. Fans propel this air upwardly through the cooling tower to pass between the work sheets on the conveyor thereby cooling the steel sheets and facilitating handling thereof. Part of this air is trapped by two superimposed baffles. The lowermost baffle directs the air trapped thereby into the bottom portion of the discharge end of the oven. The upper baffle directs the air trapped thereby into the upper portion of the discharge end of the oven. Top and bottom streams of air are thereby introduced into the elongated oven for flow through the oven in counter-current relation to the advancing pieces of work. The longitudinal flow of air through the oven is induced by a discharge stack at the work inlet end of the oven.

The air in the bottom stream supports combustion of burning gases issuing from burner pipes along the bottom of the oven. The air in the top stream circulates around the work pieces carried by the conveyor for drying the coatings thereon.

The fans 38 in the top of the oven circulate the longitudinally advancing air transversely around the oven creating spiral air currents. The heated air in the bottom stream rises by convection and also under the influence of overhead fans to flow under heat-radiating plates which separate the top and bottom streams and to be aspirated around the sides of these plates for co-mingling with the air in the upper stream.

The flames from the burners also heat the bottom plates by direct radiation and the heated bottom plates receive the whirling spiral streams of air thereover to be heated thereby.

At the work inlet end of the oven, the wet coatings are quickly dried by tandem burners and additional circulating fans which quickly bring the work pieces up to temperatures for evaporating the volatile carriers in the coatings on the work pieces. The evaporated material is immediately discharged at the work inlet end so that as the work advances further into the tunnel, it cannot re-contact the moisture-laden air and the drier air then effectively enhances the baking of the coatings.

The top fans, in creating the spiral air currents, prevent development of any "hot spots" in the oven and at the same time, are located where they cannot be contacted by the work.

It should, therefore, be understood that the oven of this invention divides incoming air into two longitudinal streams, one of which supplies air for combustion and the other of which supplies air for enhancing baking and drying. As the top air stream advances, it is transversely whirled to flow between the work pieces and to draw products of combustion from the bottom air stream into co-mingled relation therewith. The fans for effecting the

transverse whirling of the air, are located in out of the way positions where they cannot become damaged and where their driving motors will not project into aisles or the like. Each fan motor can be driven at the exact speed necessary at the particular fan location to produce the most efficient circulation.

It will be understood that variations and modifications may be effected without departing from the scope of the novel concepts of this invention.

I claim as my invention:

1. An oven construction comprising an elongated tunnel having a work inlet at one end thereof and a work outlet at the opposite end thereof, a conveyor for advancing work through the tunnel from the inlet to the outlet, an air outlet for said tunnel adjacent the work inlet, a cooling tower adjacent the work outlet, fan means circulating air through said cooling tower to pass around the work on said conveyor before the work reaches the outlet, means selectively directing some of the air from the cooling tower into the tunnel to advance therethrough in counter-current relation to the work for discharge through the air outlet at the work inlet end of the tunnel, heat-radiating plates in said tunnel above the bottom thereof and beneath the work, burner means in said bottom of the tunnel beneath said plates, means for directing some of the air from the cooling tower under said plates to supply air for combustion, duct means in said tunnel defining air passages above and along the sides of the work, said passages discharging adjacent the sides of said plates, means providing air flow paths at the sides of said plates communicating with the discharge ends of said passages, fans at spaced intervals along the length of said tunnel in the top of the tunnel coacting with said duct means to draw air into the ducts and circulate the longitudinally advancing air in spiral paths through the ducts, over the plates and between the work whereby hot spots in the oven will be eliminated.

2. An oven construction which comprises means defining an elongated open-ended tunnel, an endless conveyor having an upper run through said tunnel to move work from one open end to the other open end of the tunnel, heat-radiating plates under the upper run of said conveyor dividing the tunnel into top and bottom zones, burners in said tunnel under said plates, air inlet means at the work outlet end of said tunnel directing air into both of said zones, air outlet means at the work inlet end of said tunnel, air circulating means at the top of said top zone and disposed at intervals along the length of the tunnel for transversely circulating the air over the plates and between the work, said air circulating means creating laterally spiralling air currents having upwardly flowing paths between the work on the upper run of the conveyor, downwardly flowing paths laterally of the work, and bottom paths over the plates whereby the plates are heated by the burner and the air is heated by the plates.

3. An oven construction which comprises an elongated tunnel, heat-radiating means above the bottom of the tunnel and dividing the tunnel into an upper work-receiving zone and a lower burner zone, a conveyor extending through said upper zone for advancing work therethrough, burners beneath said heat-radiating means in said lower zone, means for advancing air longitudinally through both of said zones, fan means in the top of the upper zone at spaced intervals along the length of the tunnel, ducts in said upper zone cooperating with said fan means to convey air therefrom to the heat-radiating means for circulation over said heat-radiating means, and passages for comingling air in the bottom zone with air from said duct means to flow over said heat-radiating means whereby air advancing through said upper zone will be spirally whirled and circulated between the work on the conveyor while heated by the heat-radiating means.

4. An oven construction which comprises a drying tunnel, tracks extending longitudinally through said tunnel and under said tunnel, endless conveyor means supported by said tracks for conveying work from the inlet to the outlet of said tunnel, heat-radiating plates beneath the tracks in said tunnel dividing the tunnel into upper and lower zones, means for circulating air through both of said zones in counter-flow relation to the direction of travel of the work, burners in said lower zone beneath said plates for heating the plates, duct means in said upper zone providing passages across the top thereof and along the sides thereof having discharge outlets at the bottom of the zone adjacent the edges of the plates, and baffle means at said bottoms of the ducts coacting with the plates to provide air flow paths for directing the air over the top of the plates and for drawing air and gases from the lower zone.

5. An oven construction which comprises an elongated open-ended insulated tunnel, legs at spaced intervals along the length of said tunnel supporting the tunnel above floor level, said legs being arranged in transversely aligned pairs projecting into the tunnel above the bottom thereof, cross-beams connecting the legs of each pair at the tops of the legs, a pair of tracks supported on said cross-beams extending through said tunnel, heat-radiating plates in said tunnel mounted on said legs beneath said cross-beams and tracks and dividing the tunnel into upper and lower zones, a pair of tracks mounted under the bottom of said tunnel between said legs, a work conveyor trained through said tracks in the tunnel and under the tunnel, burners in the bottom zone under the plates, and air circulating means in the top of the top zone at spaced intervals along the length of the tunnel for spiralling whirling air passing through the tunnel while drawing air from the bottom zone to flow therewith over the plates.

6. An oven construction comprising an insulated rectangular body of appreciable longitudinal extent defining an open-ended tunnel, transversely aligned pairs of legs at spaced intervals along the length of said body supporting the body above floor level, said legs extending into said tunnel, cross-beams at the tops of said legs, tracks extending longitudinally through said tunnel supported on said cross-beams, heat-radiating plates supported on said legs in said tunnel at a level beneath said tracks, said plates dividing the tunnel into upper and lower zones, burners in said lower zone directing flames against said plates, means at spaced intervals along the length of said upper zone circulating air around the periphery of said zone to travel over said plates and between work supported on said tracks, and means at the side edges of said plates for directing air and gases of combustion into the path of air circulating in the upper zone to comingle therewith and advance over the plates.

7. In an oven construction having an elongated drying tunnel receiving work therethrough in one direction and receiving air therethrough in the opposite direction, the improvement of heat-radiating plates in said tunnel dividing the tunnel area into upper and lower zones, burners under said plates in said lower zone to heat the plates, air circulating means at the top of said upper zone at spaced intervals along the length of the tunnel for transversely circulating the air to travel around the sides of the tunnel and over the plates, and aspirating means for drawing air and products of combustion from the lower zone to co-mingle with the air circulated by said means in the upper zone.

8. In an oven construction of the elongated tunnel type having a work conveyor extending therethrough, the improvement which comprises heat-radiating pans above the bottom of the tunnel dividing the tunnel area into upper and lower zones, burner means under said pans in the lower zone, air circulating means at spaced intervals along the top of the upper zone, duct means in said upper zone coacting with said air circulating means to provide passages receiving air from the top of the upper zone and

discharging the air over said pans, and air aspirating means at the side edges of said pans for drawing air and products of combustion from the lower zone to co-mingle with the air from said duct means.

9. In an oven construction having an elongated tunnel receiving air longitudinally therethrough, the improvement which comprises heat-radiating pan means dividing the tunnel into upper and lower zones and separating the air into two streams, burners in the lower zone directing flames against the under-side of the pan means, fans at spaced intervals along the top of the upper zone, and duct means cooperating with said fans to circulate the air stream in the upper zone into two transversely whirling streams having descending paths along the sides of the upper zone, bottom paths over the top of the pan means and ascending paths through the central portion of the upper zone.

10. In an oven construction, an elongated tunnel, a work conveyor for advancing work through said tunnel, an air inlet at the work outlet end of the tunnel, an air outlet at the work inlet end of the tunnel, heat-radiating bottom wall means above the bottom of the tunnel beneath the work conveyor dividing the tunnel into upper and lower zones and dividing air into upper and lower streams, burner means in the lower zone, fan means in the upper portion of the upper zone for transversely whirling the air stream as it advances through the upper zone, and air aspirating means at the sides of the bottom wall means for drawing air from the lower zone to co-mingle with the transversely whirling air in the upper zone.

11. An oven construction which comprises an elongated insulated body defining a drying tunnel, a work conveyor extending through said tunnel, a cooling tower at the discharge end of said tunnel receiving the work conveyor therethrough, fans in the bottom portion of the cooling tower for circulating air around and through the work conveyor to cool the work before it is discharged, heat-radiating bottom wall means dividing the tunnel into upper and lower zones, burners in said lower zone, a first adjustable baffle adapted to selectively overlie the fan means in the cooling tower for deflecting air into the lower zone, a second adjustable baffle projecting from the upper zone into the cooling tower to deflect air from said fan means into the upper zone, and air outlet means at the work inlet end of the tunnel communicating with said upper and lower zones whereby air streams will circulate through the upper and lower zones in counter-flow relation to the direction of advancement of work through the upper zone.

12. In an oven construction having an elongated tunnel, the improvement of a heat-radiating wall above the bottom of said tunnel and cooperable with the tunnel to divide the tunnel into adjacent upper and lower air circulating channels, a cooling tower at the discharge end of the tunnel, fan means for circulating air through said cooling tower, and adjustable air deflectors projecting into the path of air flow in the cooling tower deflecting some of the air respectively into the adjacent channels of the tunnel.

13. In an oven construction comprising an elongated insulated body defining a drying tunnel, heat-radiating plate means in said body dividing the tunnel into upper and lower zones, said plate means having a depressed central portion and upwardly sloping walls extending from said central portion into spaced relation from the sides of the body, burners in the bottom of the body directing flames on opposite sides of said depressed central portion of the plate means to flow along the sloping walls thereof to the side edges thereof, and baffle means on the side walls of the body in spaced relation from the side edges of the plate means to direct products of combustion from said flames over the top of the plate means in the upper zone.

14. An oven construction which comprises a housing defining an elongated tunnel with a work inlet at one end and a work outlet at the opposite end, a work conveyor extending through the tunnel for advancing work through the tunnel from the inlet to the outlet end of the tunnel, means adjacent the outlet end of the tunnel for longitudinally moving air through the tunnel toward the inlet end of the tunnel in countercurrent flow relation to the movement of work through the tunnel by said conveyor, duct means in said housing defining air passages over the top and along both sides of said tunnel, said duct means having inlets spaced longitudinally at intervals along the length of the tunnel and communicating with the top of the tunnel along the longitudinal axis thereof inwardly from the side passages, means for advancing air from the tunnel through said inlets to flow laterally outwardly over the top of the tunnel and then downwardly along both sides of the tunnel through said duct means, said duct means having outlets communicating with the sides of the tunnel below the level of the conveyor in the tunnel, baffle means extending inwardly of said tunnel under said outlets for directing air from the duct means inwardly toward the longitudinal central portion of the tunnel, and heating means in the housing beneath the baffle means to heat the air, whereby the longitudinally moving air will be transversely circulated as it advances through the tunnel to rise over the surfaces of work on the conveyor into the inlets of the duct means and then flow laterally over the top and downwardly along the sides of the tunnel to be heated under the work before again rising over the work.

15. An oven construction which comprises a housing defining an elongated tunnel with a work inlet at one end and a work outlet at the opposite end, a work conveyor extending through the tunnel for advancing work through the tunnel from the inlet to the outlet end of the tunnel, means adjacent the outlet end of the tunnel for longitudinally moving air through the tunnel toward the inlet end of the tunnel in countercurrent flow relation to the movement of work through the tunnel by said conveyor, duct means in said housing defining air passages over the top and along both sides of said tunnel, said duct means having inlet means extending horizontally over substantially the length of the tunnel and communicating with the top of the tunnel laterally inwardly from the side passages, means for advancing air from the tunnel through said inlet means to flow laterally outwardly over the top of the tunnel and then downwardly along both sides of the tunnel through said duct means, said duct means having outlets for the air passages along both sides of the tunnel which communicate with the sides of the tunnel below the level of the conveyor in the tunnel, baffle means having a top surface extending inwardly of said tunnel under said outlets for directing air from the duct means inwardly toward the longitudinal central portion of the tunnel, and heating means in the housing beneath the top surface of the baffle means to heat the air, whereby the longitudinally moving air will be transversely circulated as it advances through the tunnel in oppositely moving opposed spiral paths rising over the surfaces of work on the conveyor into the inlet means, then laterally over the top and downwardly along the sides of the tunnel over the baffle means to be heated under the work before again rising over the work.

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