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H. P. GUIRL ET AL

3,270,655

AIR CURTAIN DOOR SEAL

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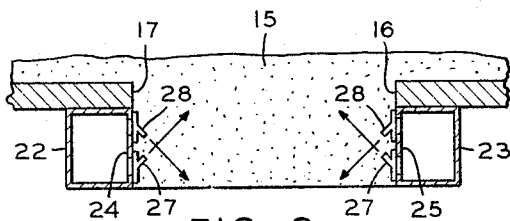
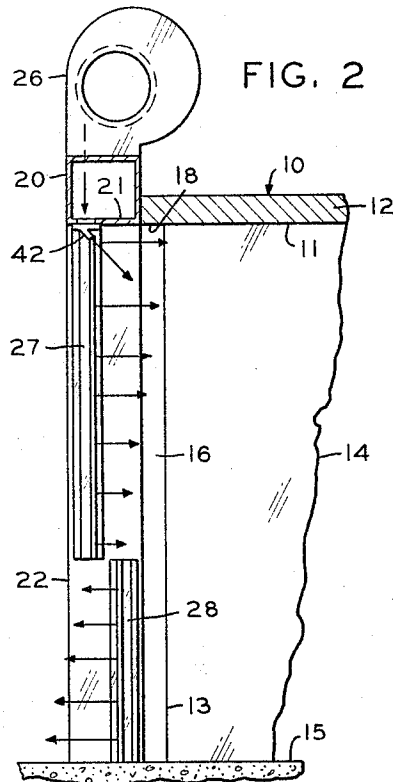
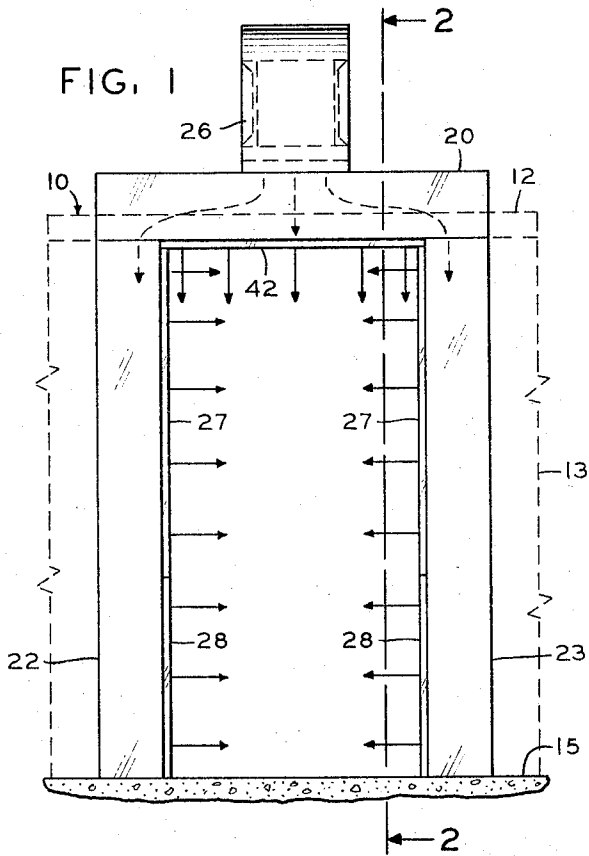


FIG. 3

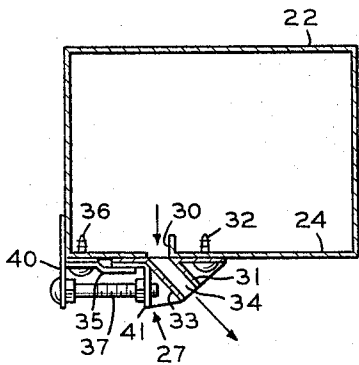


FIG. 4

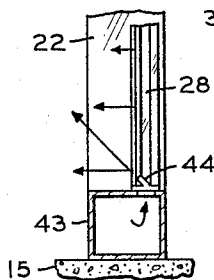


FIG. 5

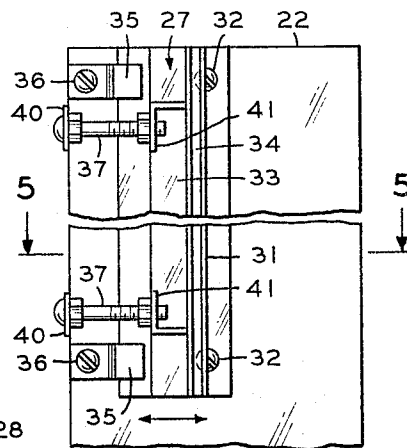


FIG. 6

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AIR CURTAIN DOOR SEAL

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This invention relates generally to improvements in an air curtain door seal and the method of forming such seal, and more particularly to an improved air curtain door seal adapted for industrial ovens.

Industrial ovens employing doors in the side walls require some means of sealing the opening to separate the atmosphere inside the oven at high temperature from the room atmosphere outside the oven at room temperature. The tendency in unsealed openings of this type is for the oven atmosphere to flow out the top of the opening, and for the room atmosphere to flow into the oven at the bottom of the opening. This flow results in a circulation that rapidly replaces the atmosphere inside the oven with room air. Under these circumstances, there is a loss of control of oven temperature, excessive heat is necessary to keep the oven at any elevated temperature, stratification of the temperature is caused in the oven with lower temperature at the bottom and higher temperature at the top, and fumes escape from the oven into a work space which causes an annoying and dangerous work condition.

An important object is to provide an effective air curtain door seal for an oven opening which overcomes the above mentioned shortcomings and disadvantages of an unsealed opening.

Another important objective is achieved by the method of forming an air curtain for a compartment opening which comprises the steps of blowing air from the periphery of the opening into and generally across the opening for a part of the height of the opening, and blowing air from the periphery of the opening outwardly of and generally across the opening for the remaining part of the opening height.

Still another important objective is afforded by adjusting the inwardly and outwardly blown air so that the amount is greater at the top and bottom respectively of the opening than that therebetween, whereby balancing of the particular condition or temperature can be accomplished for stabilization in which no air is admitted to or lost from the oven through the opening.

An important objective is realized in that the amount of blown air is adjustable so that it decreases regularly between the top and bottom of the opening in order to provide a static pressure in the opening which causes the desired stabilized condition.

Another important objective is realized by blowing the air from opposite sides of the opening generally across the opening, the air from the top portion of the opening being blown inwardly while the air from the lower portion is blown outwardly, whereby the foregoing functional results and advantages are obtained.

Yet another important object is attained by blowing air from the top side of the opening periphery into and generally downwardly across the opening for a more effective seal. Other advantages are realized under certain severe situations by blowing air from the bottom side of the opening periphery in a direction outwardly of and generally upwardly across the opening.

An important object is achieved by the structural arrangement of the component parts whereby the emission of blown air from the opposite sides of the lower portion of the opening periphery is in a plane inset from the plane of air emission at the top portion of the opening.

Another important objective is to realize an air curtain door seal for an industrial oven that is simple and

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durable in construction, economical to manufacture and assemble, highly efficient in operation, and which can be readily adjusted in the field in order to care for any condition or temperature.

5 The foregoing and numerous other objects and advantages of the invention will more clearly appear from the following detailed description of a preferred embodiment, particularly when considered in connection with the accompanying drawings, in which:

10 FIG. 1 is a front elevational view of the air curtain door seal;

FIG. 2 is a side view as seen along line 2—2 of FIG. 1;

FIG. 3 is a cross sectional view as seen along a horizontal line passed through the upper portion of the oven opening of FIG. 1;

15 FIG. 4 is a fragmentary, enlarged side elevational view of the nozzle means utilized at the upper side of the opening shown in FIG. 2;

FIG. 5 is a cross sectional view as seen along line 5—5 of FIG. 4, and

20 FIG. 6 is a fragmentary, cross sectional view similar to the bottom portion of FIG. 2 but illustrating a modified construction.

Referring now by characters of reference to the drawings, and first to FIGS. 1 and 2, an industrial oven generally indicated at 10 is disclosed, the oven providing a compartment 11 to be heated. The oven 10 includes a top wall 12, a front wall 13, and opposed side walls one of which is shown and indicated by 14 in FIG. 2. The oven 10 seats on a base 15 that constitutes a bottom closure for the compartment 11.

As will best appear from FIG. 3, the front wall 13 includes a door opening 16 defined by opposed straight, vertical side margins 17, horizontal top margin 18 constituting a part of the top oven wall 12, and a bottom margin 19 constituting a part of the base 15.

An air curtain door seal structure is provided about the periphery of the oven opening 16. This structure includes a top duct 20 arranged horizontally so that its lower margin 21 is aligned with the upper margin 18 of the oven opening 16. Located on each side of the oven opening 16 is a tubular side duct 22 and 23, the inner surface 24 of side duct 22 and the inner surface 25 of side duct 23 are aligned with the side margins 17 of the oven opening 16. The upper ends of the side ducts 22 and 23 communicate directly with the top duct 20 so that air passed into the top duct 20 flows into and through each of the side ducts 22 and 23. In the preferred embodiment, the ducts 20, 22 and 23 are of substantially square or rectangular cross section.

Mounted on and located in the middle of top duct 20 is a high pressure blower 26. The discharge of the blower 26 communicates with the interior of the top duct 20. The air discharged into the top duct 20 divides so that a portion flows in each direction toward the opposite ends, and is then directed into the vertical side ducts 22 and 23.

Nozzles generally indicated at 27 and 28 in FIG. 2 are located on each of the vertical side ducts 22 and 23. The nozzle 27 constitutes an air-directing means that directs an air flow from the side ducts 22 and 23 into and generally across the opening 16 for the upper part of the height of the opening 16. The nozzle 28 directs the air flow outwardly of and generally across the opening 16 for the bottom part of the opening height. Moreover, these nozzles 27 and 28 are adjustable to vary the amount of air so that the air flow is greatest at the top and bottom of the opening 16 and diminishes regularly therebetween. This feature of diminishing air flow is illustrated in FIG. 2 by the arrows of regularly diminishing length extending from the nozzles 27 and 28, such arrows representing vectors denoting the amounts of air at the particular points along the height of the opening 16.

The nozzles 27 and 28 may be of various constructions. However, one preferred embodiment of nozzle 27 is shown in detail in FIGS. 4 and 5. This nozzle 27 includes an elongate vertical slot 30 formed in the inner surface 24 of side duct 22. An acute angle strip 31 constituting a nozzle element is fixed by screw 32 to the duct surface 24. One side of the angle strip 31 is aligned with and located along one edge of the vertical, elongate slot 30. An obtuse angle strip 32 constituting the other cooperating nozzle element is arranged with one of its sides located substantially at and along the opposite edge of the slot 30. The obtuse angle strip 32 is adjustable to vary the effective width of the slot 30 and the width of the air-directing channel 34 formed between the strips 31 and 33.

A pair of tabs 35 are secured to the duct surface 24 by screws 36, one such tab 35 being located near the bottom and the top of the elongate nozzle strip 33. A portion of each tab 35 is spaced from the duct surface 24 to provide a narrow channel in which one arm of the nozzle strip 33 can slidably move in its adjustment toward or away from the coacting nozzle strip 31. The mechanism for effectively adjusting and retaining the nozzle strip 33 includes a pair of adjustable bolts 37, each extending between and operatively interconnecting a flange 40 fixed to the duct 22 and an ear 41 fixed to the elongate nozzle strip 33. One of the bolts 37 is provided at the top and one at the bottom of the elongate nozzle strip 33.

By adjusting the bolts 37, the effective width of the slot 30 can be adjusted so that the air-directing channel 34 delivers the air flow in a direction inwardly of and generally across the opening 16. Of course, by this simple adjustment the width of the air-directing channel 31 can be effectively diminished in size from one end to the other so that the greatest amount of air is emitted at the top of the nozzle 27 and regularly decreases toward the middle of the opening.

It will be immediately apparent that the corresponding construction can be utilized for the nozzle 28 at the lower part of this opening 16 on the side ducts 22 and 23, the only exception being that the direction of the nozzle 28 is reversed so that the air-directing channel 34 delivers the air flow in a direction outwardly of and generally across the opening 16. Again, it will be importantly noted that the nozzle 28 at the lower part of the opening 16 and utilized on the side ducts 22 and 23 has the same feature of adjusting the amount of air flow emitted so that the amount at the bottom of the opening 16 is greater than that upwardly and toward the middle of the opening.

From FIGS. 2 and 3, it will be noted that the nozzle 28 utilized on the side ducts 22 and 23 at the lower portion of the opening is in a plane inset from the plane of air emission provided by the nozzle 27 on the same side ducts at the top portion of the opening 16.

Another, yet similar, nozzle 42 is provided on the lower surface 21 of top duct 20, such top nozzle 42 being aligned substantially in the same plane with the side nozzles 27 at the upper part of the opening 16. The top nozzle 42 serves to direct the flow of air inwardly and downwardly of the opening 16. This top nozzle 42 can be adjustable in the same manner as are the side nozzles 27 and 28 in order to regulate the amount of air flow.

In an industrial oven there is a tendency for the oven atmosphere to flow out the top of the opening 16 and for the room atmosphere to flow into the oven at the bottom of such opening. This condition is brought about by the difference in temperature and, therefore, the difference in density of the air inside the oven and the air outside the oven, tending to make the hot air rise and the cold air fall, and, therefore, causing a circulating flow in a vertical plane in the oven opening 16. Generally speaking, the higher the opening 16 and the higher the oven temperature, the more rapid this circulating flow will be.

To counteract this circulating condition and to stabilize the air in such oven opening 16, a velocity type air curtain is provided by air emitting from ducts 20, 22 and 23 surrounding the opening on both sides and top respectively. Air is supplied to the top duct 20 by the high pressure blower 26, and thence is supplied to the side ducts 22 and 23. Air is emitted at high velocity from the side nozzles 27 and 28 and from the top nozzle 42. The velocity pressure contained in this flow of air from the nozzles 27, 28 and 42 is rapidly converted to static pressure as the air stream loses velocity, thereby balancing the pressure created by the difference in air densities on the two sides of the door opening 16. By adjustment of the nozzles 27, 28 and 42 both in direction and in degree of opening to control the quantity of air, a stabilized condition can be reached in which no air is admitted to the oven or lost from the oven.

The air being blown into the opening 16 from the ducts 20, 22 and 23 is heated slightly by its contact with the oven atmosphere, and, therefore, a small amount of this air rises upwardly over the top duct 20 to be again taken into the blower 26 mounted at the top center of the top duct 20 and thereby re-used as sealing air.

The result is an effective separation of the oven atmosphere from the room air, which does not interfere with the passage of material in or out of the oven through the opening 16, and does not lose its sealing effect when material is passing through the oven opening.

Under severe conditions, the structure can be modified in order to provide for an emission of an air flow upwardly from the bottom margin 19 of the oven opening 16. As is shown in FIG. 6, a bottom duct 43 seats on the base 15 and extends between and communicates with the lower ends of the side ducts 22 and 23. The air flow downwardly through the side ducts 22 and 23 enters the opposed ends of the bottom duct 43 and is discharged outwardly and upwardly of the opening 16 by a bottom nozzle 44. The bottom nozzle 44 may be of the same adjustable construction as the side nozzles 27 illustrated in FIGS. 4 and 5, and is arranged in the same plane as the side nozzles 28 at the lower part of the opening 16.

It is thought that the operation and functional advantages of the air curtain door seal for an industrial oven has been fully explained by the detailed description of the component parts, but for completeness of disclosure, such usage will be briefly set forth. It will be assumed that the oven 10 is heated so that the oven atmosphere in compartment 11 has a different density than the air outside the oven so that there is a pressure difference on the two sides of the oven opening 16 that would normally cause a rapid circulation of flow in which the oven atmosphere flows out the top of the opening 16 and the room atmosphere flows into the oven at the bottom of the opening. This circulating flow is overcome and the air stabilized in the opening 16 upon operation of the high pressure blower 26.

The air discharged from the high pressure blower 26 into the top duct 20 is delivered from the opposite ends of the top duct 20 into the side ducts 22 and 23. Air from the top duct 20 is discharged from the top nozzle 42 in a direction inwardly and downwardly of the opening 16 as is indicated in FIGS. 1 and 2. The air discharged from the side nozzles 27 at the top part of the opening 16 is delivered in a direction inwardly of and generally across the opening 16, while the air delivered from the cooperating side nozzles 28 is delivered outwardly of and generally across the opening 16. The side nozzles 27 and 28 are adjusted by manipulation of the adjusting bolts 37 so that the amount of air delivered is greatest at the top and bottom of the opening 16 and diminishes regularly toward the middle of such opening.

By regulating the nozzles 27, 28 and 42 to control the amount of discharged air and its direction, a stabilized condition is reached in which the pressure created by the differences in air density on the two sides of the opening 16 is balanced by the static pressure formed as the air streams emitted from the nozzles 27, 28 and 42 at high

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velocity lose such velocity. When balanced in this manner, air cannot be admitted to the oven nor can it be lost from the oven. There is, therefore, an effective separation of the oven atmosphere from the room air. The air curtain seal does not interfere with the passage of material into or out of the oven, and maintains its sealing effect when the material is passed through the opening 16.

A small portion of the air that is blown from the periphery of the oven opening 16 through the nozzles 27, 28 and 42 is heated slightly by the oven atmosphere and rises outwardly of the oven opening 16 along the top duct 20. Because the blower 26 is located in the position directly above the oven opening 16, this heated air is taken into the blower 26 and is re-circulated through the ducts and nozzles for sealing air.

Of course, as explained previously, when a structure is utilized in which the bottom duct 43 is present, the air is delivered to the bottom duct 43 from the side ducts 22 and 23, and is discharged into the opening 16 through the nozzle 44 in a direction outwardly and upwardly of the oven opening 16. The bottom nozzle 44 can also be adjusted to determine the desired quantity of air flow so that such flow cooperates with the air streams from the other nozzles 27, 28 and 42 to provide the effective stabilized air condition in the opening 16.

Although the invention has been described by making detailed reference to a preferred embodiment and a modification thereof, such detail is to be understood in an instructive, rather than in any restrictive sense, many variants being possible within the scope of the claims hereunto appended.

We claim as our invention:

1. In an air curtain seal for an oven:

- (a) a compartment having an opening,
- (b) means at opposite sides of the opening directing an air flow into and generally across the opening at the top part of the opening, and directing an air flow outwardly of and generally across the opening at the lower part of the opening, and
- (c) blower means supplying air to the air-directing means,
- (d) the air-directing means being adjusted to vary the amount of air so that the air flow is the greatest at the top and bottom of the opening and diminishes regularly therebetween.

2. The method of forming an air curtain seal for an oven compartment opening, which comprises the steps of:

- (a) blowing air from opposite sides of the top portion of the opening in a direction into and generally across the opening,
- (b) blowing air from opposite sides of the lower portion of the opening in a direction outwardly of and generally across the opening, and
- (c) varying the amount of air so that it is greatest at the top and bottom of the opening and diminishes regularly toward substantially the middle portion of the opening.

3. In an air curtain seal for an oven:

- (a) a compartment having an opening,
- (b) a duct along each side of the opening,
- (c) blower means blowing air into the side ducts, and

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(d) nozzle means on and communicating with each side duct, the nozzle means directing an air flow into and generally across the opening for a part of the height of the opening and directing an air flow outwardly of and generally across the opening for the other part of the opening height,

(e) the nozzle means on the side ducts at the lower part of the opening being inset relative to the nozzle means on the side ducts at the top part of the opening so that the planes of air emission are relatively offset,

(f) means adjusting the nozzle means on the side ducts so that the air flow is the greatest at the top and bottom of the opening and diminishes regularly therebetween.

4. In an air curtain seal for an oven:

- (a) an oven compartment having an opening,
- (b) a duct along the top of the opening,
- (c) a duct along each side of the opening and communicating with the top duct,
- (d) a bottom duct provided along the bottom side of the opening, the bottom duct communicating with the opposed side ducts,
- (e) blower means communicating substantially with the middle of the top duct and blowing air into the top, side and bottom ducts,
- (f) nozzle means on and communicating with each side duct, the nozzle means directing an air flow into and generally across the opening at the top part of the opening and directing an air flow outwardly of and generally across the opening at the bottom part of the opening,
- (g) means adjusting the nozzle means on the side ducts so that the air flow is the greatest at the top and bottom of the opening and diminishes regularly therebetween,
- (h) the nozzle means on the opposed side ducts at the bottom part of the opening being inset relative to the nozzle means on the side ducts at the top part of the opening so that the planes of air emission from such side nozzle means are relatively in the opening,
- (i) nozzle means on and communicating with the top duct, the nozzle means directing an air flow inwardly of and generally downwardly across the opening, and
- (j) nozzle means on and communicating with the bottom duct, the nozzle means directing an air flow outwardly of and generally upwardly across the opening.

References Cited by the Examiner

UNITED STATES PATENTS

2,312,272	2/1943	Stacey	98—40
2,516,432	7/1950	Spencer	98—36
3,021,776	2/1962	Kennedy	98—36
3,190,207	6/1965	Weisz	98—36

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