Aug. 12, 1958 R. E. NELSON 2,846,961

OVEN CIRCULATOR

Filed March 8, 1955 4 Sheets-Sheet 1

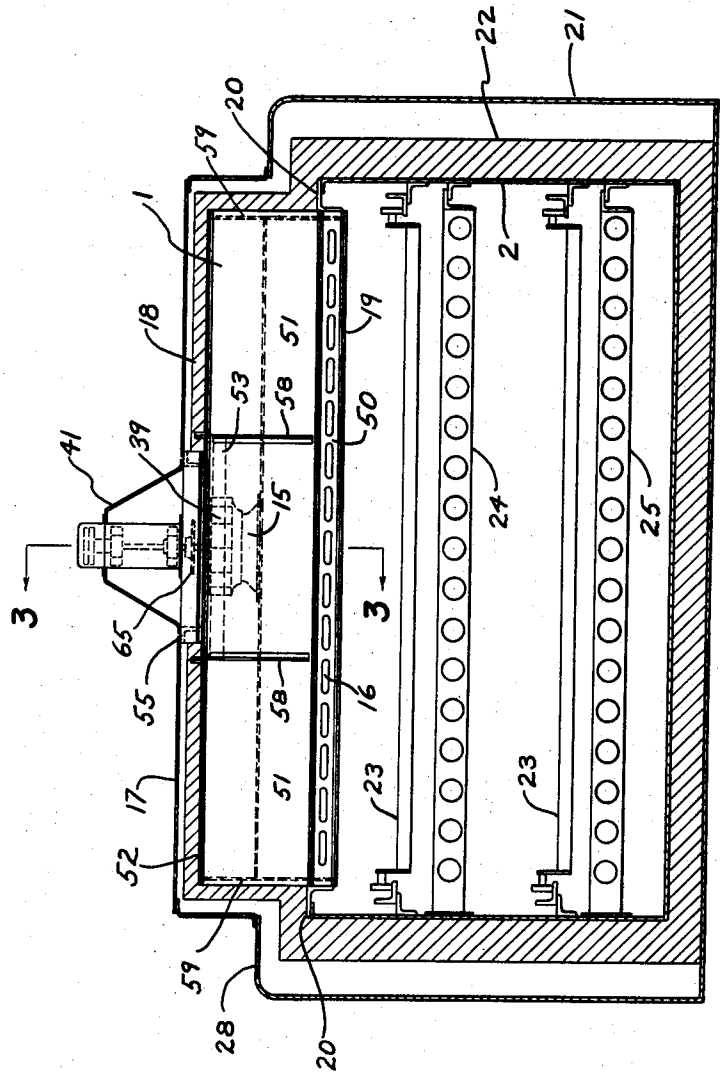


Fig. 1

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OVEN CIRCULATOR

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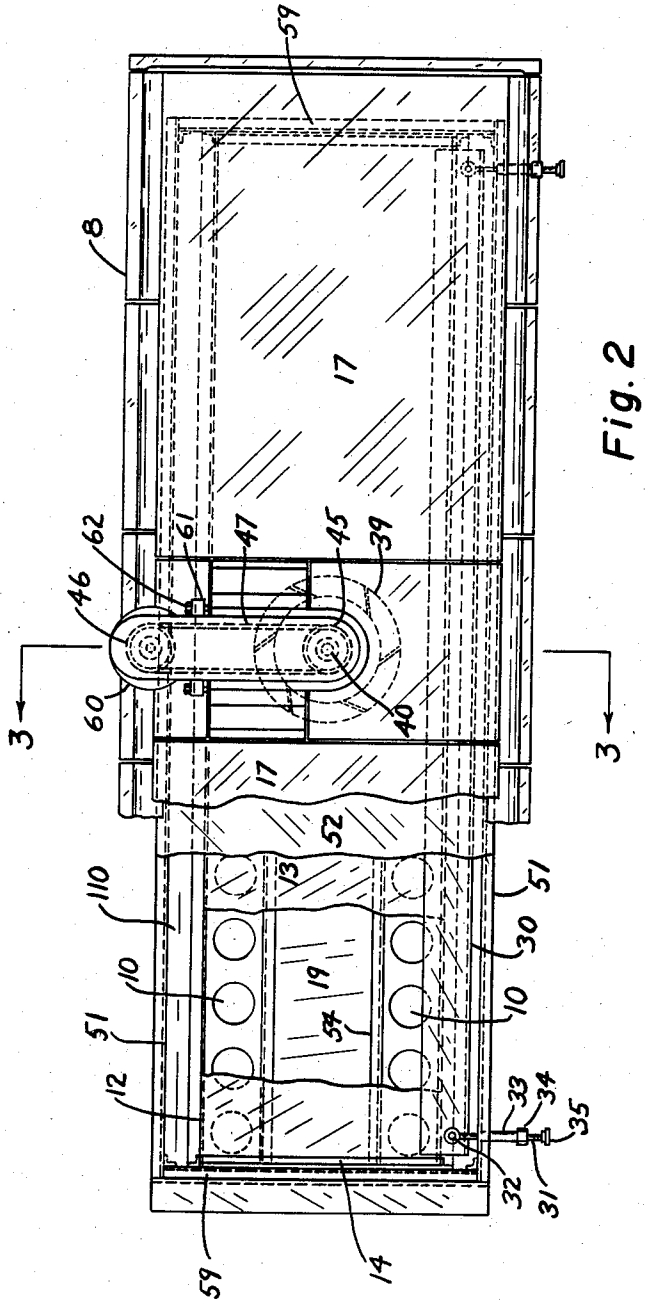


Fig. 2

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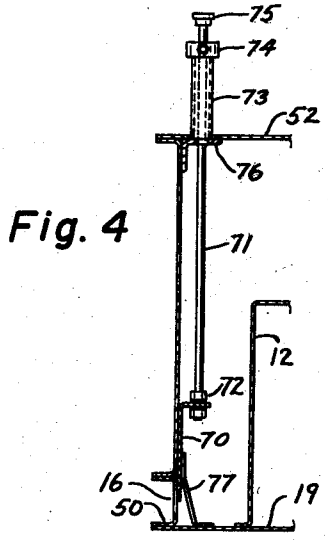


Fig. 4

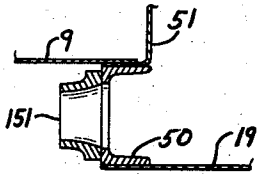


Fig. 8

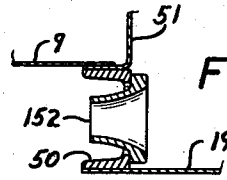


Fig. 9

Fig. 3

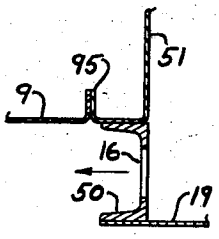


Fig. 5

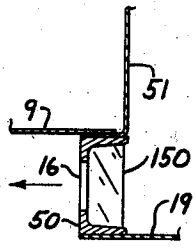


Fig. 6

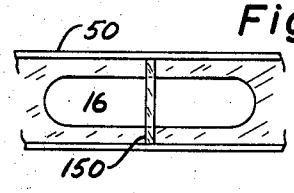


Fig. 7

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Fig. 11

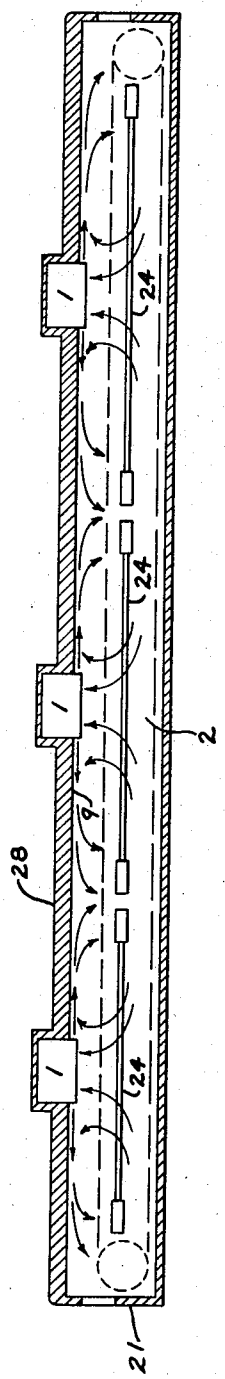
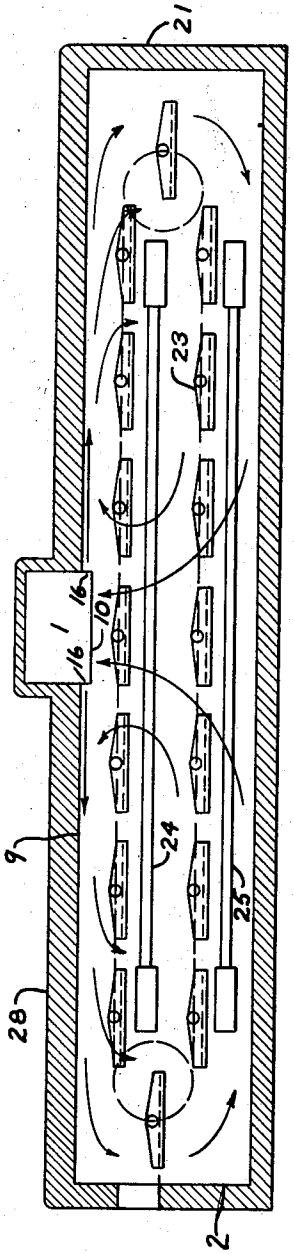


Fig. 10



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2,846,961

OVEN CIRCULATOR

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Application March 8, 1955, Serial No. 493,021

3 Claims. (Cl. 107—55)

This invention relates to the circulation of atmosphere in ovens and similar equipment. Although my invention will be shown and described as applied to ovens, it may be applied wherever it is desired to create and maintain an orderly and efficient circulation in an open chamber.

It is well known that the efficiency and uniformity of processes such as baking which involve contact transfer between an atmosphere and a product may be improved by causing the atmosphere to move over the product. Various schemes for obtaining a circulatory movement of the oven atmosphere have been proposed. Unfortunately, most of those so far tried are either expensive in construction and in application to the equipment or unsatisfactory in function. For this reason there are at present few commercial baking ovens which are well circulated.

The general object of this invention is to provide means for the circulation of atmosphere in baking ovens and like equipment which will be adequate in function and reasonable in cost, as well as adaptable to a wide variety of equipment.

Most of the circulation means so far proposed depend on the withdrawal of atmosphere from one zone of the oven and its reintroduction into another zone at some distance from the first, the circuit being completed by return flow within the oven. In my invention I bring the points of withdrawal and reintroduction close together, obtaining depth in the pattern of flow within the oven by directing the delivered flow away from the circulator at high velocity. This flow induces an additional movement of atmosphere within the oven, giving a total rate of movement greatly in excess of that handled by the circulator directly.

In order to insure that the pattern of flow is equivalent over the baking chamber from side to side, I extend both the collector or withdrawal means and the flow-directing or delivery means substantially to the full width of the baking chamber.

As a means of obtaining a balanced flow and of serving as large a portion of the baking chamber as possible, I usually divide the outgoing flow from the circulator into two parts, each controlling the flow at one side of the circulator.

As installed in the ceiling of an oven my circulator directs its delivery close to and parallel with the ceiling, sweeping the baking chamber immediately below the ceiling continuously and avoiding the accumulation there of atmosphere at excessive temperature, the source in some poorly circulated ovens of so-called "hot spots."

The foregoing method of circulation lends itself to a simple, compact construction in which all elements of the circulator are brought together into a single unit, inexpensive to construct and to install by comparison with other systems offering even passably good results.

Further objects and advantages of my invention will become apparent from the description to follow, taken in connection with the drawings, in which:

Figure 1 is a general view showing a circulator unit as installed in a tray oven of conventional design, chosen for illustration.

Figure 2 is a plan view of my circulator, partly cut away.

Figure 3 is a section taken through the circulator on the line 3—3 indicated in Figures 1 and 2.

Figure 4 is an alternative control shutter detail.

Figure 5 shows an alternative way of joining between the side of the circulator unit and the ceiling sheets of the oven.

Figure 6 is an alternative detail of the circulator side channel and delivery ports, a rear view of which appears in Figure 7.

Figure 8 is an alternative form of delivery nozzle construction, incorporating relatively long nozzles.

Figure 9 is a variation on the construction shown in Figure 8.

Figure 10 is a general schematic section taken longitudinally through a tray oven such as that of Figure 1, and shows the positioning of the circulator and the type of pattern of flow which is produced by the circulator.

Figure 11 is a similar view through a longer oven, showing the manner in which a plurality of units may be employed. For illustration only, the oven shown is of the traveling-hearth type.

Referring first to Figure 1, the numeral 1 indicates the main or distributor box of my circulator unit, made up of the top 52, sides 51, and ends 59, being completed and carried by the base unit 16 composed of the bottom sheet 19 and side port channels 50, which join with and are supported by the end carrier angles 20, which may, as in the present case, be carried directly upon the side wall structure of the oven, designated generally by the numeral 2. Additional oven structure shown in Figure 1 includes the conveyor trays 23, upper radiator 24, lower radiator 25, and the outside wall 21.

As shown in Fig. 3, the ceiling sheets 9 of the oven baking chamber are supported where they join the circulator box 1 by the ledges 26 formed by turning out the lower edges of the side sheets 51.

The junction between the deck 28 of the oven and the outside sheets 8 of the circulator may be effected at the angles 27, which may be a part of the oven outside structure. The circulator outside sheets extend upward to join with the circulator deck sheets 17. The insulation 18 of the circulator is carried over and around the main box 1 and down to join with the main oven insulation 22.

Within the main box 1 of the circulator unit is contained a smaller collector box 11, made up of top 13 and sides 12 and sharing with the main box 1 the ends 59 and bottom sheet 19. The collector intake ports 10, also shown in Figure 2, extend across the oven in the bottom sheet 19 below the collector box 11, and are purposely made small enough to offer a slight restriction to flow into the collector from the oven baking chamber, in order to insure a substantially evenly distributed withdrawal across the baking chamber.

The fan inlet ring 15 is mounted on top of the collector box 11 at its center, and draws from the box equally in both directions from the center. The fan wheel 39 is conventional in construction, having a plurality of blades indicated also by the numeral 39 and carried by the hub and back-plate 43 on the shaft 40, supported by the bearings 42. These bearings mount to the fan drive box 41. End location of the shaft 40 is provided by the spacer sleeve 44, which carries the driven sheave 45, secured to the shaft 40, at a definite height above the upper bearing 42. The motor 60 drives the fan shaft through the drive sheave 46, driven sheave 45, and belts 47, and is carried by the box 41 through the shelf 63 which supports the motor mounting plate 61. This plate is positioned for belt adjustment by the four screws 62, acting in nuts 64 on the box 41. The

bearings 42 are protected from excessive heat by the cooling wheel 64, mounted on the shaft 40 below the lower bearing 42.

The fan drive box 41 is supported through the mounting frame 55, which rides on the main box 1 through the insulating spacer blocks 56. The frame 55 is bolted through the top of the box 1 and through the reinforcing corner angles 53, which extend within the main box 1 between the side angles 58, to which they are likewise bolted. Rigidity in the location of the fan drive mounting frame 55 is also provided by the box 1, especially the top 52 and ends 59. Concentricity of the fan wheel 39 and the inlet 15 is obtained after mounting of the fan by shifting the inlet 15, which is adjustably bolted to the collector box 11.

The delivery of the fan wheel 39 is directly into the main box 1, which carries the flow around the collector box 11 into the spaces 110 formed between the lower portions of the sides 51 and the sides 12 of the collector box, terminating at the bottom 19 and to the delivery ports or orifices 16. These ports are formed in the side channels 50 and deliver laterally into the baking chamber of the oven, immediately below and parallel to the oven ceiling 9.

Although in many instances no means of controlling the delivery of the outlet ports 16 is needed, such control is sometimes desirable in special situations such as the case in which a row of delivery ports face an opening in the oven structure such as a loading door. In order to avoid unwanted blowing out of the oven in such a case, the delivery of the ports affected may be curtailed. The shutter 30 serves this function. It can be adjusted to vary the opening leading to the space 110 by moving the shutter toward or away from the wall 51. This is accomplished through the adjusting rods 31, the ends of which are formed as eyes and fit over the pins 32, secured to the shutter 30. These rods 31 need not be moved in or out to the same degree; any desired difference in the control from side to side of the oven may be obtained by a differential in rod adjustment. The rods 31 pass out through the tubes 33 and seals 34 to the operating handles 35, permitting adjustment to be made externally and, if desired, even while the circulator and oven are in operation.

An alternative means of adjustment, offering the advantage of varying the effective area of the ports 16, is shown in Figure 4. This incorporates a shutter 70, control rods 71 secured to the shutter by sleeves 72, shutter guides 77, tube 73, tube mounting angle 76, seal and lock 74, and operating handle 75. Adjustment is made by raising or lowering the rods 71.

Figure 5 shows an alternative way of joining the ceiling sheets 9 with the side of the circulator. Here the side sheet 51 and the ceiling sheet 9 are both formed into vertical flanges at 95. The advantage of this construction is in installation, when a considerable amount of vertical tolerance is possible in this joint to take up vertical offsets.

An alternative side channel and port construction is shown in Figures 6 and 7. Here the channel 50 is reversed from the position of Figure 3, giving an extended approach to the ports 16. Lateral components of flow through the ports 16 are reduced by the guide plates 150.

Figures 8 and 9 show the two alternative channel constructions further modified by the addition of formed nozzle-pieces 151 and 152 respectively, which further improve the direction of the outgoing flow.

Figure 10 shows the manner of application of the circulator to an oven requiring but one unit, such as a small tray oven similar to that of Figure 1 or the present figure. Here the inside of the oven is designated generally by the numeral 2, the outside wall generally by 21, the ceiling by 9, the roof deck by 28, trays by 23 and upper and lower radiators by 24 and 25.

The circulator unit, using the main box designation 1, is mounted in the ceiling of the oven, extending across the baking chamber 2. Oven atmosphere is drawn into the unit through collector ports at 10 and is delivered back into the baking chamber through ports 16 below the ceiling level on both sides of the circulator 1.

The normal pattern of flow in each direction from the circulator is determined by the direction and strength of the outgoing flow from the ports 16 and by the path of flow available. In this connection it is important that the ceiling line, especially near the circulator, be substantially free of obstructions which could break up the outgoing stream. Given an unobstructed ceiling, I usually consider a distance of about 20 feet each way from the circulator, or a total circulated distance of 40 feet, as the practical limit of effective circulation.

As the high-velocity delivery travels out from the circulator, it mixes with atmosphere of the baking chamber, which is drawn into the stream and correspondingly diminishes its speed. At the same time the effective depth of the stream increases, until the stream breaks down into the lower part of the oven and reverses direction.

Return flow along the lower part of the oven carries the pattern back toward the circulator. Part of the return flow continues to the collector of the circulator, while another part passes upward through the line of product and joins the outgoing stream directly.

It will be seen that the pattern of flow with respect to the product is predominantly upward nearest the circulator unit and downward at its extremes.

Figure 11 illustrates the application of several circulator units to a longer oven. As illustrated, three circulators are applied to a traveling-hearth oven having three indirect-fired radiator heating units.

Although the disposition of circulator units at about mid-run of each radiator section is not essential, I consider it preferable in the majority of cases. Where this is done the spacing of heating sections may dictate the length of oven circulated by each circulator unit, rather than the total potential of the circulator.

Radiators near the ceiling of the oven do not interfere with the effective use of my circulator, provided the circulator is so located in each case as to avoid breaking up of the essential outgoing stream by obstacles such as headers. The location of headers near the collector intake ports is not a handicap unless the closeness is such as actually to throttle the flow. Since, in the general case, the tubes of a radiator are substantially parallel with the initial direction of flow, they offer no real obstruction to an effective pattern of circulation.

I claim:

1. A circulator for ovens and like equipment having an open process chamber including a ceiling thereof, comprising a power-driven fan or blower, a collector box in said ceiling extending transversely thereof and communicating with the inlet of said fan or blower, a distributor box communicating with the outlet of said fan or blower and having a top and sides surrounding said collector box in spaced relationship to the top and sides thereof, and delivery means into said process chamber connecting with the lower portions of the spaces formed between the sides of said distributor box and said collector box.

2. Structure according to claim 1, said delivery means being below said ceiling and adapted to deliver laterally into said process chamber.

3. Structure according to claim 1, said delivery means being adapted to deliver laterally into said process chamber close to and parallel with said ceiling.

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