

PATENT SPECIFICATION

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(54) FOOD PROCESSING OVEN

(71) I, KEVIN JOSEPH HICKS of 29-33 King Road, Hornsby, New South Wales, 2204, Commonwealth of Australia, an Australian citizen, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:

10 This invention relates to an oven for use in food processing and, in particular, for use in the baking of cookies or biscuits. For convenience, the invention is herein described in the context of biscuit manufacture but it will be appreciated that the oven in accordance with the invention has wider application.

15 Biscuit manufacture requires that heat should be applied to the biscuit mix at different levels or for different periods of time during three distinct stages in the baking process. Thus, the biscuit mix should be subjected to an initial heating stage when it first enters the oven for the purpose of controlling the size and colour required of the finished product. Thereafter, the mix should be subjected to a second heating stage for the purpose of baking the biscuit through, and to a final heating stage for the purpose of baking the underside of the biscuit and completing the baking. The heat level applied at the various stages should be controllable and variable to accommodate different mixes.

20 25 30 35 40 45 Ovens which are customarily employed in the baking of biscuits comprise a tunnel-like structure and an endless conveyor which passes in a straight line through the tunnel. Heating elements are strategically located at various zones within and along the length of the tunnel for the purpose of restricting or controlling heat transfer from one zone to another. Various controls (including air draft controls) are associated with the ovens for the purpose of regu-

lating heat levels within the various zones. As the biscuits travel through the oven they encounter each of the zones, in turn, and each stage of the baking process is carried out in a unique one of the zones of the oven.

The ovens as above described and as currently employed have proved to be generally satisfactory in terms of applying a controlled amount of heat to a biscuit during the various stages of a baking process. However, they are inherently large in size, and they are therefore costly in terms of both capital expenditure and siting area required.

60 Attempts have been made to avoid the abovementioned size and cost problems by the construction of an oven which employs a conveyor belt which is driven through a serpentine path within a single oven chamber. Such an oven utilises an upper electric heating element for applying heat during the initial baking stage and a lower bank of gas fired burners for supplying heat for the second and final baking stage. The oven is naturally purpose built on site.

75 However, this oven construction has been found to present its own problems. Whilst the size and hence the cost of the oven is reduced, it has been found that no effective control can be exerted over heat required for the various baking stages, due to the migration of heat from one zone of the oven chamber to another.

80 Such heat migration occurs to an uncontrollable extent due to the more compact nature of the oven and a desired change in the heat applied in one region of the oven automatically influences the conditions in other regions of the oven. This results in the baking process being adversely affected as the temperatures of the different baking zones of the oven cannot be adjusted in isolation to their opti-

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num values.

An object of the invention is the provision of an improved compact food processing oven in which different cooking stages can be carried out at different controlled temperatures without adversely influencing the cooking stages being carried out in other zones of the oven.

In accordance with the present invention there is provided a food processing oven suitable for baking biscuits or cookies and comprising an oven chamber having an inlet and an outlet, an endless conveyor including baking trays arranged to be driven through the oven chamber, the conveyor following a serpentine path which includes a plurality of horizontal passes at different levels in the oven chamber, first, second and third groups of electric heating elements disposed within the oven chamber for directing heat onto products carried by the baking trays during first, second and third stages respectively of conveyance of the products through the oven chamber, control devices in circuit with the first and third groups of heating elements and arranged independently to maintain the heat emission from such elements at preselected adjustable levels, a further control device associated with the second group of heating elements and arranged to provide for a predetermined heat level within the second stage zone of the oven chamber, the further control device including a temperature sensor located within the second stage zone whereby in operation of the oven, the heat level control in the second stage zone compensates for any heat migration into the second stage zone from the first and third stage zones, the oven chamber having no fixed baffles separating the first, second and third stage zones but the baking trays serving, in operation of the oven, to inhibit migration of heat between the respective stage zones.

The oven in accordance with the invention and as above defined provides for accurate temperature control over a baking process and this does in turn permit the use of relatively unskilled labour for monitoring a baking operation. Thus, operators may be furnished with instructions as to settings for the various controls which are appropriate to a particular food product mix. Also, inasmuch as the oven may be regarded as having self-regulatory control, automatic setting of the control devices can be effected by way of various codings. The coding may be contained on punch cards or in a memory device.

The invention will now be described in more detail, by way of example, with reference to the accompanying drawings, in which:—

FIGURE 1 shows a schematic side ele-

vation view of a cubical oven;

FIGURE 2 shows a scrap view of a conveyor which passes in a serpentine fashion through the oven; and,

FIGURE 3 shows circuit connections applicable to various heating elements which are located within the oven.

As shown in Figures 1 and 2, the oven comprises a parallelepiped oven chamber 10 through which biscuits are conveyed in order that they might be subjected to a baking process. A series of shaft mounted sprockets 11 are located within and outside the chamber 10, and the sprockets serve to support a product conveyor 12 which passes in a serpentine fashion through the chamber.

The product conveyor, as indicated in Figure 2, comprises a pair of spaced-apart link-chain type conveyor bands 13 and 14 which suspend a series of laterally extending biscuit support trays 15. The support trays 15 are pivotably mounted to the conveyor bands and they are counterbalanced in such manner that they maintain a substantially constant orientation during their passage through the oven chamber.

Although not so shown in the drawings, the product conveyor would normally incorporate endless conveyor chains which serve to carry the trays 15 through a biscuit mix loading station and through a subsequent cooling zone and unloading station. Such stations are well known in the art and as they form no part of the invention they are not illustrated or further described.

A bank of six "first" heating elements 16 are located at the upper end (zone 1) of the oven chamber, the elements being in the form of rod type electric radiant heating elements extending across the width of the chamber above the top run of the trays.

Another bank of six "second" heating elements 17 are located within an intermediate portion (zone 2) of the chamber, and a further bank of four "third" heating elements 18 are located toward the lower end of the chamber (zone 3). Elements 16, 17 and 18 extend parallel to one another.

The respective banks of elements 16, 17 and 18 are disposed within the chamber for radiating heat onto the biscuits during their passage through first, second and third stages of conveyance of the products through the chamber. The respective stages are indicated as zones 1, 2 and 3 in Figure 1 of the drawings, but it will particularly be noticed that there are no structural fixed divisions (e.g. baffles) between the various stages. These are avoided because the use of independently controllable banks of radiant heating rods enables the heating to which the biscuits are subjected in the different zones to be regulated without noticeably influencing the heating in other

adjacent zones and the trays located at any one time in each horizontal run of the conveyor provide an effective horizontal baffle to inhibit heat radiation and convection between the zones.

The conveyor 12 moves at a substantially constant adjustable velocity through the oven chamber 10.

As is shown in Figure 3 of the drawings, the first and third banks 16 and 18 of heating elements are connected to a common electrical current supply through control devices 19 in order that heat emission from such elements might be maintained at a preselected (but variable) level. Such control devices comprises Type TYJ Series Sunvic "Simmerstat" (Registered Trade Marks) regulators (marketed by Sunvic division of A.E.I.).

The second bank 17 of heating elements is connected to the supply of electrical current through a contactor 20 which is energised by way of a controller 21 and can break a 45 amp current. The controller 21 functions to control energisation of the heating elements 17 and so as to provide for maintenance of a predetermined heat level within the second stage zone of the oven chamber.

The controller 21 comprises an electronic temperature controller which responds to a thermocouple type temperature sensor 22 located within the second zone of the oven chamber. A controller which has been found suitable for this purpose is currently commercially available and is a "Mini" temperature controller Series 19-90 produced by Pye Ether Ltd.

In order to provide for maintenance of a balanced heating effect across the full width of the oven chamber 10, a further bank of three heating elements 23 are located one along each side of the chamber, as shown in Figure 1.

The upper heating element of each three elements 23 is arranged horizontally immediately beneath the six elements 16 and perpendicularly to them. Its ends are directly beneath the two end elements 16. In similar manner the middle heating elements 23 are arranged horizontally directly beneath the ends of the middle pair of heating element 17 with their ends adjacent those of the elements 17. The lower heating elements 23 are arranged in corresponding manner directly beneath the ends of the upper pair of heating elements 18.

The top bank of six elements 16 is switchable in three pairs as shown in Figure 3. Each of the elements 16, 17 and 18 has a dissipation of 1500 watts. The two upper elements 23 have a dissipation of 900 watts and the lower two elements 23 have dissipation of 250 watts. When in use each of

the elements radiates a deep red heat. The function of the two banks 23 is to compensate for any difference in heat losses at the sides of the oven chamber so that the biscuits adjacent the ends of the trays 15 are heated at their edges despite the loss of heat from the terminal portions of the heating elements at which the electrical connections to them are made.

The oven chamber 10 has a fabricated metal sheet wall covered with thermal insulation and the only two openings in it are those necessary beneath for entry and exit of the continuously moving conveyor 12. The trays are of triangular section and are also fabricated from steel sheets so that they present a horizontal smooth top surface on which the biscuits rest.

The overall length of the oven is 11½ ft; its height is 4 feet 10 inches (which includes ¼ foot riser legs to which wheels can be fitted and which provide the necessary ground clearance. The legs can be removed and are not shown as they form no part of the invention); and its width is 3½ feet which includes external control knobs. The only external connection necessary is the electrical lead for supplying power to the oven.

On switching on, the oven requires about 15-25 minutes run-up time to stabilise its interior temperature. As the oven chamber is insulated and closed, apart from the bottom openings for the conveyor 12, it heats up to provide a generally uniform stable air temperature within it of 150°C to 200°C. The settings applied to the heaters are variable to suit the biscuit mix and cooking cycle.

The temperature settings of the heating elements are chosen to fulfill the following functions.

The bank of six heating elements 16 serves to control the expansion of the incoming biscuit mix which tends to spread on the trays 15 until a firm crust is formed by the exterior layer drying out. This contains further expansion. The first two pairs of heaters are individually set to determine when this occurs and thus fix the final shape of the biscuit. The third pair of heating elements is set to impart the required colour to the finished biscuit by further heating the exterior, dried-out layer.

The biscuits then make three runs through the central region [zone 2] of the oven. This zone is temperature stabilised to a temperature normally 50°C - 70°C lower than the top region of the oven, by the thermocouple 22 and the contactor 20. The spacing of the heaters 17 is such that uniform cooking of the biscuit throughout its thickness occurs in this zone and the desired texture is imparted to it.

The final stage of cooking takes place

in the third zone which is normally at 50°C to 70°C less than the middle zone 2. Its temperature is determined by the setting of the heater elements 18. Preferential cooking of the undersides of the biscuits occurs in this zone as a result of the temperature of the trays 15, on which they rest, being greater than the surrounding air because of their retention of heat from the higher temperature zones through which they previously passed.

In a typical example of use of the apparatus the trays, which are 2 feet long and 4½ inches wide, are each loaded from an extruder with six pieces of biscuit dough mix. The conveyor runs continuously at constant speed and at any one time there are 120 trays in the oven. Each tray spends 15-20 minutes in the oven from which it will be appreciated that the output is 2160 biscuits an hour.

From the above description it will be appreciated that the oven has the following advantages. It is fabricated under factory conditions and transported to site of use (rather than being purpose built *in situ*). It is compact, easy to use and versatile. It requires only one electrical point and produces no fumes so that chimneys, gas connections, draughts and flues and unpleasant smells are avoided. It is easy to clean. If it is required to move the oven, it can be done without dismantling it.

WHAT I CLAIM IS:

1. A food processing oven suitable for baking biscuits or cookies and comprising an oven chamber having an inlet and an outlet, an endless conveyor including baking trays arranged to be driven through the oven chamber, the conveyor following a serpentine path which includes a plurality of horizontal passes at different levels in the oven chamber, first, second and third groups of electric heating elements disposed within the oven chamber for directing heat onto products carried by the baking trays during first, second and third stages respectively of conveyance of the products through the oven chamber, control devices in circuit with the first and third groups of heating elements and arranged independently to maintain the heat emission

from such elements at preselected adjustable levels, a further control device associated with the second group of heating elements and arranged to provide for a predetermined heat level within the second stage zone of the oven chamber, the further control device including a temperature sensor located within the second stage zone whereby in operation of the oven, the heat level control in the second stage zone compensates for any heat migration into the second stage zone from the first and third stage zones, the oven chamber having no fixed baffles separating the first, second and third stage zones but the baking trays serving, in operation of the oven, to inhibit migration of heat between the respective stage zones.

2. An oven as claimed in claim 1 wherein the inlet and the outlet are provided in the lower part of the oven and wherein trays entering the oven ascend through an upright passage before entering the first stage zone.

3. An oven as claimed in claim 1 or claim 2 wherein the first group of heating elements is located above the uppermost horizontal pass of the conveyor, the third group of heating elements is located above the lowermost horizontal pass of the conveyor, and the second group of heating elements is located intermediate the first and third groups, the second group comprising vertically separated banks of horizontally disposed heaters, each bank of heaters being located between horizontal passes of the conveyor.

4. An oven as claimed in any one of the preceding claims and including further heating elements located adjacent and extending parallel to side walls of the oven chamber.

5. An oven substantially as hereinbefore described with reference to the accompanying drawings.

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from such elements at preselected adjustable levels, a further control device associated with the second group of heating elements and arranged to provide for a predetermined heat level within the second stage zone of the oven chamber, the further control device including a temperature sensor located within the second stage zone whereby in operation of the oven, the heat level control in the second stage zone compensates for any heat migration into the second stage zone from the first and third stage zones, the oven chamber having no fixed baffles separating the first, second and third stage zones but the baking trays serving, in operation of the oven, to inhibit migration of heat between the respective stage zones.

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