(12) UK Patent Application (19) GB (11) 2 152 647 A

(43) Application published 7 Aug 1985

(21) Application No 8400362

(22) Date of filing 7 Jan 1984

(51) INT CL⁴
F27B 9/12 C03B 25/00 F27B 9/40

(52) Domestic classification
F4B 102 119 JV
C1M 422 MB
U1S 1386 F4B

(56) Documents cited
GB 1495190 GB 1449658 GB 1118832

(58) Field of search
F4B
C1M

(71) Applicant
Stein Atkinson Stordy Ltd (United Kingdom),
Midland House, Ounsdale Road, Wombourne,
Wolverhampton WV5 8BY

(72) Inventor
M N Menzies

(74) Agent and/or Address for Service
Raworth Moss & Cook,
36 Sydenham Road, Croydon, Surrey CR0 2EF

(54) Furnace with sub-zones having air flow control device

(57) A furnace through which articles may be continuously or intermittently passed from an inlet end to a discharge end, the furnace having at least one zone provided with air recirculation and divided (by walls 19–21) into a plurality of sub-zones (15–18) each provided with separate means (28–31) for circulating air within that sub-zone transversely of the direction of movement of articles therethrough and each sub-zone incorporating at least one flow control device movable to permit air from that sub-zone to pass to an adjoining sub-zone. Preferably the device is in the form of a damper (36) movable from a first position in which recirculation occurs only in the sub-zone to a second position (36b) in which the air circulated over articles in the sub-zone is passed to an adjoining sub-zone, a variety of intermediate positions (36a) of the damper permitting different proportions of the air in each sub-zone to be recirculated therein or passed to an adjoining sub-zone.

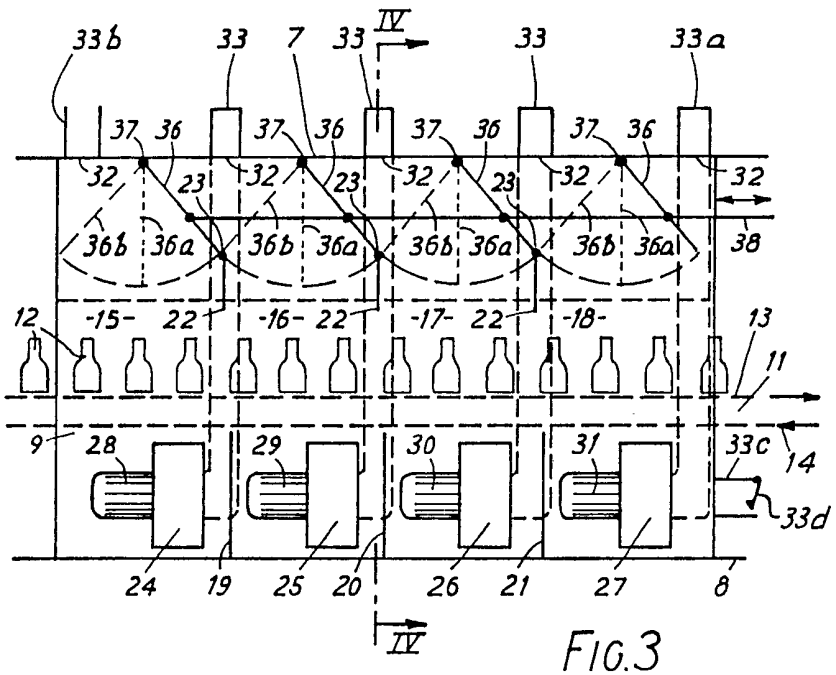

FIG.3

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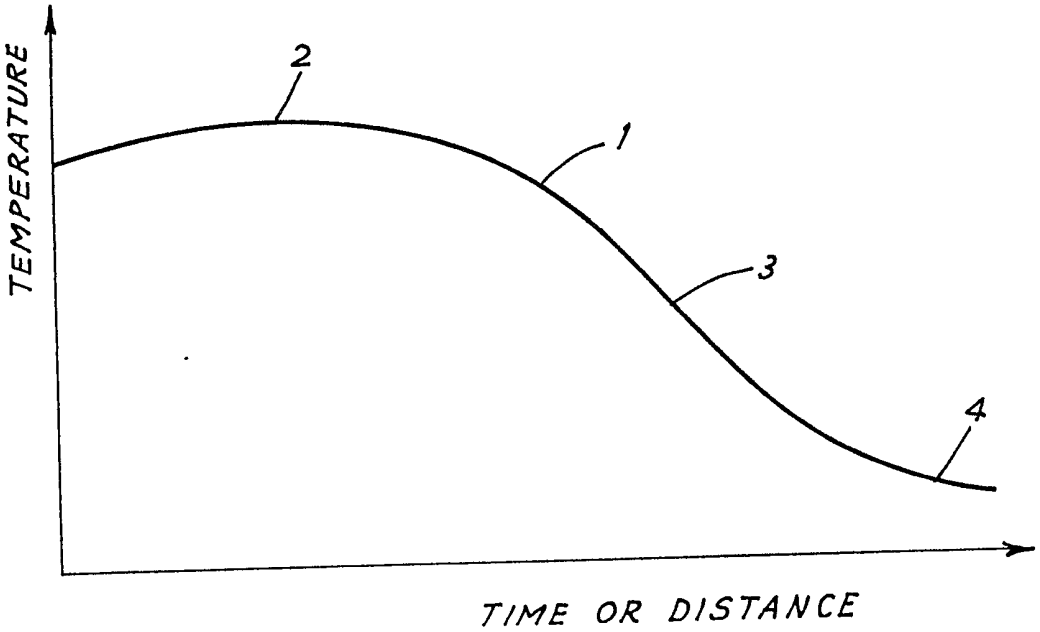

TEMPERATURE
2
1
3
4
TIME OR DISTANCE

FIG. 1

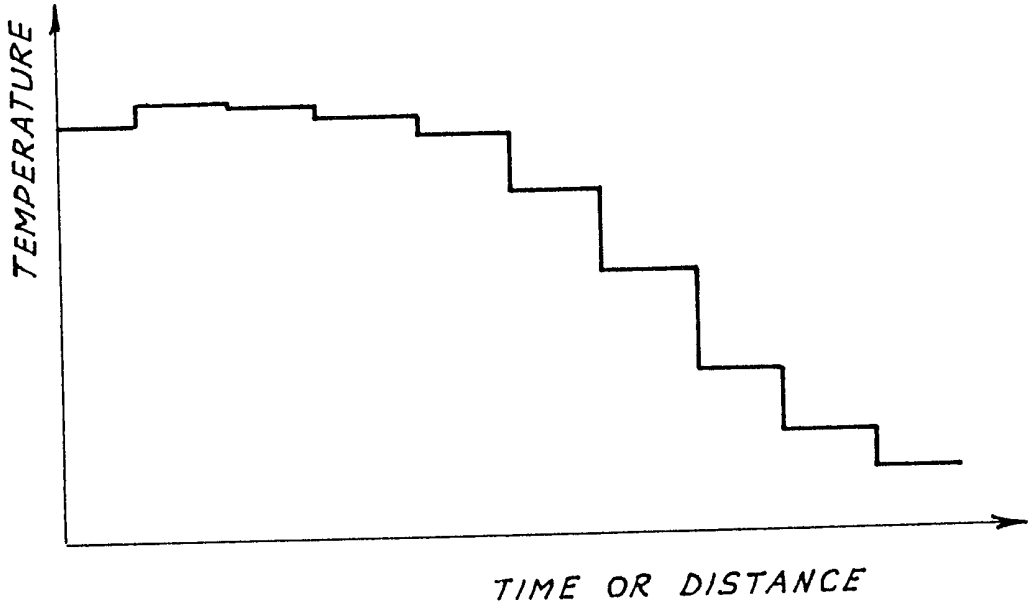

TEMPERATURE
TIME OR DISTANCE

FIG. 2

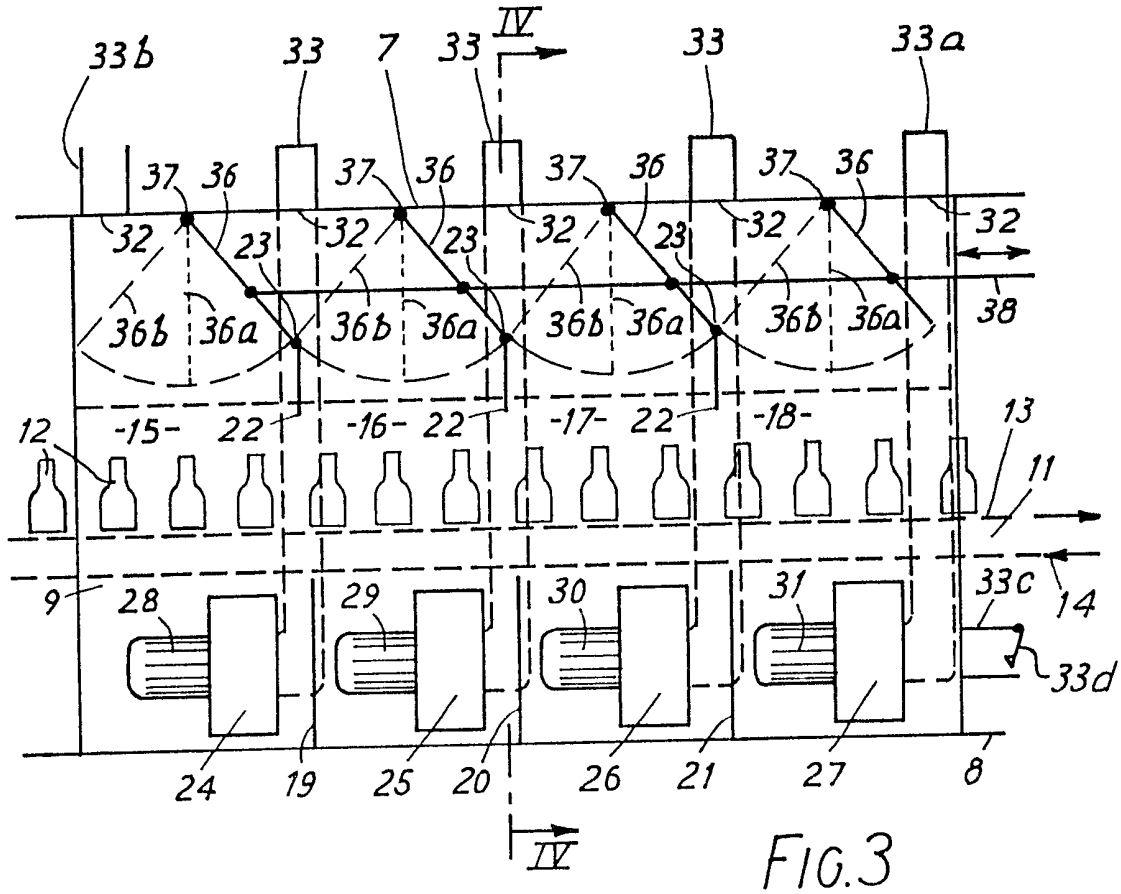
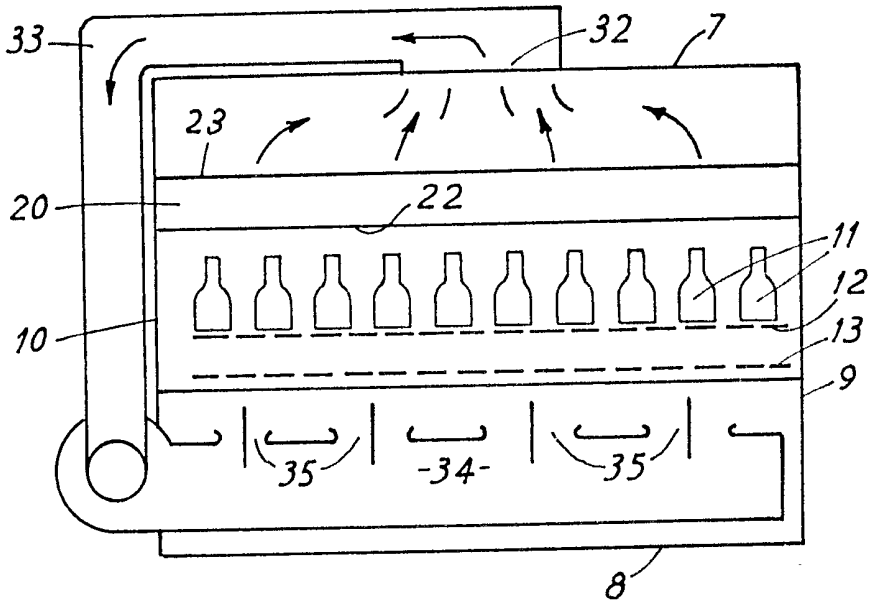

33b
33
7
33
IV
33
33a
37
36
32
23
36b
36a
38
-15-
-16-
-17-
-18-
22
12
13
11
14
9
28
29
30
31
33c
33d
24
19
25
20
26
21
27
8
IV

FIG.3


33
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22
11
12
10
13
9
35
-34-
35
8

FIG.4

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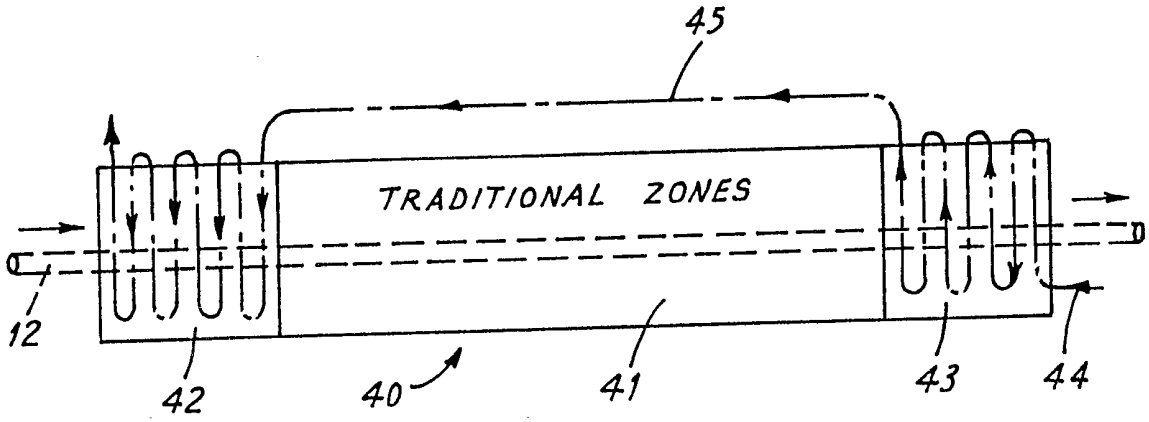

FIG.5

SPECIFICATION

Furnace with sub-zones having air flow control device

This invention relates to furnaces and is particularly but not exclusively concerned with glass container annealing and decorating lehrs.

Early annealing lehrs did not have air circulation; some were then provided with a fan towards the discharge end and more recently they have been divided longitudinally into zones with full air recirculation in at least one of the zones to improve heat transfer coefficients and enhance zonal temperature homogeneity. However, in the rapid cooling section of the lehr only a coarsely stepped approximation to an ideal cooling curve can be obtained and it is this insufficiency of temperature homogeneity that limits the capacity of this section of the lehr.

In decorating lehrs cold, decorated articles must be heated rapidly, subjected to an annealing stage at a fairly constant temperature and then rapidly cooled. The energy requirement for this process is high and, conventionally, much of the hot air at the discharge end of a decorating lehr is wasted.

It is therefore an object of the present invention to provide an improved furnace having enhanced air recirculation and which is particularly although not exclusively applicable to glass container annealing and decorating lehrs.

According to the present invention there is provided a furnace through which articles may be continuously or intermittently passed from an inlet end to a discharge end, the furnace having at least one zone provided with air recirculation and divided into a plurality of sub-zones each provided with separate means for circulating air within that sub-zone transversely of the direction of movement of articles therethrough and each sub-zone incorporating at least one flow control device movable to permit air from that sub-zone to pass to an adjoining sub-zone. Preferably the device is movable from a first position in which recirculation occurs only in the sub-zone to a second position in which the air circulated over articles in the sub-zone is passed to an adjoining sub-zone, a variety of intermediate positions of the device permitting different proportions of the air in each sub-zone to be recirculated therein or passed to an adjoining sub-zone.

When the furnace is an annealing lehr the zone may be disposed intermediate the length thereof. In this case the sub-zone at the discharge end of the zone may draw air from atmosphere and the sub-zone at the charge end of the zone may have a vent for exhausting air therefrom.

When the furnace is a decorating lehr two zones may be disposed respectively at the charge and discharge ends thereof; the sub-zone nearest the discharge end of the zone at the charge end taking its air from the sub-zone nearest the charge end of the zone at the discharge end.

The above and other aspects of the invention will now be described by way of example with reference to the accompanying drawings in which:–

Figure 1 is a graph showing an ideal annealing curve for a glass annealing lehr;

Figure 2 is a graph showing in exaggerated form a typical annealing curve in known glass annealing lehrs having some air recirculation;

Figure 3 shows, diagramatically, a longitudinal section through a glass annealing furnace zone according to the present invention having four sub-zones;

Figure 4 is a section on the line IV–IV of Fig. 3 and

Figure 5 shows diagramatically, a longitudinal arrangement for a decorating lehr.

Fig. 1 of the drawings shows the ideal shape of curve 1 of temperature/time or distance, for a glass container annealing lehr. Typically glass containers from a glass making machine (not shown) will be passed directly into the lehr at a temperature of about 550°C. During their passage through the lehr their temperature will rise slightly at 2 and then fall rapidly at 3 to a fairly steady low level 4.

Fig. 2 shows, in slightly exaggerated manner, the type of stepped curve 5 obtained with conventional annealing furnaces having air recirculation in all of its zones. In practice the curve will actually lie somewhere between Figs. 1 and 2 but the form of the Fig. 2 curve clearly shows that the biggest "steps" inevitably occur at the steepest part of the curve representing rapid cooling and it is precisely during this period of rapid cooling that close control of temperature is most desirable.

Figs. 3 and 4 of the drawings show a zone 6 of a glass annealing furnace, the remainder of which has been omitted. The zone 6 is disposed along the length of the furnace at a position approximating to the steepest part 3 of the annealing curve. The zone 6 has top, bottom and side walls 7, 8, 9 and 10 and a conveyor 11 for glass bottles 12 having an upper run 13 and a return run 14.

The zone 6 is divided into four sub-zones 15, 16, 17 and 18 separated by transverse walls 19, 20 and 21. Each wall has an opening 22 through which the conveyor 11 carrying its containers 12 may pass and the upper ends 23 of the walls are spaced from the top wall 7 of the zone 6. Externally of each sub-zone and below the level of the conveyor 11 centrifugal fans 24, 25, 26 and 27 driven by electric motors 28, 29, 30 and 31 are mounted. Air is drawn from the top of each sub-zone through apertures 32 (Fig. 4) into ducts 33 and 33*a* extending above the

top wall 7 and downwardly outside the side wall 10 to the respective one of the fans. The fans 24, 25 and 26 are arranged to recirculate air only but the fan 27 has an inlet 33*c* normally closed by a weight controlled flap valve 33*d* communicating with the atmosphere externally of the zone 6. This air is then passed by each fan through a horizontal duct 34 extending through each sub-zone below the conveyor 12 and is discharged upwardly through apertures 35.

In the upper part of each sub-zone, a damper 36 is pivoted at its upper end 37 to the top wall 7. Intermediate their ends all the dampers are pivoted to a longitudinally movable blend control rod 38 operable in a manner, not shown, from outside the lehr.

It will be noted that the duct 33*a* associated with the sub-zone 18 at the discharge end of the zone 6 lies wholly inside the end of the zone. Similarly the duct 33*b*, which discharges to atmosphere, lies wholly within the sub-zone 15 at the input end of the zone. The remaining ducts 33 have their associated apertures 32 respectively in register with the transverse walls 19, 20 and 21.

By moving the rod 38 all the dampers 36 may be moved, together, from their full line positions, through dotted line positions 36*a* to chain line positions 36*b*. In the full line position of the dampers, the inlet duct 33*a*, at the discharge end of the zone 6 is shut off and hot, recirculated air from the sub-zones 18, 17 and 16 is respectively passed to the preceding sub-zones 17, 16 and 15 while recirculated air from the sub-zone 15 is exhausted via the duct 33*b*. Fresh air is drawn into the fan 27 and the duct 33 through the inlet 33*c* of sub-zone 18 when the suction therein opens the flap valve 33*d*. This condition represents the maximum rate of cooling where all the recirculated air is passed rearwardly through each sub-zone as rapidly as possible and is then exhausted to atmosphere.

In the chain line positions 36*b* of the dampers the outlet duct 33*b* is shut off and the air in each sub-zone is continuously recirculated within that sub-zone. This condition represents maximum recirculation and minimum cooling. The dotted line positions of the dampers 36 represent the large number of intermediate positions that the dampers may occupy to achieve variations in sub-zone recirculation and rate of cooling. It will be understood that although a single blend control rod 38 moving the dampers 36 in unison is preferred, the dampers could be controlled individually.

Fig. 5 of the drawings shows an arrangement for a decorating lehr 40 having a central part 41 made up of traditional zones and zones 42 and 43 respectively at the input and discharge ends of the lehr. These zones 42 and 43 are generally in accordance with Figs. 3 and 4 but the zone 42 is installed in reverse. Cold air is drawn from atmosphere at 44, passed through the sub-zones of the zone 43 which constitutes the rapid cooling part of the lehr and the very hot air passes through a duct 45 to the sub-zones of the zone 42. In this case the ware passing through the zone 42 is heated. Spent air carrying volatiles from the decoration process is exhausted to atmosphere at 46. Although the duct 45 has been shown to be external of the central part 41 it could pass therethrough. Alternatively the hot air could be discharged into the central part and drawn from the other end thereof into the zone 42.

In all the arrangements above described it will be understood that a small quantity of recirculated air will diffuse horizontally above the conveyor and the passage through which the ware 12 passes.

CLAIMS

1. A furnace through which articles may be continuously or intermittently passed from an inlet end to a discharge end, the furnace having at least one zone provided with air recirculation and divided into a plurality of sub-zones each provided with separate means for circulating air within that sub-zone transversely of the direction of movement of articles therethrough and each sub-zone incorporating at least one flow control device movable to permit air from that sub-zone to pass to an adjoining sub-zone. Preferably the device is movable from a first position in which recirculation occurs only in the sub-zone to a second position in which the air circulated over articles in the sub-zone is passed to an adjoining sub-zone, a variety of intermediate positions of the device permitting different proportions of the air in each sub-zone to be recirculated therein or passed to an adjoining sub-zone.

2. A furnace substantially as herein described with reference to Figs. 3 and 4 or Fig. 5 of the accompanying drawings.

Printed in the United Kingdom for
Her Majesty's Stationery Office. Dd 8818935, 1985, 4235.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.