

[54] **SHRINK TUNNEL**

[75] Inventor: **Herbert K. Carver, Jr.,** Oakford, Pa.

[73] Assignee: **J. B. Dove Inc.,** Levittown, Pa.

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[51] Int. Cl. **F26b 3/00**

[58] Field of Search **34/31, 33, 34, 223; 219/388; 98/36**

[56] **References Cited**

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Primary Examiner—**Carroll B. Dority, Jr.**

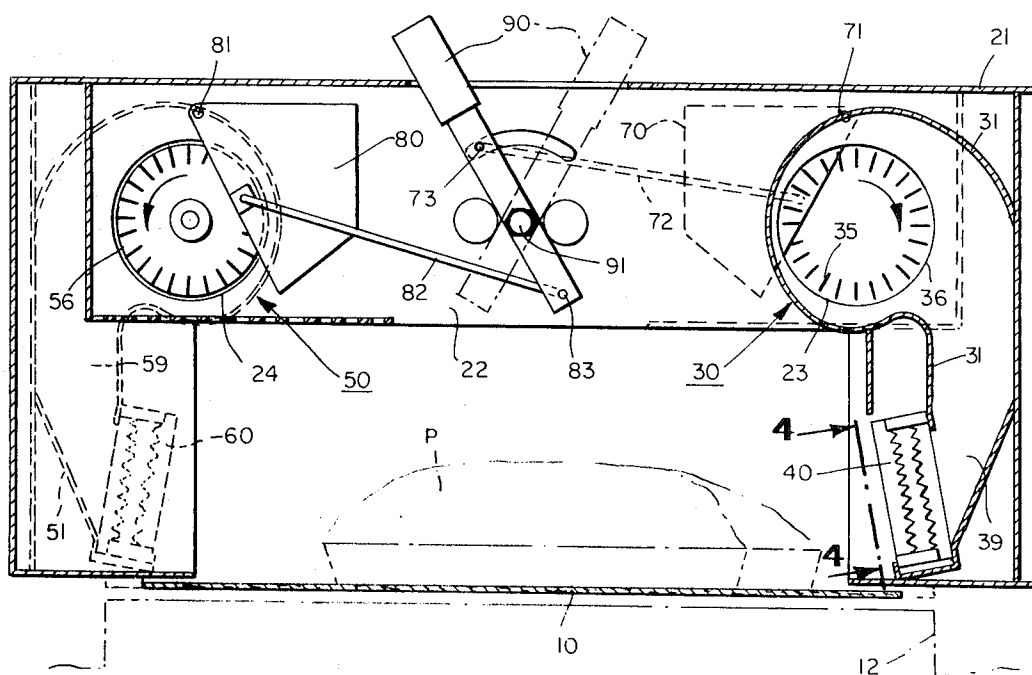
Attorney—**Paul & Paul**

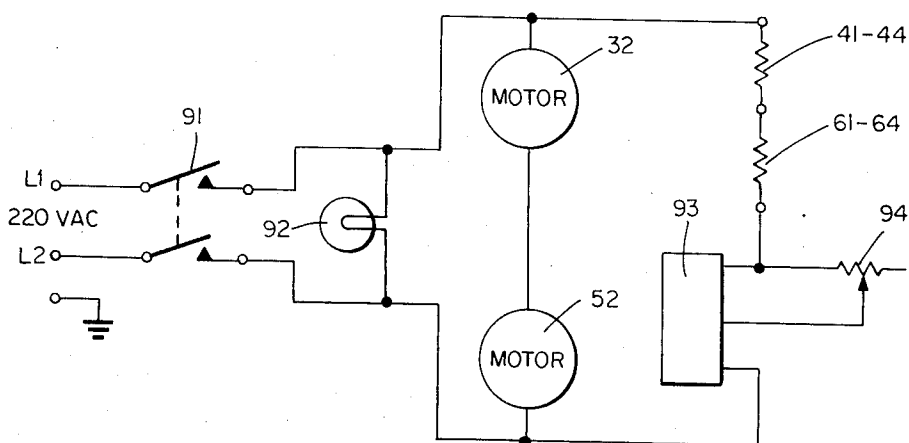
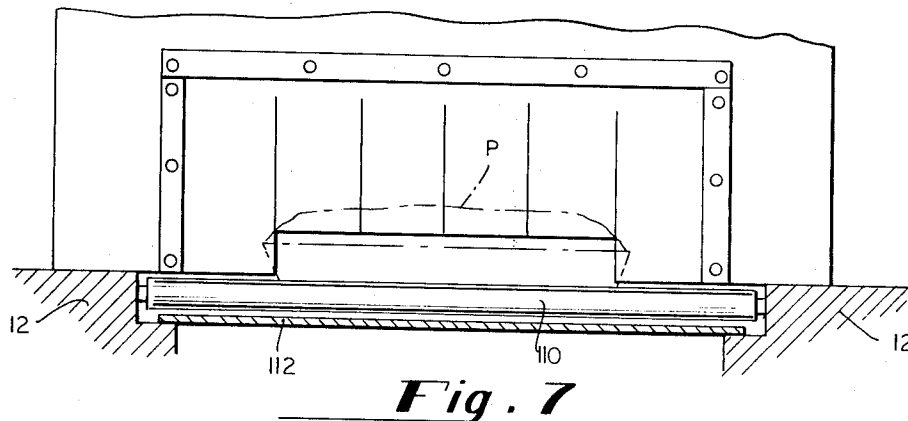
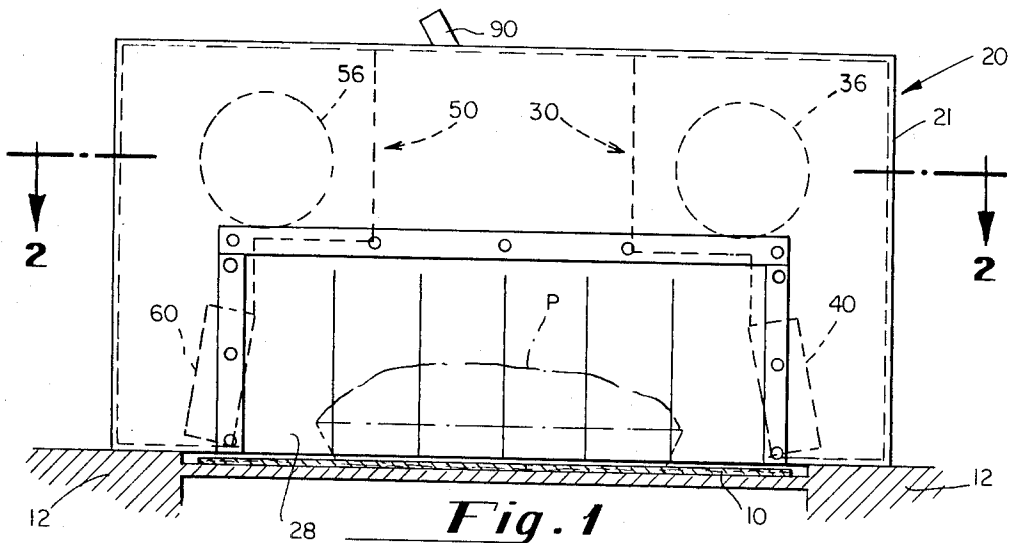
[57] **ABSTRACT**

A shrink tunnel, for shrinking plastic wrapping film

about a package as it moves along on a conveyor, has two blower-heater units within its housing, one at each side of the conveyor. The blower-heater units are so constructed and so positioned that each delivers narrow vertical laminar streams of heated air diagonally and slightly downwardly across the shrink zone in the tunnel and across any package which is passing therethrough on the conveyor. The heated streams of air projected from the two blower-heater units flow in opposite directions, with the streams of air of one blower-heater being located in vertical planes which are parallel and laterally adjacent to the vertical planes of the streams of air of the other. The heated streams of air projected from each blower-heater are sucked into an intake duct of the other, are re-heated, and projected back through the shrink zone and across the package which may be passing therethrough. Heated air is thus caused to flow back and forth and in so doing impinges directly upon all sides and upper surfaces of any film-wrapped package which may be passing through the tunnel. The velocity at which the heated air moves is not high, and as the air moves across the shrink zone from the heater of one blower to the intake duct of the other, the air which impinges upon the package tends to follow the contour of the package as it is pulled on and into the intake duct of the other blower.

15 Claims, 8 Drawing Figures

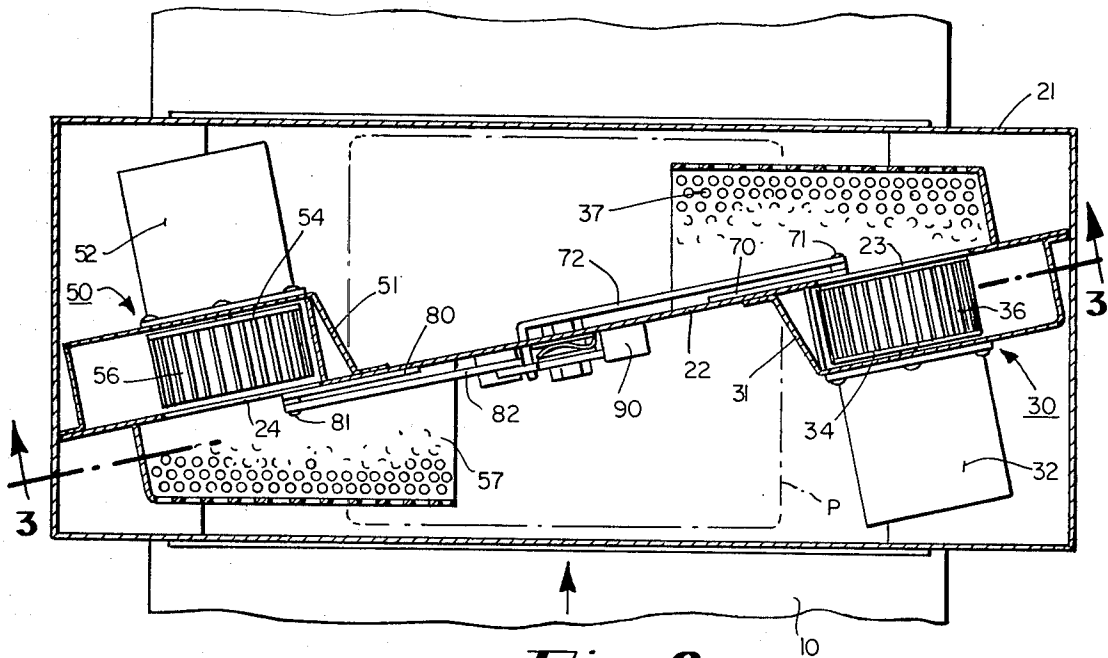




INVENTOR.
Herbert K. Carver, Jr.

BY

Paul + Paul
ATTORNEYS.



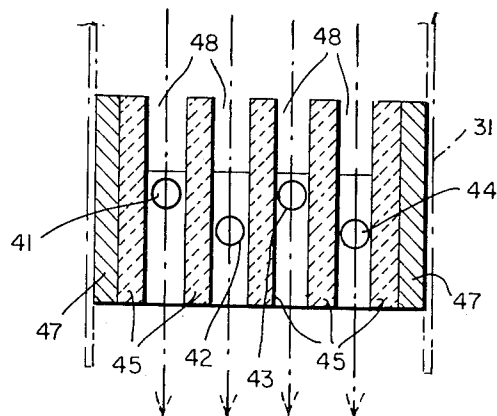
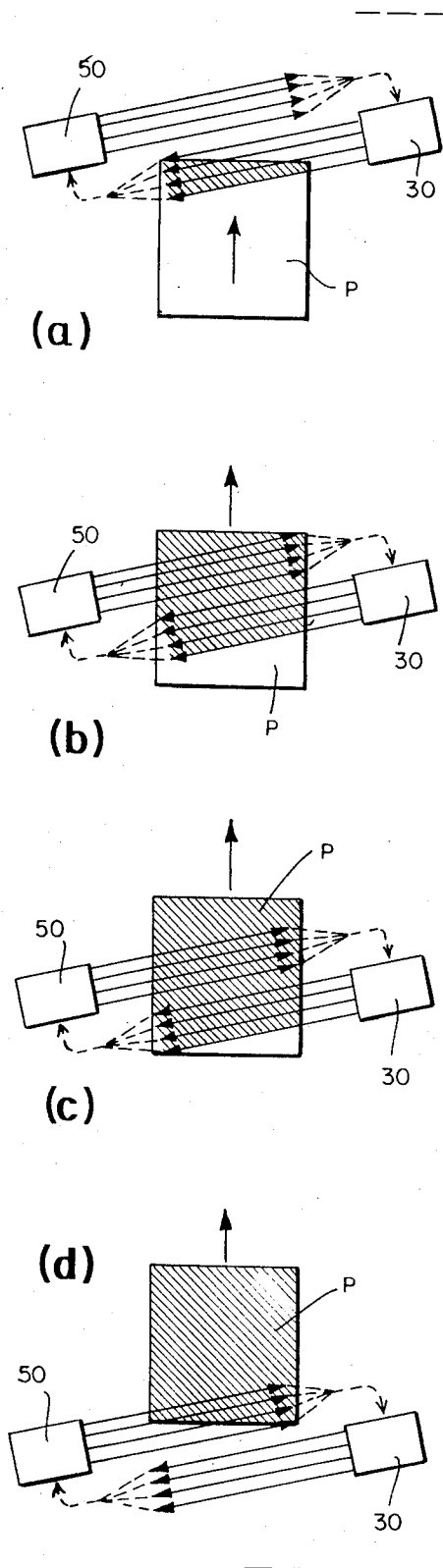


Fig. 5.

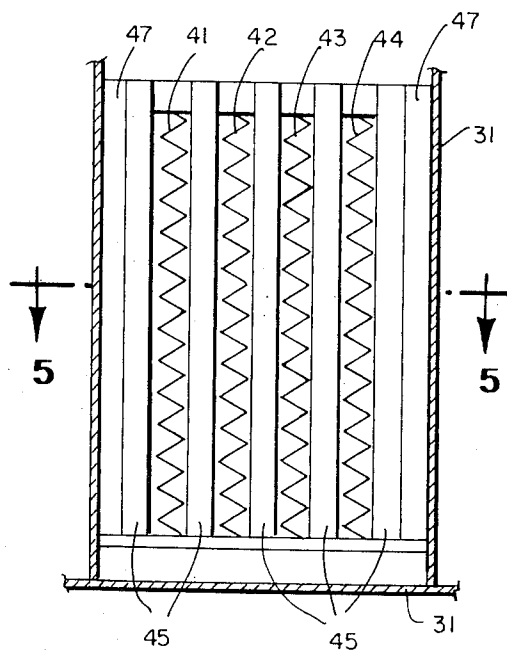


Fig. 4

Fig. 6

INVENTOR.
Herbert K. Carver, Jr.
BY
Paul + Paul
ATTORNEYS.

SHRINK TUNNEL

BACKGROUND OF THE INVENTION

The present invention relates to package wrapping and particularly to apparatus and method for shrinking heat-shrinkable thermoplastic film about the contents of a package. More particularly, the invention relates to an improved shrink tunnel, and its method of operation.

Shrink tunnels are well known in the prior art and numerous patents have been granted relating thereto. Such shrink tunnels are usually mounted over or in close relation to a conveyor on which are carried the film-wrapped packages which are to be heat shrunk. As the conveyor carries the film-wrapped package through the tunnel, hot air generated by the tunnel apparatus comes into contact with the thermoplastic film and causes the film to shrink about the package and its contents. Many prior art shrink tunnels operate as ovens, i.e., the package merely moves into and out of a heated zone without direct impingement of heated air streams on the package. In such shrink tunnels, heated air escapes from the tunnel each time a package moves into and out of the tunnel through the entrance and exit curtains.

SUMMARY OF THE INVENTION

A principal object of the present invention is to provide a more efficient apparatus and method for shrinking heat-shrinkable thermoplastic film about a package as it passes along on a conveyor.

Another object is to provide an improved form of shrink tunnel which operates more efficiently, requires less power, and is more economical to operate.

Another object is to provide a more efficient shrink tunnel which is of short length so that the tunnel radiates less heat, particularly into a cool or refrigerated area, thereby providing efficiencies not only with respect to the operation of the tunnel but also with respect to the operation of the refrigeration system.

Another object is to provide an efficient tunnel having a shrink zone of short length, whereby the contents of the package do not become hot.

The foregoing objects are achieved, in accordance with the present invention, by providing a short shrink tunnel having a shrink zone in which laminar streams of heated air, generated within the tunnel, are caused to flow back and forth across the moving package in adjacent air paths, with little or no air escaping from the tunnel.

More specifically, the new shrink tunnel has a blower-heater unit on each side of the conveyor path. The units are so constructed and so positioned that narrow vertical streams of laminar heated air are directed diagonally, slightly downwardly, and in opposite directions across the shrink zone in the tunnel through which the packages are passing. The opposing streams of air are spaced laterally from each other, with the air stream propelled at relatively low velocity from one blower being sucked into the intake duct and orifice of the other blower.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view of a shrink tunnel according to the present invention;

FIG. 2 is a top view, in section, looking down along the line 2—2 of FIG. 1;

FIG. 3 is an elevational view, in section, looking along the line 3—3 of FIG. 2;

FIG. 4 is an enlarged view of one of the heaters, looking along the line 4—4 of FIG. 3;

FIG. 5 is a top view, in section, of the heater of FIG. 4 looking down along the line 5—5 of FIG. 4;

FIG. 6 are a series of sequential diagrams to illustrate how the diagonally directed narrow vertical streams of heated air impinge upon all sides and upper surfaces of a flat rectangular package as it passes through the shrink tunnel;

FIG. 7 illustrates a slight modification of the apparatus of FIGS. 1—6;

FIG. 8 is a wiring diagram of a presently preferred electrical circuit for controlling the temperature of the heated air.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 is a view of the front end of a shrink tunnel 20 constructed in accordance with the present invention. In FIG. 1, a film wrapped package P, shown in phantom, is within the tunnel 20 having passed through the split curtain 28 at the front or input end of the tunnel. The package P is being carried along on a conveyor belt 10 which is supported on the conveyor frame 12. Shrink tunnel 20 includes a main housing 21 which is supported by suitable means on the frame 12 astride the conveyor belt 10. In accordance with the present invention, shrink tunnel 20 is provided with two blower-heater units, 30 and 50, one at each side of the housing 21, one on each side of the path of the conveyor 10.

Before describing the structure of shrink tunnel 20 of the present invention, it will be helpful to describe the novel air flow, and for this purpose reference will now be made to FIG. 6 which consists of four diagrams identified as (a) to (d). In FIG. 6(a), a package P, travelling in the direction indicated by the arrow, has just entered into the shrink zone in the tunnel 20 and low velocity streams of heated air from blower-heater 30 have impinged upon the front edge and front portion of the package. In FIGS. 6(b) and 6(c), the package P is progressing more deeply into the shrink zone, and its left portion is being impinged upon by streams of heated air from blower-heater 50, while heated air streams from blower-heater 30 are impinging upon the right portion of the package. In FIG. 6(d), the package P has progressed beyond the air streams from blower-heater 30, and the rear edge and rear portion of the package is now being impinged upon by heated air streams from blower-heater 50.

In FIGS. 6(a) through 6(d), the four solid arrow-headed lines from each of the blower-heater units represent four narrow vertical laminar streams of heated air emanating from the blower-heater units 30 and 50, while the dashed lines represent the streams of air from one blower being sucked into the orifice of the other through the intake duct thereof. It will be observed that the streams of air from the blowers are directed diagonally across the path of the moving package.

In FIG. 6(a) through 6(d), the area of package P which is shown shaded is the area which has been imp-

inged upon by the heated air streams from one or the other or both of the blower-heater units 30 and 50. The package P, in FIGS. 6(a) through 6(d), has been assumed to be flat, as, for example, a package containing a tray having two lamb chops therein. In such case, the air streams may sweep across the flat package as indicated. However, when the package P is not flat, as, for example, when it is peaked, or crowned, or contains an irregular body of some heights, such as a chicken, the air streams from each of the blowers will follow the contour of the package and will be sucked into the input duct on the opposite side of the tunnel.

It will be seen from FIG. 6, and from the foregoing description that the entire surface (except only the bottom which is resting on the conveyor belt) is impinged upon and shrunk by direct streams of heated air as the package passes through the relative narrow shrink zone in the tunnel.

Reference is now made to FIGS. 2 and 3 for an understanding of the structural features of the improved shrink tunnel of the present invention. As seen in FIG. 2, mounted diagonally within the main housing 21 of shrink tunnel 20 is a partition plate 22 which, as seen in FIG. 3, extends downwardly from the top of the housing about half way toward the base, leaving therebeneath an opening of sufficient height and size for the packages P to pass through. Supported on partition plate 22, at each end thereof, and on opposite sides of the plate 22, are sub-housings 31 and 51, respectively, for the blower-heaters 30 and 50, respectively. The two blower-heaters, 30 and 50, one at each side of the tunnel housing 21, are similar to each other, and it will be necessary to describe but one of them in detail. Blower-heater 30 will be described.

Supported externally on sub-housing 31 is a drive motor 32 having a drive shaft 33 which projects through the wall of sub-housing 31 and into the interior thereof. Mounted for rotation on drive shaft 33 within sub-housing 31 is a support or backing plate 34 on which are mounted in radial fashion the fan blades 35 of the blower 36 of the blower-heater unit 30. A circular opening 23 is provided in partition plate 22 in registry with the orifice of blower 36. Heat insulating material, not shown, separates the body of motor 32 from the blower sub-housing 31.

The sub-housing 31 of the blower 30 is so shaped, as seen in FIG. 3, to form a short duct portion 39 which curves downwardly to a discharge or exit in which is mounted a heater unit 40. The heater unit 40 is in the same vertical plane as the blower 36, i.e., the heater unit 40 is directly below the blower 36, both being on the same side of the vertical plane of partition 22. As will be explained, heater 40 is so constructed, in accordance with the present invention, that it not only heats the air immediately before the air enters the shrink zone, it also functions as a nozzle which converges the air from blower 36 into a plurality of narrow vertical laminar streams which are projected into and through the shrink zone.

The construction of heater unit 40 is illustrated in FIGS. 4 and 5 of the drawing. As there shown, heater unit 40 consists of four heater elements 41, 42, 43 and 44, preferably helical coils with large surface areas for greater heat transfer and lower watt density, yet the turns of the coils are spaced far enough apart to pro-

vide low resistance to the air stream. The heater coils 41-44 may be connected either in series or in parallel. The coils are physically disposed vertically and in staggered relation, as seen in FIGS. 4 and 5. Separators 45, preferably of electrical insulation refractory material, are disposed between the heater elements and also on the outward sides thereof, forming therebetween four narrow vertical passages 48 through which the air passes. It is in these passages 48 that the four heater elements 41-44 are vertically disposed. Material similar to that of the separators 45 provides a base which is supported in a metal frame 47 secured to the housing 31 at the discharge or nozzle end thereof.

Referring again to FIG. 2, supported on the diagonal partition plate 22 on the rear or opposite side from blower-heater unit 30 is an input duct 37 the bottom and sides of which may be perforated for allowing passage of air therethrough while excluding from the intake of the blower any foreign particles of a size which may possibly cause damage.

The blower-heater 50 on the left side of the shrink tunnel housing 21 is identical, or at least similar, in construction to that just described with respect to blower-heater 30, and corresponding parts will be easily recognized in the drawing.

While the shrink tunnel 20 is in operation, air is sucked in through the input duct 37 which is on the rear side of partition 22, then through the circular opening 23 in the partition plate 22, and into the orifice of blower 36 on the front side of partition plate 22. This air is then driven by the rotating fan blades 35 down through duct 39 and out through the heater 40, i.e., through the four slots or passages 48 in which the heater coils 41, 42, 43 and 44 are vertically disposed. As a result, four narrow vertical laminar streams of heated air are projected at low velocity, in a diagonal and slightly downward direction due to the position of heater 40, across the conveyor belt 10, from right to left, on the front side of partition plate 22 and across any package P which may at that time be moving along on the belt within the shrink tunnel. This air impinges upon and flow along the near sides and surfaces of the film-wrapped package and is drawn in through the input duct 57 of blower 56. The air thus drawn in passes through the opening 24 in partition plate 22 and into the orifice of blower 56 on the rear side of partition plate 22. This air is then projected by blower 56 down through the duct 59, out through the heater unit 60 and across the conveyor belt 10 from left to right and impinges upon the near sides and surfaces of the package P on the belt within the shrink zone. In FIG. 2, the package P is moving in the direction indicated by the arrow. Thus, FIG. 2 and the diagrams of FIG. 6 correspond so far as orientation is concerned.

To summarize, the air in FIGS. 2 and 3 is sucked into the input duct 37 on the rear side of partition plate 22 and through the circular opening 23 in partition plate 22 into the orifice of blower 36. The air is then propelled by blower 36 down through duct 39, out through the four slots 48 in heater 40 and across the conveyor 10 and across any package P which may be thereon at that time. This air is then sucked into the input duct 57 on the front side of partition plate 22, through the circular opening 24 in partition plate 22 and into the orifice of blower 56 on the rear side of par-

tition plate 22. This air is then propelled down through duct 59 and out through the four slots in heater 60, across the conveyor 10 and across the package P and is sucked back into input duct 37, to complete the cycle. It will be understood that in the foregoing summary the statement that the air flows "across the package" is an abbreviated way of say that the air in crossing the conveyor impinges upon the near side and top surfaces of any package P that may be passing through the shrink zone. This air follows the contour of the package surfaces and is drawn into the input ducts and orifice of the other blower.

It will be seen that the air flow in the tunnel is back and forth, with one stream flowing in one direction and the other stream flowing in the opposite direction, with the two streams separated laterally by a buffer zone and not interfering with each other. The streams of air are projected by the blowers through the heaters at relatively low velocity, just enough velocity to carry across and be picked up by suction and drawn into the input duct and orifice of the other blower. The principal function of curtains 28 and 29 is to obstruct environmental air from being sucked into the tunnel, rather than to prevent heated air from escaping.

Several different means may be provided for adjusting the quantity of heat applied to the package P. One such means is illustrated in FIGS. 2 and 3. Another and preferred means of adjustment will be described later. Or, a combination of both may be used.

In FIGS. 2 and 3, cover plates 70 and 80 are shown for adjustably covering the openings 23 and 24 leading to the orifices of blowers 36 and 56, respectively. Cover plates 70 and 80 are shown to be pivotally supported at 71 and 81, respectively, on partition plate 22, cover plate 70 being on the rear side and cover plate 80 on the front side of partition plate 22. The cover plates 70 and 80 are connected, by links 72 and 82 and pins 73 and 83 to a common adjustment lever 90 which is pivotally mounted on stub shaft 91 and movable between a "low" limit position shown in solid line, and a "high" limit position shown in phantom.

The apparatus shown in FIGS. 2 and 3 and now being described may preferably be so designed that (1) with the lever 90 in the "high" position, which reduces the openings into the orifices of the blowers 36 and 56, and with highest voltage applied to the heater elements of heaters 40 and 60, the air intake to the blowers will be sufficient to allow the heaters to operate without glowing while yet heating the air to the highest level desired, and (2) with the lever 90 in the "low" position which increases the openings into the orifices of the blowers, and with lowest voltage applied, the air is heated to the lowest level desired. It will be understood that adjustment of the lever 90 to the "high" position, by decreasing the area of blower intake, decreases decreases the volume of air per unit of time passing through the heater, thereby increasing the amount of heat imparted to such volume of air during a given time interval.

While the adjustment means just described is one way of adjusting the heat, the presently preferred method is illustrated in FIG. 8. In the circuit of FIG. 8, when the ON-OFF switch 91 is closed, the blower motors 32 and 52 are connected across the power line L1-L2, and so is pilot light 92. In FIG. 8, the four heater coils 41-44 are represented by a single re-

sistance element identified as 41-44, and similarly, the other four heater coils 61-64 are represented by a second single resistance element identified as 61-64. These two resistance elements, representing the two sets of heater coils 41-44 and 61-64 are connected across the line L1-L2 in series with a Triac power control module 93. A control rheostat 94 controls the angle at which the Triac is triggered to start conducting on each half cycle of the input supply voltage. Thus, the power output of the heater elements is infinitely variable from zero wattage to maximum wattage. The power output is essentially constant in relation to time. The heater elements conduct a portion of each half cycle of the input supply voltage and produce an average power output.

In some cases, it may be desirable to be able to control both the wattage output of the heater element and the velocity of the heated air. In such cases, both the electrical adjustment of FIG. 8 and the mechanical adjustment of FIG. 3, may be employed.

FIG. 7 represents slight modifications with respect to the shrink tunnel 20 and conveyor. In the description of the shrink tunnel of FIGS. 1-6, the conveyor belt 10 has been assumed to be impervious to air. Thus, in FIGS. 1-6, the conveyor belt itself prevents loss of air downwardly, and the only air that is lost during operation is that which is due to the opening of the front and rear curtains 28 and 29 when the packages P pass through. In some instances, the conveyor may not be an air impervious belt, but may, for example, be a mesh, or a roller type of conveyor. A roller conveyor 110 is illustrated in FIG. 7. In such case, a deflector plate 112 may be mounted in frame 12 below the roller conveyor under the shrink tunnel to deflect air back into the housing of the shrink tunnel. In such case, heated air will impinge upon and shrink the film on the bottom of the package.

A second modification which is illustrated in FIG. 7 concerns the length of the split curtains. In FIGS. 1-6, the curtains 28 and 29 are assumed to be full length, as shown in FIG. 1. In some installations, because of the short length of the tunnel, the curtains may be shortened to allow high packages to pass through the shrink zone without having the curtains draped across the top of the package.

Due to the high efficiency of the new tunnel apparatus described herein, considerably less power is required. A high percentage of air is re-circulated and only a small percentage is lost. This results from the blow-out-and-suck-in feature, and to the recasting of the air back and forth in laminar fashion across the path of the package. In optimum operation, the air does not move any faster than is necessary to maintain the laminar characteristics. The slower the movement of the laminar air, the better the heating. In the tunnel device of the present application, the tunnel may be only 10 inches long; the shrink zone even shorter. Thus, the exposure time of the package to the high temperature is short. The contents of the package do not get hot, but a sufficient number of heated molecules impinge upon the film within the short period of time to impart sufficient heat to the film to accomplish satisfactory shrinking.

As indicated previously herein, the fact that the new tunnel has lower heat losses to the environmental at-

mosphere, due to less heated air escaping through the curtains and to less heat radiation from the tunnel housing, contributes not only to a more efficient shrink tunnel, but also, in those cases where the shrink tunnel is operating in an air conditioned or refrigerated atmosphere, to a more efficient refrigeration system.

Also, as previously indicated, the method of operating tee shrink tunnel involves moving the air through the narrow passages of the heaters at a relatively low velocity, just enough to cause the air streams to reach the suction of the intake on the opposite side. The slow moving air retains its laminar characteristics, and follows the contour of the package on its way to the intake duct. A further desirable effect is that the large surface heater elements are in longer contact with the slow moving air and are able to heat more molecules of air. Thus, the heater elements may be operated at lower temperature and yet provide sufficient heated air to shrink the film, while the contents of the package do not get hot. A further advantage is that, in comparison with prior art oven-type shrink tunnels which are ordinarily thermostatically controlled, and which have an ON-OFF temperature range which requires time to attain, the temperature of the heated air of the shrink tunnel of the present invention responds very quickly to the adjustment controls. This quick response is particularly advantageous, for example, where the operator is changing from one type of packaged item to another which requires more (or less) heat, as there is little or no delay waiting for the new temperature.

What is claimed is:

1. A shrink tunnel for shrinking heat-shrinkable film about a package which is passing therethrough, said shrink tunnel comprising:

- a. a housing;
- b. a first blower-heater unit mounted within said housing at one side of the path of movement of said package;
- c. a second blower-heater unit mounted within said housing at the other side of said path;
- d. each of said first and second blower-heater units including a blower, an intake duct for the blower, a motor drive for the blower, a heater, and a duct leading from the blower to the heater;
- e. said heater being constructed to function as a discharge nozzle and positioned to direct heated air diagonally laterally across the path of movement of said package;
- f. said heaters being so positioned and oriented relative to each other that the heated air discharged from one of said heaters flows in a plane which is laterally adjacent the plane of the heated air discharged from other of said heaters;
- g. each of said blowers having its intake duct located directly opposite and in the plane of the direction of air flow from the other of said blowers;
- h. said input ducts of said blowers being so positioned and oriented relative to said heaters that heated air discharged from the heater of each one of said blower-heater units is sucked into the intake duct of the other.

2. Apparatus according to claim 1 characterized in that each of the heater units of said first and second blower-heater units comprises:

- a. a plurality of heater elements vertically disposed and laterally spaced from each other;

- b. partition elements between said heater elements and forming a plurality of narrow vertical passages through which the air is discharged in narrow vertical streams.

3. Apparatus according to claim 2 characterized in that:

- a. said housing is provided with a mounting plate diagonally positioned relative to the axis of said housing;
- b. said blower-heater units are mounted on said plate, one at each end thereof;
- c. the blowers of said respective units being mounted on opposite sides of said plate;
- d. the intake ducts of said respective blowers being mounted on opposite sides of said plate;
- e. the intake duct of each blower being mounted on the opposite side of said plate from the blower;
- f. said plate being provided with openings providing communication between the input duct and the blower.

4. Apparatus according to claim 3 characterized in that adjustment means are provided for adjusting the temperature of the heated air discharged from said heaters.

5. Apparatus according to claim 2 characterized in that said heaters are so positioned that said narrow vertical streams of air are discharged from said heater passages diagonally and slightly downward relative to the path of movement of said package.

6. Apparatus according to claim 2 characterized in that said heater elements are helical coils.

7. Apparatus according to claim 2 characterized in that said heater elements are connected electrically in series.

8. Apparatus according to claim 4 characterized in that said adjustment means includes mechanical means for varying the velocity of the air moving across the heater elements.

9. Apparatus according to claim 4 characterized in that said adjustment means includes electronic means for varying the effective voltage applied to said heaters.

10. Apparatus according to claim 3 characterized in that:

- a. each of said heaters is positioned below its associated blower, both being in the same vertical plane, and
- b. the input duct of the one blower is in the same diagonal vertical plane as the blower and heater of the other unit.

11. Apparatus according to claim 4 characterized in that said adjustment means comprises:

- a. mechanical means for varying the velocity of the air moving across the heater elements; and
- b. electronic means for varying the effective voltage applied to said heaters.

12. The method of shrinking heat-shrinkable plastic film about a package as it moves along a path, said method comprising:

- a. projecting streams of heated air in laterally adjacent paths in opposite directions diagonally across the path of said package;
- b. creating a suction in planes common to the paths of each of the projected streams;
- c. sucking each of said streams toward the side of the package path opposite that from which said stream was projected, and

d. re-projecting said sucked-in air back across the package path in an air path laterally adjacent to its first-named path.

13. The method according to claim 12 characterized in that the heated air stream is projected at a low velocity but sufficient to enable the air stream to reach a point at which it is drawn by suction toward the opposite side of the package path, whereby when the heated air stream impinges upon a package the air stream tends to follow the contour of the package.

14. The method according to claim 12 characterized in that the air stream is heated immediately before it is projected across the package path.

15. The method according to claim 14 characterized in that the heated air streams are narrow vertical streams and that the moving package is exposed to the heated air for but a short time insufficient to cause the contents of the package to become hot.

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