

[54] APPARATUS FOR HEAT-SHRINKING A PLASTIC FILM ON A LOAD

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53/30, 53/184, 206/46 FR, 219/354

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219/388, 405; 53/27, 30, 184; 34/31, 33, 225;  
156/351; 206/46 FR

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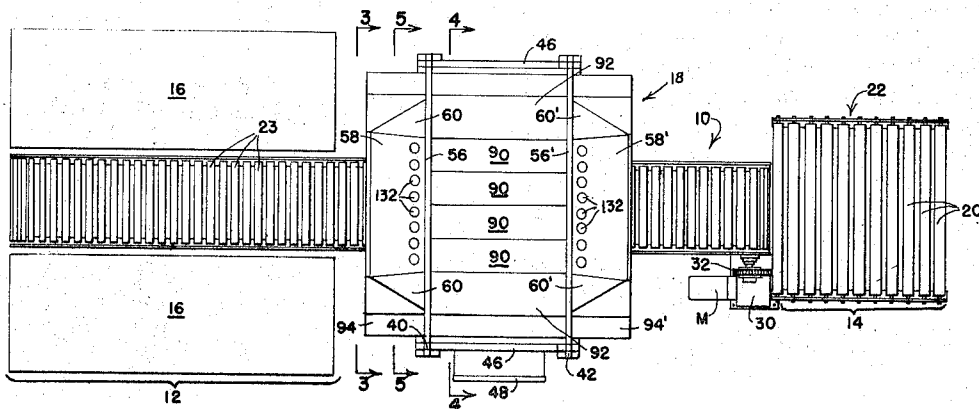
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[57] **ABSTRACT**

A method and apparatus for applying a protective covering to a load by pulling the open end of a heat-shrinkable inverted film bag downwardly over the load until the lower rim of the bag appreciably overhangs the lower end of the load, initially directing infrared radiant heat on the overhanging rim region of the bag to rapidly shrink the same beneath the load, subsequently directing additional infrared heat inwardly through the sides and closed top of the bag and against the load to establish surface heating of the load and consequent outward reflection of infrared heat through the sides and top of the bag to enhance and rapidify shrinking thereof with a consequent pulling of the underlying pre-shrunk rim region of the bag upwardly to thus establish a seal between such rim region and the bottom of the load and inhibit escape of heated air from the bag, such shrinking of the sides of the bag serving to place the thus covered load under both horizontal and vertical compression.

### 5 Claims, 11 Drawing Figures



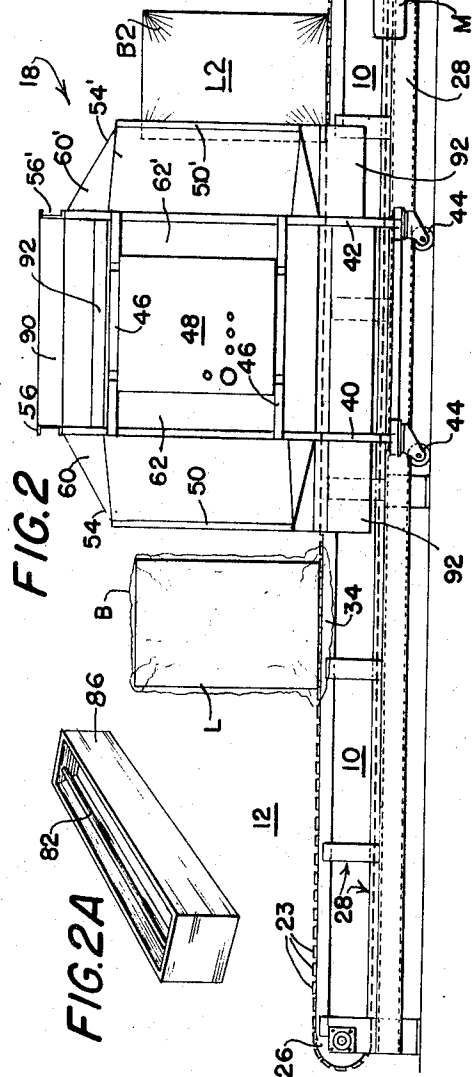
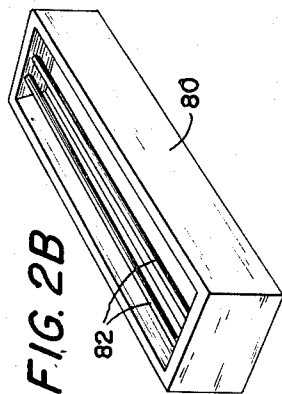
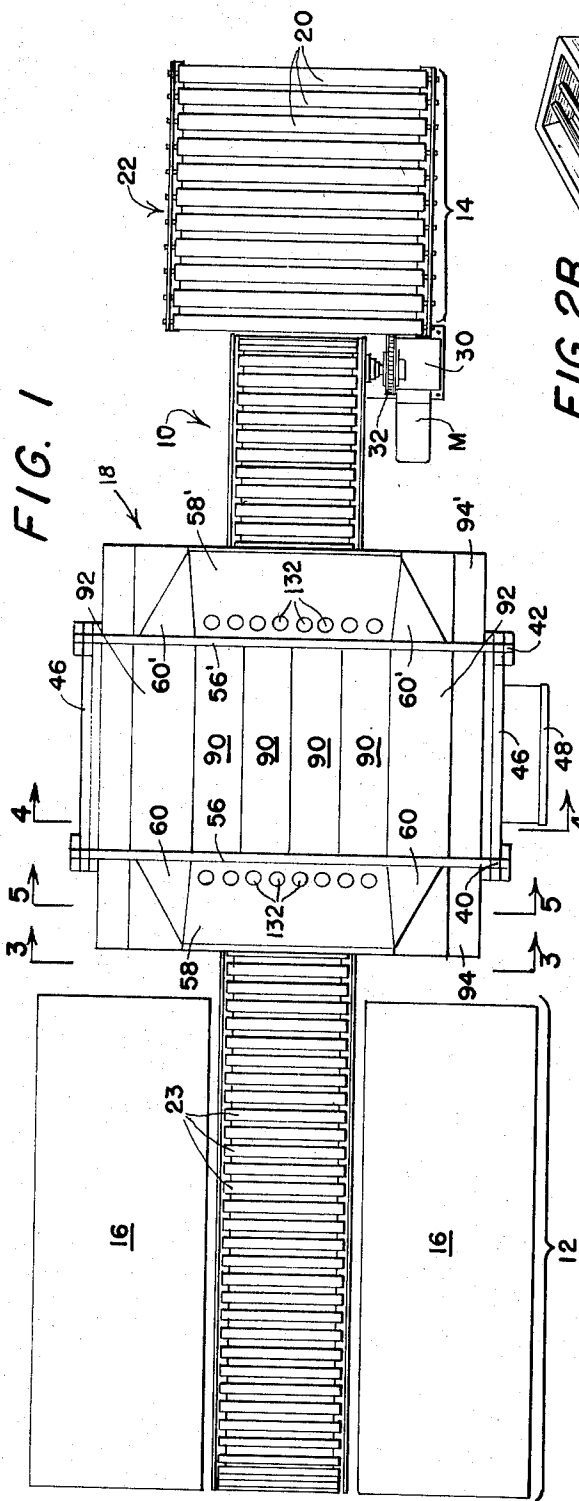


**FIG. 3**

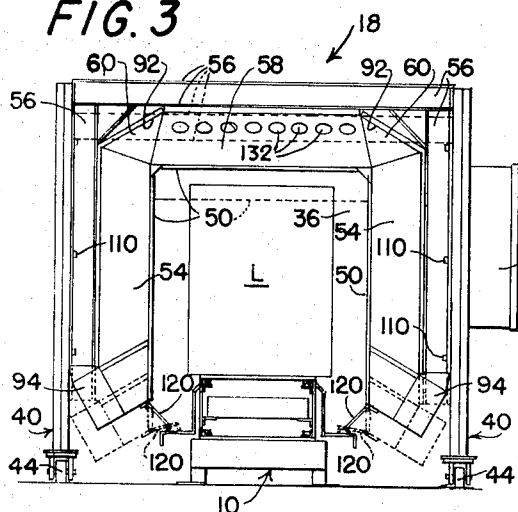


**FIG. 4**

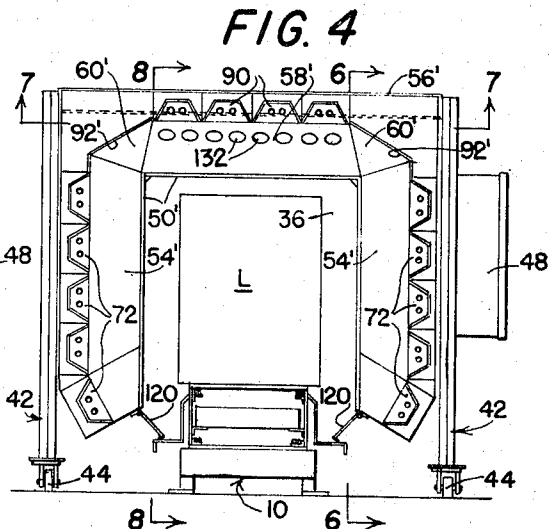


**FIG. 5**

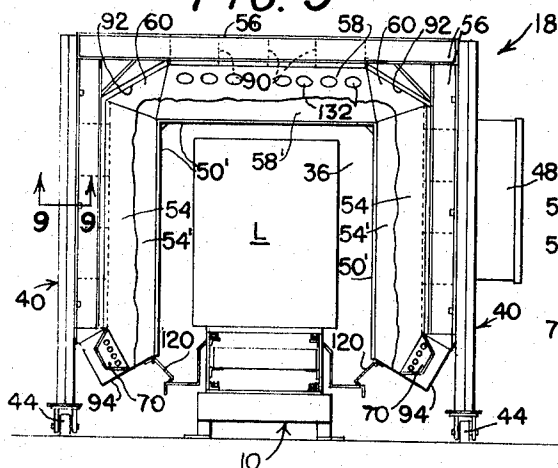


FIG. 6

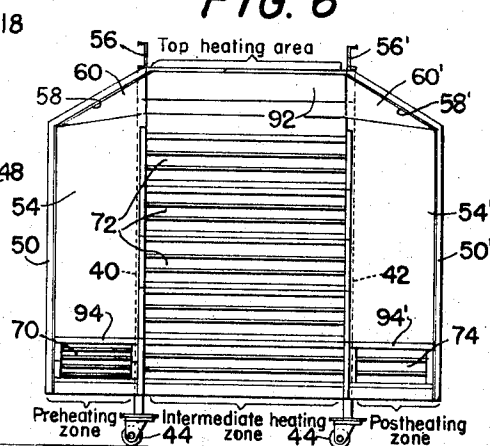


**FIG. 7**

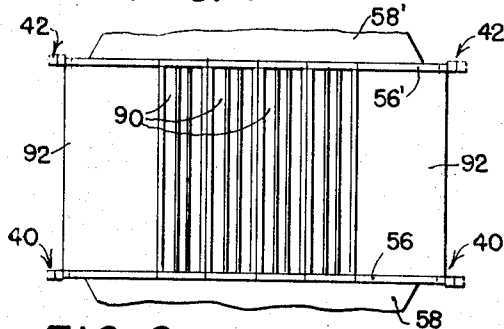


**FIG. 8**

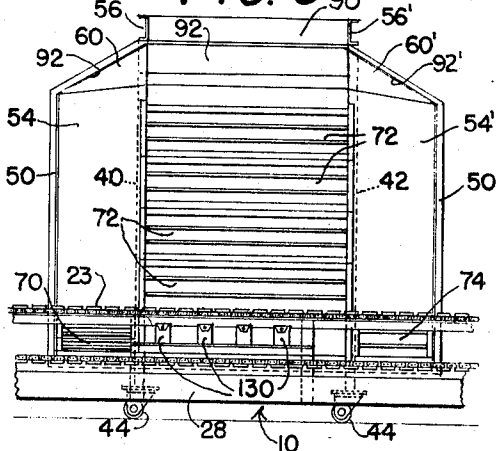
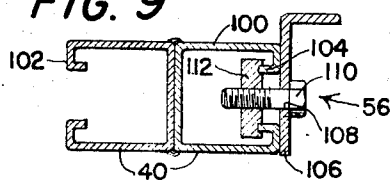


**FIG. 9**



## APPARATUS FOR HEAT-SHRINKING A PLASTIC FILM ON A LOAD

The present invention relates to a method of and apparatus for effectively covering a load with a heat shrinkable film such as a polyethylene film or the like.

In the commercial shipping and storing of a wide variety of products, it has been found advantageous to cover such loads to protect the same against dust or moisture to prevent pilferage and to stabilize the loads against relative movement of the component parts of the loads. Heat shrinkable films, as for example films which are comprised of homopolymers or copolymers of ethylene or propylene readily lend themselves to such covering of loads and are therefore widely used for this purpose. Various materials which can be formed into a film that is capable of shrinking when heated may be used. In the manufacture of these films, they are prestretched so that they subsequently become shrunk when heated and cooled. Heat-shrinkable films of this nature are impervious to moisture and frequently they are transparent so that the covered articles may be identified. When the load is to be disassembled, the film covering may readily be cut with a knife or shears and stripped from the load.

One widely used method of covering a load with a heat-shrinkable film employs a bagging operation wherein the load is caused to be enclosed in an open bag which is pulled downwardly over the load until the lower open rim of the bag overhangs the lower end of the load, after which the thus bagged load is placed upon a conveyor and transported through a shrink tunnel which is established by an arched oven structure having facilities for hot air circulation therein. The entrance and exit openings of the shrink tunnel usually are provided with heat-retaining doors and the load which enters the tunnel undergoes a dwell period within the tunnel during which uniform heating of the film bag takes place so that, upon subsequent cooling the desired shrinking of the film will take place.

Considering now the heat shrinking aspects of load-enclosing film bags and heating ovens of the type set forth above, the aforementioned overhang of the bag below the level of the load establishes a short apron or skirt which, during the shrinking operation, is drawn inwardly in centripetal fashion beneath the bottom of the load where it establishes a marginal intumed flange-like area which is drawn upwardly under the influence of the vertical shrinkage which takes place at the sides of the bag. In this manner both vertical and horizontal compression of the load is attained. Present day tunnel-forming heating ovens which distribute heat uniformly and simultaneously to all areas of the bag-like film covering on the load are possessed of certain limitations, principal among which is the inability of such ovens to insure adequate inward drawing of the overhanging apron or skirt beneath the load. In the case of rectangular loads which are greatly in predominance, usually only the corners of the load are encompassed by the apron. The reason for this is that commercial film bags are made to shrink multi-directionally and when uniform heat is applied thereto both vertical and horizontal shrinkage takes place simultaneously so that during the time that the overhanging apron is shrinking horizontally inwardly, it also is being drawn upwardly due to vertical shrinkage of the sides of the bag. Thus, when full film shrinkage has been effected, it is found that a major portion of the apron-like over-

hang has not been pulled beneath the load but rather it has been pulled upwardly along the sides of the load, leaving only a narrow under-the-load flange to perform the desired vertical compression of the load. More often than not, such an under-the-load flange is completely dissipated along the medial regions of the load edges so that only underlying corner flanges can be relied upon for vertical load compression.

The present invention is designed to overcome the above-noted limitation that is attendant upon conventional heat-shrink ovens where uniform film heating takes place and, toward this end, the invention contemplates the provision of a novel tunnel-forming heat shrink oven which, as a bag covered load passes through the tunnel, insures complete and initial inward drawing of the apron-like overhang beneath the load, after which the resultant and entire under-the-load flange is drawn upwardly to apply vertical compression to the load.

In carrying out the invention the heat shrink oven relies for its film-heating function upon the use of a series of conventional quartz tube heaters which are fixedly positioned at the sides of the heating tunnel and on the tunnel roof and are so disposed that they radiate infrared heat inwardly at selected power levels for the performance of predetermined localized heating functions. As the conveyor-supported load enters the heating tunnel, and before radiant heat is applied to the sides of the inverted bag film, intense radiant heat is applied to the depending overhanging apron or skirt in order to rapidly shrink the latter and cause the same to be drawn inwardly beneath the load to establish an intumed peripheral flange-like rim which underlies not only the corners but the side edges of the load. Thereafter, as the load moves further into the tunnel, radiant heat is directed against the sides of the bagged load. This radiant heat, especially in the case of transparent or nearly transparent film, readily passes through the sides of the film bag and effects rapid but transient surface heating of the load without raising the temperature thereof as a whole. The load then radiates such heat backwardly or outwardly through the sides of the film bag, thus imparting to the same a dual heating effect which rapidly shrinks such sides and causes the previously established intumed flange-like rim beneath the load to be drawn upwardly against the underneath side of the load in sealing relationship with respect thereto to place the load under vertical compression. During such radiant heating of the sides of the film bag, air within the inverted bag become heated and expands, thus creating internal pressure within the bag and causing "ballooning" thereof. Because the intumed flange-like rim closely hugs the underneath side of the load, the pressurized air within the film bag is slow to escape, its only avenue of escape being that which is presented by the small cracks or crevices which exist between the bottom of the load and the preshrunk intumed beneath-the-load flange, the air literally squeezing or forcing its way outwardly from these crevices. In this manner, although localized radiant heating of various areas of the film bag at different selected power levels may take place, as distinguished from the uniform overall heating of the bagged load which heretofore has been considered essential, the film becomes shrunk uniformly against the sides and top of the load as it settles into place under the influence of escaping air. By such a method and heating tunnel arrangement, rapid

and immediate hugging of the load by the bag is avoided so that any irregularities which may be present in the bag film prior to the application of heat thereto will not create counterpart folds or wrinkles in the heat shrunk film. The provision of a method and apparatus such as has briefly been outlined above constitutes the principal object of the present invention.

The tunnel-forming heat-shrink oven of the present invention is possessed of additional advantages which are not present in connection with conventional heating ovens designed for the same purpose. Heretofore such ovens have been specifically designed for use in connection with the packaging of successive loads which are substantially alike, both as regards their size and their contour. Ordinarily, fixed conveyor structures are installed on the floor of the packaging area and the ovens are constructed on or about the conveyor framework in fixed relationship. Thus, as each bagged load passes through the oven tunnel, the same positional relationship of the radiant heating units relative to the bag film takes place. However, if an attempt is made to package a load other than the one for which the oven is designed, for example a differently shaped load or a smaller load, an entirely different positional relationship obtains. This may result in undesirable localized heating of the bag film, some areas of the film being subjected to excessive heat and other areas not receiving adequate heat for shrinking purposes.

The tunnel-forming heat shrink oven of the present invention also overcomes this last mentioned limitation that is associated with heat-shrink ovens currently in use and, accordingly, there is provided an oven which is adjustable insofar as its effective height is concerned so that, within certain limits, loads of differing height may be accommodated. Unlike heating ovens which rely for their shrinking operation upon the circulation of heated air, ovens which employ radiant heating units must be designed with a fairly critical placement of such heating units. Not only is the heating time critical so that conveyor movements must be carefully regulated, but the positioning of the various radiant heating units is extremely critical inasmuch as the amount of heat which is assimilated by the plastic bag film is a factor which varies roughly according to the square of the distance between the heating elements and the bag film. Therefore, especially where stack height is concerned, any changes in this vertical dimension will affect a change in the amount of heat which is applied to certain localized regions of the bag film. According to the present invention, means are provided whereby the effective height of the oven tunnel may be varied relative to the floor, and consequently the load-carrying conveyor, so that when loads of varying height are treated, the heating units which direct radiant heat against the upper regions of the bagged load may be maintained at the same relative distance from the load so that either underheating or overheating will be avoided.

An additional advantage of the present invention resides in the portability of the oven, means being provided whereby the same is tractionally mounted on the floor of the bagging area whereby it may be rolled into and out of position above the conveyor which is fixedly positioned on such floor. Thus, this enables the oven to be readily withdrawn from the conveyor to an out-of-the-way position where it may conveniently be inspected and where such repairs as are necessary, for ex-

ample, heating unit substitution, may be performed without interference by the conveyor, or where repair or adjustment of the conveyor may be accomplished without interference by the oven.

According to the present method although radiant heating is, in the main, employed for bag film heating purposes, it is desirable that a high level of heat be maintained within the tunnel, especially in the lower region thereof where shirt skinking operations are carried out. Accordingly, although the opposite ends of the tunnel are open, both radiant heat and heat of convection are conserved by the provision of self-adjusting baffle and reflector shields which direct heat against the lower regions of the bag covered load regardless of the particular height for which the tunnel may be adjusted.

Finally, although the present tunnel-forming oven has been designed specifically for use in connection with the practicing of the above-described method which involves the rapid pre-shrinking of an overhanging skirt or apron beneath the lower edges of the load, means are provided whereby, if desired, the oven may be employed to accommodate the complete covering of a given load with heat-shrinkable film, including the coextensive application of such film to the underneath side of the load. Accordingly, a series of auxilliary infrared heating units are fixedly positioned within the confines of the conveyor immediately below the upper reach of the latter and are so disposed that they will direct radiant heat upwardly and against and through the film covering which underlies the load, back reflection of the radiant heat taking place in the manner previously described in connection with the passing of infrared rays through the vertical sides of the film covering. In such an instance the "ballooning" of the covering takes place as previously described and slow egress of the heated air within the covering takes place between the folds of the film. Ordinarily, where slight apron overhang is resorted to as previously described, these auxilliary heating units will not be energized but, in certain instances, as for example where the apron overhang is of appreciable extent, these auxilliary heating units may be employed, not only to give a terminal shrinking action to the indrawn flange beneath the load, but also to create a heat barrier which will inhibit escape of air through the crevices which exist between the returned heat shrunk film flange and the bottom of the load, thus prolonging the escape of entrapped air from the bag film and allowing the over-all expanse of film to settle more slowly and evenly against the sides of the load.

Other objects and advantages of the invention, not at this time enumerated, will readily become apparent as the nature of the invention is better understood.

In the accompanying two sheets of drawings forming a part of this specification, one illustrative embodiment of the invention has been shown.

In these drawings:

FIG. 1 is a plan view of a load bagging installation embodying the improved tunnel-forming heat shrink oven of the present invention, together with its associated load-transporting conveyor structure;

FIG. 2 is a side elevational view of the structure shown in FIG. 1 and showing, additionally, a bag-enveloped load immediately prior to its entry into the oven tunnel for heat shrinking purposes, and an addi-

tional completely packaged load emerging from the oven tunnel;

FIG. 2A is a perspective view of one of a series of conventional single-tube quartz heater employed in connection with the present invention;

FIG. 2B is a perspective view of one of a series of two-tube quartz heaters employed in connection with the invention;

FIG. 3 is a sectional view taken on the line 3—3 of FIG. 1;

FIG. 4 is a sectional view taken on the line 4—4 of FIG. 1;

FIG. 5 is a sectional view taken on the line 5—5 of FIG. 1;

FIG. 6 is a sectional view taken on the line 6—6 of FIG. 4;

FIG. 7 is a sectional view taken on the line 7—7 of FIG. 4;

FIG. 8 is a sectional view taken on the line 8—8 of FIG. 1; and

FIG. 9 is an enlarged sectional view taken on the line 9—9 of FIG. 5.

Referring now to the drawings in detail and in particular to FIGS. 1 and 2, wherein a load bagging installation embodying the present invention is disclosed, a conveyor structure 10 extends between a load-bagging area 12 and a discharge area 14. One or more work tables 16 at the bagging area facilitate placement of a load such as that indicated at L in FIG. 2 on the receiving end of the conveyor structure 10 and the application of a heat shrinkable film bag B to the load in a manner that will be made clear presently. After the film bag B is applied to the load the latter is moved by means of the conveyor 10 at a predetermined rate of speed continuously through an arch-like tunnel forming oven 18 of novel design which straddles the conveyor 10 and within which the film bag becomes heated so that upon emergence from the oven tunnel, the load with its heat shrunk film bag will assume the condition of a completed package which is represented by the load L2 and its film covering B2. The discharge end of the conveyor structure 10 is in register with a series of dead rollers 20 suitably carried in a take-off frame or rack 22 and by means of which the packaged loads may be withdrawn from the discharge area 14.

The conveyor structure 10, work tables 16 and take-off rack 22 are purely conventional and no claim is made herein to any novelty associated therewith, the novelty of the present invention consisting rather in the nature of the tunnel-forming oven 18 and the method by means of which the film bag is caused to shrink about the load L during passage of the bag covered load through the oven 18. Briefly however it is pointed out that the conveyor structure 18 embodies an endless slat-type conveyor chain assembly 23 mounted on driving and idler pulleys 24 and 26 respectively which are suitably mounted in an elongated fixed conveyor framework 28. The driving pulley 22 is powered by an electric motor M which operates through a gear reduction device 30 and a chain and pulley combination 32 to effect clockwise rotation of the driving pulley 24 as viewed in FIG. 2 so that the upper reach of the endless conveyor chain assembly will move in the direction of the arrow and thus transport successively bagged loads L from the bagging area 12 through the oven 18 and from thence to the discharge area 14.

Before entering into a discussion of the specific nature of the novel tunnel-forming oven 18 it is deemed pertinent to discuss the character of the film covered load which is operated upon by the oven during passage of such load through the oven tunnel, it being understood that the oven 18 is specifically designed to perform a novel heat-shrinking method upon the film bag B whereby improved film uniformity and distribution in the completely packaged load is attained. Accordingly, the film bag B is applied to the load by inverting the same and pulley the open rim of the bag downwardly over the load until the lower rim region thereof overhangs the lower end of the load as indicated at 34 in FIG. 2. The bag is dimensioned so that it fits loosely over the load and may thus be pulled downwardly in telescopic fashion without difficulty. Various materials are available for use in making the film from which the bag is constructed, a preferred film being polyethylene. Preferably, but not necessarily, the bag is constructed from a film which shrinks predominately in one direction and the bag is cut and folded so that in the completed and inverted bag shrinkage is multidirectional but predominately in a horizontal direction.

The thickness of the film will vary according to the character of the load, the lighter the load, the thinner the film. The present invention has been found to be particularly useful in the packaging of refractory bricks and particularly for enclosing brick packages of the type shown and described in U.S. Pat. No. 3,356,013, granted on Dec. 5, 1967 and entitled "Method and Apparatus for Packaging Bricks." Such packages are of rectangular outline and consist of a number of individual pack units, each of which is encircled by a single peripheral loop of metal strapping, with the various pack units being held in longitudinal alignment and contiguity by longitudinally extending corner strips which extend along the edges of the package and about which the various metal straps are positioned. Brick packages of this character weigh in excess of 3,000 pounds and, in bagging them according to the present invention a polyethylene bag film having a thickness as great as 0.01 inches. Where a heat-shrinkable polyvinyl chloride film is used in constructing the bag, a film of approximately one-third the thickness of a polyethylene film will have the equivalent strength.

As will be pointed out in greater detail presently, the oven 18 is so designed that it establishes a tunnel 36 (FIGS. 2, 3 and 4) through which the conveyor structure 10 extends so that the loosely bagged load L when supported on the upper reach of the conveyor will move through the tunnel from the bagging area 12 to the discharge area 14. The sides of the tunnel 36 are provided with a plurality of quartz heating units by means of which infrared radiant heat is directed inwardly of the tunnel and against the adjacent sides of the bag B and the top wall of the tunnel is provided with additional quartz heating units by means of which infrared radiant heat is directed downwardly and against the top of the bag above the load L. According to the present method, the various heating units are so disposed that during travel of the bagged load through the tunnel 34 radiant heat is predominantly applied to the overhanging skirt portion 34 for heat-shrinking purposes in order to insure that such skirt portion will rapidly be drawn inwardly beneath the underneath side of the load due to the relatively high horizontal shrinkage factor of the film as previously set forth before the vertical

shrinkage factor which is present in the bag sides will have time to draw this overhanging skirt portion 34 upwardly above the bottom edges of the load. Toward this end, the skirt portion 34 below the load is subjected to preliminary radiant heat at a preheating zone at the time the load initially enters the oven tunnel and before the load encounters additional radiant heat at the main heating zone within the oven for the purpose of heat-shrinking the relatively expansive sides and top of the bag.

Referring additionally to FIGS. 3, 4 and 5, the oven 18 involves in its general organization an oven framework including a pair of vertical front supporting posts 40 and a pair of vertical rear supporting posts 42, the four supporting posts constituting framework corner posts and being supported on casters 44 and the posts 40 being maintained spaced from the posts 44 by means of longitudinally extending horizontal members 46 (FIGS. 1 and 2) which support a rectangular control panel 48. The posts 40 and 42, together with the horizontal members 46, serve as a support for a vertically adjustable oven casing which is comprised largely of polished sheet metal stock such as aluminum and the inside surfaces of which constitute heat reflector surfaces which function in a manner that will be made clear presently. Insofar as the cutting and fitting together of the individual sheet metal components of the oven casing are concerned, the front or entrance end of the oven structure is roughly of frusto-pyramidal form and is substantially identical to the rear or exit end of the oven structure so that a description of the entrance end will suffice for the exit end, similar reference numerals being applied to the parts at these two ends. In effect, the frusto-conical entrance end establishes an entrance vestibule while the frusto-conical exit end establishes an exit vestibule.

As best shown in FIGS. 1, 2, 3 and 5, the tunnel entrance is established by the provision of an archframe 50 which is connected by a pair of diverging side reflector sheets 54 to a somewhat larger arch frame 56, the latter being vertically adjustable on the side legs 40. A sloping top reflector sheet 58 extends between the frames 50 and 56 while triangular gusset-like reflector sheets 60 extend between the sheets 58 and 54. The various reflector sheets 54, 58 and 60 thus establish the generally frusto-pyramidal front wall at the entrance end of the oven tunnel. Similar plates and arch frames which are similarly numbered with prime designations establish a substantially identical rear wall at the exit end for the tunnel. In between the entrance and exit ends of the tunnel, outer side plates 62 (FIG. 2) extend between the front and rear posts 40 and 42 and complete the stationary oven framework.

In order to achieve the various objects of the present invention, as well as to efficiently carry out the method thereof each side of the oven tunnel has associated therewith three series of infrared radiant heating units, all of which are so disposed along the sides of the tunnel as to direct infrared rays inwardly and against the sides of the bagged load L as it passes continuously through the tunnel. The disposition of the various series of heating units on each side of the tunnel is substantially the same and may best be visualized by reference to FIG. 6. As indicated by the brackets in this view, a first series of heating units 70 establishes a preheating zone, a second vertical series of heating units 72 estab-

lishes an intermediate heating zone, and a third series of heating units 74 establishes a postheating zone.

The individual heating units 70, 72 and 74 are preferably of the type commonly known as quartz heaters, various heaters being commercially available on the market for use in connection with the present invention. As illustrated in FIG. 2B a typical two-tube heater is disclosed and consists of an elongated open box-like casing 80, having a reflector 82 therein and across which there extends a pair of heat-radiating quartz tubes 82 through which there extend the usual electrical resistance elements (not shown). This illustrated heating unit is representative of one of the units 72 in the normal heating zone of the oven. Quartz heaters similar to the illustrated unit 80 but having only a single quartz tube are available, such a unit being shown in FIG. 2A and designated at 86. Heaters of this type are also available with three or four quartz tubes, the two heating units 70 in the preheating zone on opposite sides of the oven tunnel embodying four such tubes. It will be understood that the various heating units are provided with suitable electrical lead-in and lead-out connections (not shown) which are operatively connected to the control panel 48. Such heating units also are available in varying lengths and widths.

A fourth horizontal series of infrared heating units 90 (FIGS. 1, 2, 4, 7 and 8) extend between the front and rear arch frames 56 and 56' and, in effect, establish a ceiling for the oven tunnel, as well as establishing a top heating area within the intermediate heating zone. The units 90 are identical to the heating units 72 in that they are of the two-tube type. Inclined reflector plates 92 extend between the series of reflector units 90 and the series 72 as shown in FIGS. 4 and 8).

Considering now the disposition of the series of heating units 70 in the preheating zone, these units are supported in inwardly opening sheet metal box-like enclosures 94 (FIGS. 3, 5, 6 and 8) which are disposed within the generally frusto-pyramidal entrance end of the oven tunnel and they are positioned slightly below the level of the upper reach of the conveyor chain assembly in such a manner as to direct radiant heat upwardly and inwardly against the overhanging bag rim 34 as the load approaches and enters the medial region of the tunnel. Insofar as the disposition of the series of heating units 72 is concerned, these series extend vertically from below the level of the upper reach of the conveyor upwardly along the sides of the tunnel to a region adjacent the top of the tunnel as shown in FIGS. 6 and 8. The lowermost heating unit 72 of each series assumes approximately the same inclination as the heating units 70 in the pre-heating zone and serves to direct radiant heat beneath the load which is passing through the tunnel to maintain the skirt portion 34 heated as the load progresses through the tunnel. The remaining heating units 72 are disposed so as to direct radiant heat horizontally inwardly against the side of the bagged load. The series of heating units 90 serve to direct radiant heat over the top of the bagged load while the two heating units 74 are disposed in box-like casings 94' similar to the casings 94 and direct radiant heat beneath the load in the skirt region of the film bag B during the time that the load emerges from the oven tunnel. The net effect of the application of radiant heat to the bagged load by the various heating units 70, 72, 74 and 90 as the load travels through the oven will be described in detail subsequently when the operation of

the oven in carrying out the method of the present invention is set forth.

As previously stated, the sheet metal structure which establishes the oven tunnel is adjustable bodily as a unit relative to the four supporting posts 40 and 42, the manner in which such adjustment may be made being illustrated in FIG. 9. The various posts 40 and 42 are of a composite nature and consist of two similar channel members disposed in tandem or back-to-back relationship and including an inner member 100 and an outer member 102. Each channel member is provided with a pair of intumed reentrant rim flanges 104. The arch frames 56 and 56' are constructed of shallow channel stock and the outside flange 106 of each arch frame leg is formed with a plurality of vertically spaced holes 108 therethrough. Bolts 110 (see also FIGS. 3 and 5) project through the holes 108 and carry slide nuts 112 which, upon tightening of the bolts, are drawn against the rim flanges 104 in clamping relationship. It is to be noted that when the elevation of the oven casing structure is to be raised or lowered it is not necessary to remove the nut and bolt assemblies 110, 112, all that is necessary being to loosen the bolts 110 and raise or lower the arch frames 56 and 56' to the desired position, after which the bolts 110 may be retightened. Infinite adjustment of the oven casing for height may thus be effected, the nuts 112 sliding vertically along the intumed reentrant rim flanges 104 while the adjustment is being made.

It will be understood that in any oven of the radiant heating type the radiation of heat from such heating units as may be employed will set up stray or scattered convection eddy currents in various directions and, therefore, in the present oven in order to retain as much heat as possible in the lower region of the oven tunnel, a pair of elongated longitudinally extending combined closure and reflector plates 120 are hingedly connected to the box-like enclosures 94 for the heating units 70 in the preheating zone and the distal edges of these hinged plates 120 rest by gravity upon shelf portions 122 which are established by a pair of angular reflector plates 124 secured to the conveyor frame 28 on opposite sides of the latter. The oven structure is disclosed herein with the oven casing in its fully raised condition with the reflector plates 120 assuming inwardly and downwardly inclined position. It will be apparent however that, as shown in dotted lines in FIG. 3, when the oven casing is lowered to its fullest extent, the hinged reflector plates 120 will assume upwardly and inwardly inclined positions. In all vertical positions of which the oven casing is capable of assuming, the reflector plates 120 will rest on the shelf portion 122 and close the gap which otherwise would exist between the box-like enclosures 94 and 94' and the conveyor frame 28.

Referring now to FIG. 8, a fifth series of infrared heating units 130 is shown as a matter of option as being fixedly mounted within the confines of the conveyor frame 28 and arranged in side by side relationship and in a longitudinal row so as to direct radiant heat upwardly through the upper reach of the endless slat-type conveyor chain assembly 23. These heating units are preferably of the one-tube type illustrated in FIG. 2A and the function thereof, when put to use, will be described subsequently.

In the operation of the herein described tunnel-forming oven, the work tables 16 at the bagging area 12

will facilitate the draping of a given load L with an inverted bag such as the heat-shrinkable film bag B and the placement of the draped load on the receiving end of the conveyor 18, after which the conveyor will cause the load to move into and through the oven tunnel 36. As previously described, during the draping operation the lower open rim of the bag is pulled downwardly to establish the over-hanging apron or skirt 34 which projects below the level of the bottom of the load.

Assuming the load L to be unpalleted and to be of rectilinear configuration as is the case in connection with the packaging of strapped brick units of the type shown in the afore-mentioned U. S. Pat. No. 3,356,013, as the load moves into the generally frusto-pyramidal entrance end of the tunnel casing through the arched frame or doorway 50 the depending overhanging skirt 34 moves into preheating zone where it comes into direct register with the radiant heating units 70 on opposite sides of the conveyor and below the level of the bottom of the load. Since these units embody four quartz tubes, the heat which is directed against the skirt 34 is relatively intense and causes rapid shrinking of the skirt inwardly beneath the bottom of the load due to the predominately horizontal shrinkage factor of the film. As the load progresses further into the oven tunnel and passes through the arch frame 56, the skirt 34 continues to be heated but to a lesser extent as it moves into register with the inclined lowermost heating units 72 in the intermediate heating zone which also are disposed below the level of the bottom of the load. At the same time, the lateral sides and top of the film bag B become exposed to radiant heat emanating from the remaining heating units 72 which extend upwardly along the sides of the tunnel to a region at least as high as the top of the load, as well as the ceiling heating units 90. The radiant heat issuing from these latter heating units 72 and 90 will to a certain extent be absorbed by the sides and top of the film bag but an appreciable amount of such heat will pass through the film and raise the surface temperature of the load which, in the illustrated form is stated herein to be refractory material.

Such surface heating of the load initiates two phenomena. First, heat is radiated from the surface of the load outwardly and back through the bag sides and top, thus creating a dual heating effect since the film absorbs both inwardly and outwardly directed radiant heat. As a consequence the bag sides and top are constrained to shrink while at the same time the horizontal component of shrinkage causes the intumed skirt beneath the load to be drawn bodily upwardly so as to place the load under vertical compression. During this time, convection currents which are generated within the bag enclosure due to such surface heating of the load will expand the bag in balloon-like fashion since the intumed skirt portion of the bag hugs the underneath peripheral region of the load and thus inhibits escape of air from the interior of the bag, the only avenue of escape being that which is presented by the narrow crevices which are created between the tightly drawn skirt and the bottom of the load and through which the pressurized air "squeezes." In any event, the escape of air from the bag is greatly restricted so that rapid shrinking of the bag sides against the load is avoided and these sides will gradually settle onto the sides and top of the load in a uniform manner without creating folds or wrinkles. During such gradual shrinking of the bag sides, the lowermost heating units 72 in the inter-

mediate heating zone continue to maintain heat applied to the intumed apron 34 beneath the load and thus maintain the same taut.

During emergence of the load from the tunnel 36, the heating units 74 in the postheating zone continue to direct their radiant heat upwardly and inwardly beneath the bottom of the load to finalize the firmness of the apron flange beneath the load. Thereafter, the completely packaged load will be conducted by the conveyor 18 onto the dead rolls 20 of the discharge area 14 from whence it may be withdrawn to make room for a succeeding bagged load.

In order to prevent undue heat build-up in the upper regions of the oven tunnel, the reflector sheets 58 and 58' may be provided with venting openings 132 and 132' respectively therein.

While the present tunnel-forming oven 18 has been designed specifically for the packaging of rectilinear loads such as the previously mentioned stacked and strapped bricks, the provision of the series of heating units 130 (FIG. 8) extends the usefulness of the oven so that it may be effectively employed for heat shrinking a film about a load in such a manner that the latter is fully enclosed with all sides thereof being completely covered by the film. A compactible mass of fibrous material which assumes a flattened rolled condition represents an example of such a load. The load may be enclosed in the film bag, the open rim of the bag folded around the exposed end of the load in any suitable manner, and the bag then placed on its side and positioned on the conveyor 18 for passage through the oven tunnel 36. The oven controls may be operated to deenergize the heater units 70 in the preheating zone and the units 74 in the postheating zone while the heating units 72, 90 and 130 remain energized. The slanting vertical and horizontal reflector sheets 54, 54', 60, 60', 58 and 58' reflect sufficient radiant heat from the heater units 72 and 90 to heat shrink the leading and trailing edges of the bag while the upper and side surfaces of the bag are subjected to the direct radiant heat emanating from such heater units.

Under certain circumstances the heating units 130 may be caused to remain energized during the packaging of rectilinear loads such as the load L. With these latter heating units in operation, radiant heat is applied to the underneath side of the load to augment the shrinking effect of the lowermost heating units 72.

The electrical circuitry and the manual control knobs or buttons for energizing the motor M, controlling the speed thereof, and for selectively energizing the five series of heating units have not been disclosed herein since they embody conventional relay circuits. Exemplary of the manual control devices on the panel 48 are a series of instrumentalities 140 which may include a start button, an off-on button for each of the five series of heater units, an off-on button for the conveyor motor M, and a rotary speed control knob for adjusting the speed of travel of the conveyor 10.

The invention is not to be limited to the exact arrangement of parts shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit of the invention. Therefore, only insofar as the invention has particularly been pointed out in the accompanying claims is the same to be limited.

Having thus described the invention, what I claim and desire to secure by letters patent is:

1. Apparatus for heat shrinking an inverted bag of shrinkable plastic film which is positioned about a generally rectilinear load with its open lower rim region depending in apron-like fashion below the level of the bottom of the load, said apparatus comprising an elongated conveyor for conducting the bagged load continuously and unidirectionally, an arch-like heating oven straddling said conveyor and establishing an open-ended heating tunnel provided with entrance and exit openings and having a horizontal top wall above the conveyor and vertical side walls on opposite sides of the conveyor, means within the tunnel establishing a preheating zone adjacent the entrance end thereof, an intermediate heating zone, and a postheating zone adjacent the exit end of the tunnel, means for actuating the conveyor to move the bagged load forwardly through said zones successively and in the order named, a pair of infrared heating units longitudinally coextensive with and disposed in said preheating zone on opposite sides of the conveyor and below the effective level thereof and arranged to direct radiant heat upwardly and inwardly of the tunnel for heating said depending apron-like rim region of the bag film to shrink the latter beneath said bottom side of the load as the bagged load enters the tunnel, a second pair of infrared heating units longitudinally coextensive with and disposed in the intermediate zone on opposite sides of the conveyor and disposed below the effective level thereof and similarly arranged to direct radiant heat upwardly and inwardly of the tunnel against the inwardly shrunk rim region of the bag film as the bagged load progresses through the tunnel, a series of infrared heating units longitudinally coextensive with and disposed in said intermediate zone on opposite sides of the conveyor, extending from a region adjacent the effective level thereof immediately above said second pair of heating units to a region adjacent the top of the tunnel, and arranged to direct radiant heat laterally and horizontally inwardly against the sides of the bagged load during progression of the same through the tunnel, and a third pair of infrared heating units longitudinally coextensive with and disposed in said postheating zone on opposite sides of the conveyor and below the effective level thereof and arranged to direct radiant heat upwardly and inwardly of the tunnel against said inwardly shrunk rim as the bagged load emerges from the tunnel.

2. Apparatus as set forth in claim 1 including, additionally, a third series of infrared heating units longitudinally coextensive with said intermediate heating zone, disposed directly above the conveyor and arranged to direct radiant heat vertically downwardly against the top of the bagged load during progression of the same through the tunnel.

3. Apparatus as set forth in claim 2 including, additionally, a fourth series of infrared heating units disposed within the confines of the conveyor and substantially coextensive with said intermediate zone and arranged to direct radiant heat vertically upwardly against the bottom wall of the load and the underlying shrunk rim region of the bag.

4. Apparatus as set forth in claim 2, wherein said oven embodies a fixed framework including four quadrilaterally arranged vertical corner posts, a sheet metal oven casing infinitely and vertically adjustable on and

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supported by said corner posts and establishing said top and side walls of the tunnel.

5. Apparatus as set forth in claim 2, wherein said oven embodies a fixed framework including a pair of vertically disposed front corner posts and a pair of vertically disposed rear corner posts, a relatively large inverted front arch frame supported by and vertically adjustable on said front corner posts, a similar inverted rear arch frame supported by and vertically adjustable on said rear corner posts, and an oven casing supported by said arch frame and vertically adjustable bodily therewith, said casing including a relatively small first arch frame rearwardly of said rear arch frame and establishing an entrance opening for the tunnel, a relatively small second arch frame rearwardly of said rear arch frame and establishing an entrance opening for the tunnel, diverging sheet metal reflector sheets extending between the side legs of the second and rear

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arch frames, a sloping top reflector sheet extending between the arch portions of the second and rear arch frames, gusset-like reflector sheets extending between the adjacent edges of the latter diverging and sloping reflector sheets, said reflector sheets establishing a generally frusto-pyramidal entrance vestibule for the tunnel, a relatively small third arch frame forwardly of said front arch frame and establishing an exit opening for the tunnel, diverging sheet metal reflector sheets extending between the side legs of the third and front arch frames, a sloping top reflector sheet extending between the arch portions of the third and front arch frames, gusset-like reflector sheets extending between the adjacent edges of the latter diverging and sloping reflector sheets, the reflector sheets which extend between the third and front arch frames establishing a generally frusto-pyramidal exit vestibule for the tunnel.

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