Oct. 13, 1970 E. M. BICKHAM ET AL 3,534,393

HEAT TUNNEL

Filed Dec. 27, 1967 4 Sheets-Sheet 1

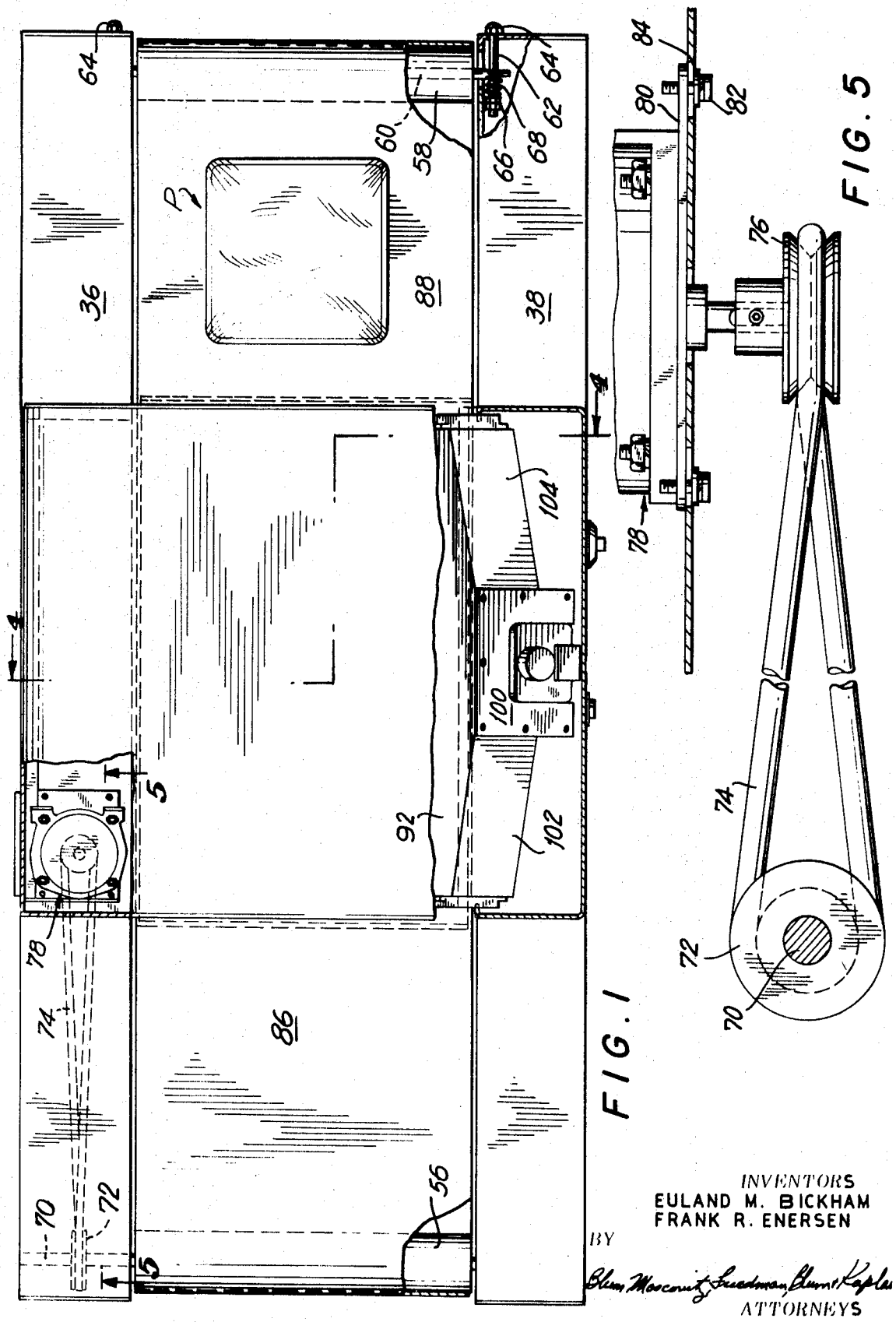



FIG. 1




FIG. 5

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FIG. 2

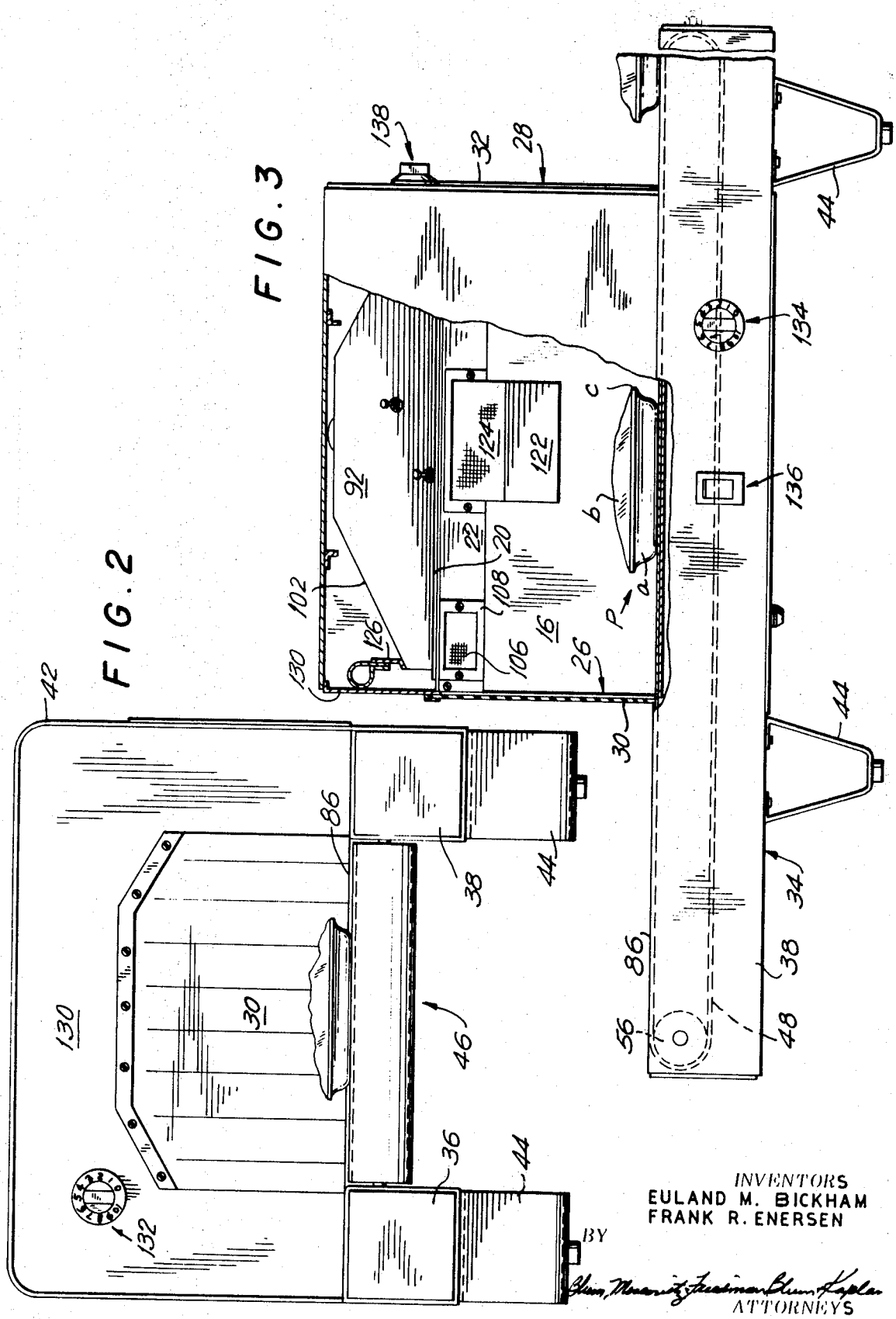



FIG. 3

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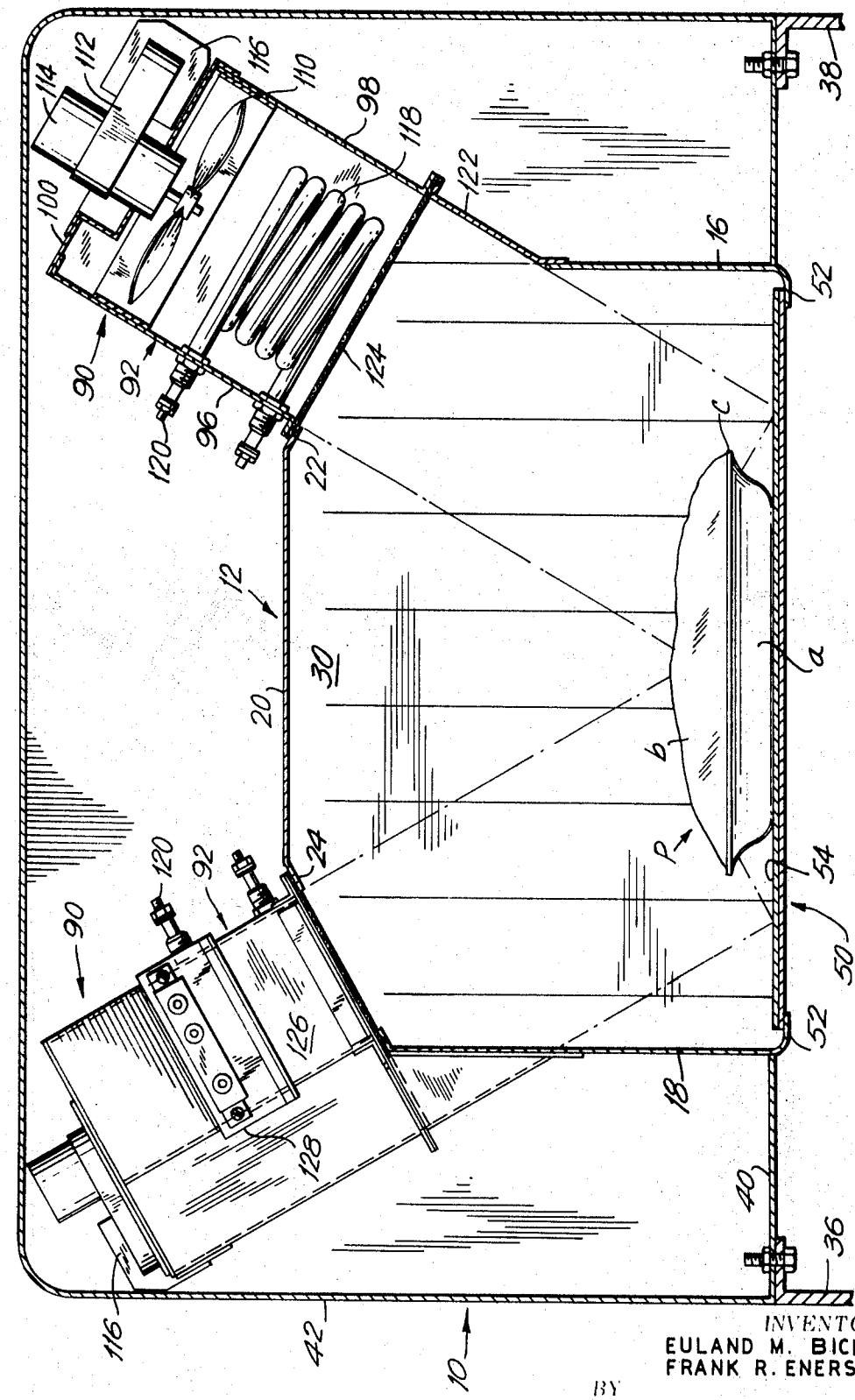
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HEAT TUNNEL

Filed Dec. 27, 1967 4 Sheets-Sheet 3

FIG. 4




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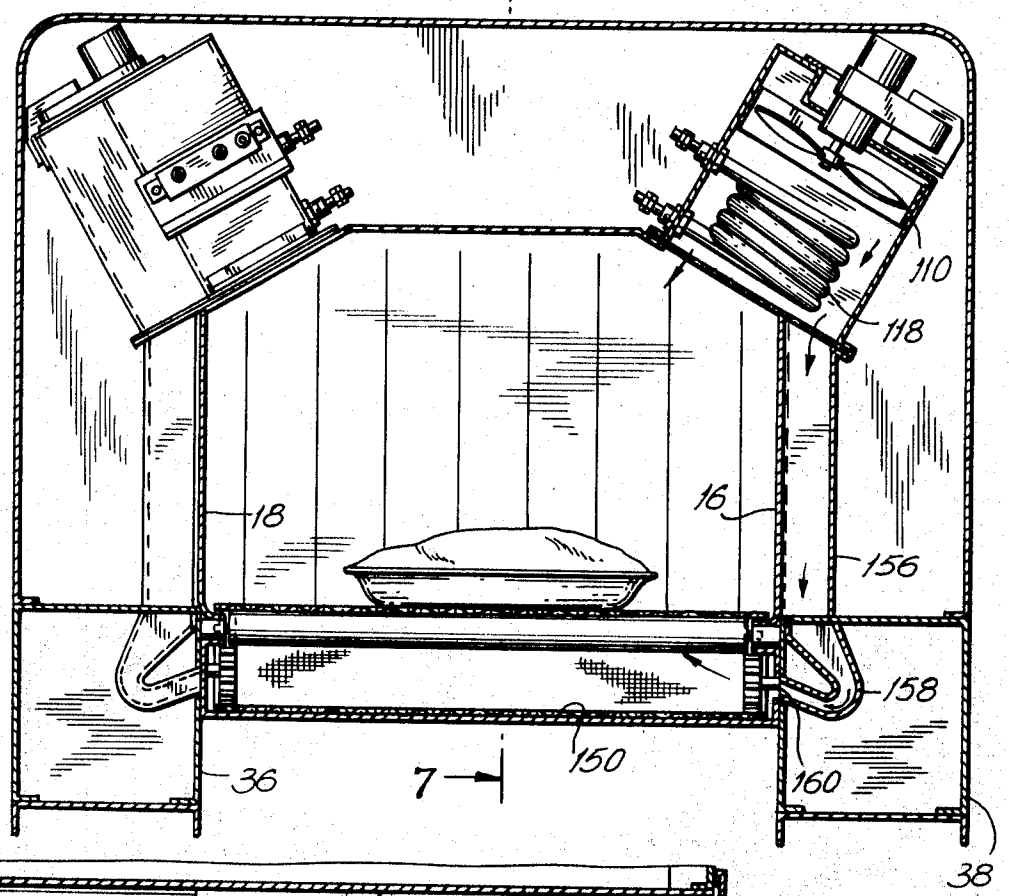
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HEAT TUNNEL

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FIG. 6



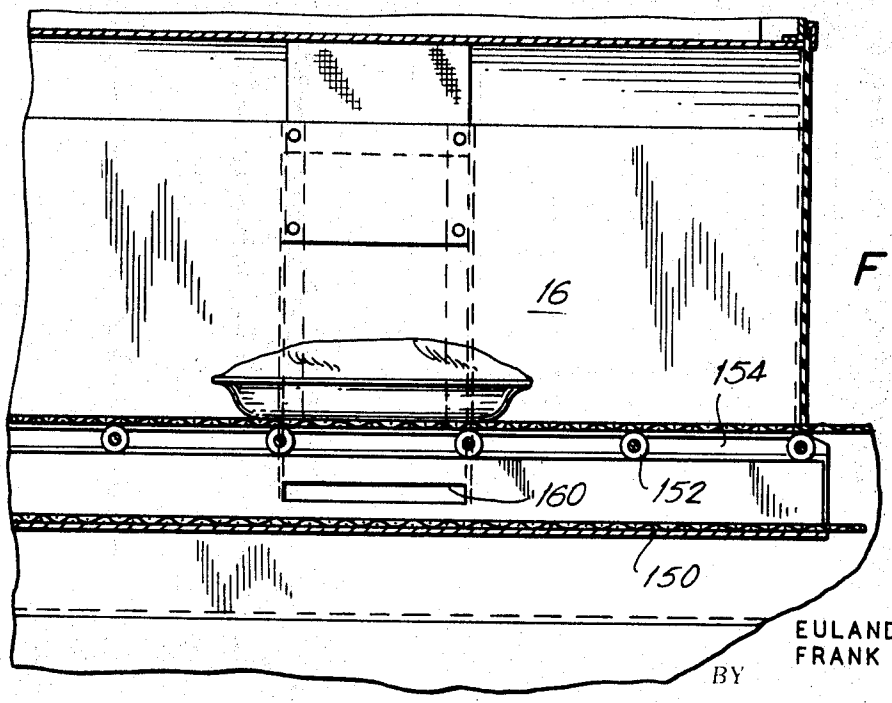




FIG. 7

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United States Patent Office

3,534,393

Patented Oct. 13, 1970



3,534,393

# HEAT TUNNEL

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Int. Cl. F27b 9/10
U.S. Cl. 219—388 10 Claims

## ABSTRACT OF THE DISCLOSURE

A heat tunnel for carrying out heat shrink packaging operations. A tunnel assembly has an open bottom, a pair of opposed side walls extending upwardly from this open bottom, and a top wall extending between these side walls, this tunnel assembly having an inlet end and an opposed outlet end. An elongated base means carries the tunnel assembly and extends beyond the inlet and outlet ends thereof. An endless conveyor means is carried by the base means and has an upper run which extends along the open bottom of the tunnel assembly, this upper run having a receiving end extending forwardly beyond the inlet end of the tunnel assembly to receive a package which is to be treated and a discharge end extending rearwardly beyond the outlet end of the tunnel assembly from which a treated package can be removed. An air-directing means communicates with the interior of the tunnel assembly for directing heated air currents along the interior of the tunnel assembly into engagement with a package traveling therethrough, and this air-directing means provides for the air currents a closed circuit which provides for repeated recirculation of air which is used to heat a package conveyed through the tunnel assembly by the conveyor means.

## CROSS REFERENCE TO RELATED APPLICATION

The heat tunnel of this application is designed to treat packages received from a sealer disclosed in copending application Ser. No. 693,976, filed on Dec. 27, 1967, now Pat. No. 3,475,880.

## BACKGROUND OF THE INVENTION

The present invention relates to heat tunnels.

In particular, the present invention relates to heat tunnels which are adapted to be used in heat shrink packaging operations.

Thus, in the packaging of materials such as foodstuffs in trays, the foodstuffs are wrapped with a heat-shrinkable film which extends over the material in a tray and which has its periphery shrunk beneath a lip of the tray, these latter operations being performed on a sealer. The package which is thus covered with the heat-shrinkable film which has its periphery shrunk beneath the lip of the tray in which the material is located is then directed through a heat tunnel so as to shrink the film tightly against the periphery of the tray and the material therein.

With known heat tunnels of this general type there are several drawbacks. The time required to carry out the heat shrink packaging operations is excessively long. The known heat tunnel structures undesirably heat the surrounding atmosphere, and care must be exercised not to contact hot exposed surfaces of the known structures. In addition, with the known structures considerable energy is required to heat the air which engages the packages to the required temperature.

## SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide a heat tunnel of the above general



type which will, however, avoid the above drawbacks.

In particular, it is an object of the present invention to provide a heat tunnel capable of recirculating the air which is used to treat a package passing through the tunnel, so that in this way once the required air temperature is reached, little energy will be required to maintain this temperature.

A further object of the invention is to provide a heat tunnel which will have only cool exterior surfaces so that the surrounding atmosphere will not be undesirably heated and so that there will be no danger to people adjacent the tunnel who may happen to contact the exterior structure thereof.

Furthermore, it is an object of the invention to provide for a heat tunnel an air circulating path which will very efficiently heat a package during movement thereof through the tunnel.

Furthermore, it is an object of the invention to provide a construction which can be very readily regulated so as to adapt the extent of heating to the particular packages which are treated.

Furthermore, it is an object of the invention to provide a heat tunnel which is of a relatively simple compact construction, capable of occupying only a small space and being inexpensively manufactured, and capable of being readily operated even by inexperienced personnel.

According to the invention the heat tunnel includes a tunnel assembly having an open bottom, a pair of opposed side walls extending upwardly from the open bottom, and a top wall extending across and connected to the side walls, this tunnel assembly having an inlet end and an opposed outlet end. An elongated base means carries the tunnel assembly and extends beyond the opposed ends thereof, and a conveyor means, which is of endless configuration, has an upper run extending through and along the open bottom of the tunnel assembly, this conveyor means communicates with the interior of the tunnel assembly for directing heated air therethrough along a path which engages a package conveyed through the tunnel by the conveyor means. This air-directing means provides for conveyor means. This air-directing means provides for the heated air a circuit which enables the heated air to be repeatedly circulated through the interior of the tunnel assembly, so that in this way the amount of air which must be heated is maintained at a minimum.

Still other objects and advantages of the invention will in part be obvious and will in part be apparent from the specification.

The invention accordingly comprises the features of construction, combinations of elements, and arrangement of parts which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, reference is had to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a top plan view of a heat tunnel of the invention with part of the outer wall structure broken away to show some interior components;

FIG. 2 is a front end view of the heat tunnel shown as it appears in elevation when looking toward the inlet end of the tunnel assembly;

FIG. 3 is a fragmentary longitudinal side elevation of the heat tunnel with part of the outer wall structure also broken away to show interior components;

FIG. 4 is a transverse sectional elevation taken along line 4—4 of FIG. 1 in the direction of the arrows and showing details of the structure for directing heat air currents into engagement with a package;

FIG. 5 is a longitudinal elevation taken along line 5—5 of FIG. 1 in the direction of the arrows and fragmentarily illustrating the drive for the conveyor means;

FIG. 6 is a transverse sectional elevation similar to FIG. 4 but showing a different embodiment of a heat tunnel of the invention; and

FIG. 7 is a fragmentary side elevation of an interior wall of the tunnel assembly, taken along line 7—7 of FIG. 6 in the direction of the arrows.

## DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings, it will be seen from FIG. 4 that the heat tunnel **10** of the invention includes a tunnel assembly **12** having an open bottom **14**, a pair of opposed side walls **16** and **18** extending upwardly from the open bottom **14**, and a top wall **20** extending between the side walls **16** and **18** and having a pair of opposed downwardly sloping side portions **22** and **24** which are directly connected with the side walls **16** and **18**, respectively. The tunnel assembly **12** has an open front inlet end **26** and an open rear outlet end **28** respectively shown at the left and right ends of the tunnel assembly in FIG. 3. A slit curtain **30** is hung from the top front end of the tunnel assembly hanging across the inlet end **26** thereof, and a similar slit curtain **32** is hung from the rear top end of the tunnel assembly and hangs across the rear outlet end **28** thereof. These slit curtains **30** and **32** are made of fabric based heat-resistant rubber and serve to prevent, to a large extent, escape of heated air from the interior of the tunnel assemly **12**.

A base means **34** carries the tunnel assembly. This base means **34** has a pair of elongated hollow side portions **36** and **38** of rectangular or square cross section which at their intermediate portions are cut away, as fragmentarily indicated in FIG. 4 and removably carry a wall **40** at the lower end of an outer shell **42** which encloses the entire tunnel assembly **12** except for the inlet and outlet ends thereof. The elongated tubular parts **36** and **38** of the base means **34** have opposed closed ends, and their bottom walls are fixed to supports **44** which mount the base means **34** at a suitable elevation above a table or the like, for example. It will be noted that the base means **34** extends forwardly beyond the inlet end **26** and rearwardly beyond the outlet end **28** of the tunnel assembly **12**.

The base means supports a conveyor means **46** which includes an endless belt **48** having an upper run **50** which travels along the open bottom **14** of the tunnel assembly guided at its outer edges by inwardly directed lips **52** at the bottom ends of the side walls **16** and **18**, as shown in FIG. 4. This belt **48** may be made of a plurality of plies **54**, as indicated in FIG. 4, of high-temperature butyl rubber. At its front end the endless conveyor belt **48** is guided around a driving roller **56**, and at its rear end it is guided around an idler roller **58**. The roller **58** is formed with an axial bore through which a rod **60** freely extends, and as is shown in FIG. 1 the ends of the rod **60** project into the hollow tubular portions **36** and **38** of the base means **34** and have flattened ends formed with openings through which rods **62** respectively extend, these rods extending through openings in the rear closure walls of the tubular assemblies **36** and **38** and having outer heads **64** which engage these rear closure walls. At their inner ends the rods **62** are threaded and carry a pair of lock nuts **66** which engage one end of a coil spring **68** which bears against the flattened end of the rod **60**, so that with these assemblies at the rear end of the base means **34** the endless conveyor belt **48** is maintained at a suitable tension.

Adjacent the front ends of the tubular assemblies **36** and **38** of the base means **34** the driving roller **56** is fixed to a shaft **70** supported for rotary movement in any suitable bearings carried by the base means **34** and fixedly carrying a driving pulley **72**.

As is shown most clearly in FIG. 5, the drive means for driving the conveyor means **46** includes not only the driving pulley **72** but also the endless belt **74** which extends around and along the interior of a groove in the pulley **72**, this belt **74** also extending around a horizontal pulley **76** fixed adjustably to the bottom end of a driving motor and gear reduction assembly **78**. This assembly **78** has a base plate **80** carrying screws **82** which pass through slots **84** formed in the top wall of the tubular assembly **36**, so that in this way the position of the motor and gear reduction assembly **78** along the base means can be adjusted to adjust the tension of the belt **74**. It is to be noted that the pulleys **76** and **72** as well as the belt **74** and the drive shaft which is connected to the pulley **76** are all situated in the hollow interior of the tubular assembly **36** of the base means, while the motor and gear reduction assembly **78** is situated within the enclosure **42** between the right side wall thereof and the wall **16**, as viewed in FIG. 4, so that in this way the entire drive for the endless belt is completely enclosed.



It is to be noted that with this construction the upper run **50** of the endless belt or band **48** of the conveyor **46** has a front receiving end **86** for receiving a package P and a rear discharge end **88** from which the package P may be removed. Thus, these receiving and discharge ends of the conveyor means extend forwardly and rearwardly beyond the inlet and outlet ends of the tunnel assembly, respectively, and when a package is placed on the receiving end **86** of the conveyor means it will be conveyed along the interior of the tunnel assembly first through the inlet end thereof, then through the interior thereof, and then through the outlet end thereof, the conveyor means being continuously driven during operation of the heat tunnel.

The particular packages P which are treated include trays *a* containing a material such as suitable foodstuffs which is covered by a heat-shrinkable film *b*, and during previous operations on a sealer the periphery of the film *b* has been shrunk beneath a lip *c* of the tray *a*. The film *b* is a clear plastic film of heat-shrinkable polyvinyl chloride or polyethylene, for example, and after being treated in the heat tunnel this film is tightly draw over the material in the tray *a* and has its periphery in continuous engagement with the underside of the lip *c*.

An air-directing means is provided for directing heated air currents into engagement with a package P as it travels through the interior of the tunnel assembly **12**. This air-directing means **90** includes at each side of the tunnel assembly **12** on the sloping wall portions **22** and **24** of the top wall **20** a duct structure **92** which is open at the bottom so as to be closed by the sloping wall portion **22** on one side and the slopping wall portion **24** at the other side of the top wall **20** of the tunnel assembly **12**. This duct structure **92** at each side of the tunnel assembly has its own opposed side walls **96** and **98**, a central top wall portion **100** and a pair of forward and rearward sloping wall portions **102** and **104**. The front and rear ends of each duct structure are closed. Each sloping wall portion **22** and **24** is formed adjacent its front and rear ends with a pair of inlet openings each covered by a suitable mesh **106** carried by a frame **108** which is fastened to each wall **22** and **24**, as shown at the left end of the sloping wall portion **22** in FIG. 3. The central wall portion **100** of each duct structure **92** carries a motor driven fan **110** having its fan blades situated within the duct structure **92** and its motor extending to the exterior of the wall portion **100**, as shown most clearly at the upper right portion of FIG. 4. A bracket **112** which carries the motor **114** which drives the fan **110** carries a block **116** which rests directly on the duct structure and which engages the inner surface of a side wall of the outer enclosure **42**, as is also shown in FIG. 4.

Beneath each fan **110** is located a heating coil **118** which is electrically conductive so as to form a resistance heater, and the ends of the coil **118** extend through the wall **96** of each duct structure **92** where these ends **120** of the coil **118** may have suitable electrical leads connected thereto. Beneath each heating element **118** the sloping wall portions **22** and **24** extend outwardly beyond the side

walls **16** and **18** and are connected with suitable extensions **122** of the side walls, these extensions **122** forming part of the duct structure **92** for directing heated air currents into the interior of the tunnel assembly **12**. The sloping wall portions **22** and **24** are also formed with openings beneath the heating elements **118**, and these openings are also covered by a suitable mesh **124**.

Thus, with this construction when the elements **118** are energized and the fans **110** operate only a pair of air current streams will be directed from opposed upper central portions of the tunnel assembly **12**, adjacent the sides thereof, diagonally downwardly onto a package P traveling through the interior of the tunnel assembly, and these air currents will then flow forwardly and rearwardly along the interior of the tunnel assembly **12** to be drawn through the inlet openings covered by the meshes **106**, this heated air which is drawn in through these inlet openings traveling from the opposed ends of each duct structure **92** toward the center thereof to which it is drawn by the fan **110** which again drives the air out through the mesh **124** after it passes over the heating elements **118**. The curtains **30** and **32** of course prevent substantial escape of heated air to the exterior of the tunnel assembly, so that with this construction there is a continuous recirculation of the heated air providing a very efficient heating of the package with a minimum consumption of energy. Thus, as is apparent from FIG. 4, with this structure a pair of oppositely inclined streams form the only flow of heated air with these streams directed inwardly toward each other transversely of the direction of movement of the conveyor means to substantially meet at the conveyor means so as to achieve in this way a concentration of the heated air currents at the package on the conveyor means.

Because the shell **42** completely encloses the tunnel assembly, except for its inlet and outlet ends, and provides a housing for the air-directing means **90** in the space between the tunnel assembly and the shell **42**, the exterior surface of the shell **42** is cool at all times.

The front and rear ends of each duct structure **92** can carry suitable brackets **126** on which any desired elements such as control assemblies or elements for guiding wires and the like may be mounted. One such bracket **126** is shown at the upper right portion of FIG. 4 carrying a control assembly **128**. The controls may be manipulated from the exterior of the heat tunnel, and such controls may be located either at the front and rear end walls **130** of the enclosing shell **42** or at the sides of the base means **34**. Thus, FIG. 2 shows a thermostat control **132** accessible at the front wall **130** of the shell **42** for adjusting a thermostat which controls the extent to which the elements **118** are heated, while FIG. 3 shows at the visible side of the base means **34** a control **134** to regulate the conveyor speed by regulating the speed of the driving motor and gear reduction assembly and an enclosure **136** for protective fuses. An additional control of any type may also be located at the rear wall **130** of the shell **42**, and such a control **138** is indicated at the upper right portion of FIG. 3.

The walls of the tunnel assembly **12** are made of stainless steel while the outer shell **42** is made of an epoxy painted steel or an unpainted stainless steel. The air space which is created between the tunnel assembly **12** and the outer shell **42** assures that this outer shell remains cool, thus eliminating hazards to personnel and limiting heat radiating into the room to the area in which the heat tunnel is located.

The embodiment of the invention which is illustrated in FIGS. 6 and 7 is identical with that of FIGS. 1–5 except that instead of a conveyor belt, a foraminous endless conveyor means in the form of an endless chain **150** is provided, the upper run of the chain being supported for movement along rollers **152** supported for rotary movement at their ends in suitable bearings which are carried by strips **154** which are respectively fixed to the inner side surfaces of the tubular structures **36** and **38** of the base means **34** just beneath the lips which are directed inwardly at the bottom ends of the side walls **16** and **18**. This endless chain is driven by suitable sprocket wheels located at the ends of a pair of rollers one of which is driven by the gear reduction and motor drive as described above and the other of which is idle with the same adjusting structure being used for tensioning the endless conveyor means of FIGS. 6 and 7.

With this embodiment the side walls **16** and **18** have beneath the outer portions of the heating elements **118** vertically extending outer ducts **156** which communicate at their lower ends with elbows **158**, respectively, these elbows being respectively situated within the hollow tubular assemblies **36** and **38** of the base means, as shown in FIG. 6. The elbows **158** terminate in rectangular discharge openings **160**, one of which is shown in FIG. 7, and as a result part of the air which is driven by the fan **110** will be deflected downwardly along the ducts **156** to travel around the elbows **158** and out through the openings **160**. From these openings **160** this heated air current will travel upwardly through the upper run of the foraminous endless conveyor **150** to engage the package at its underside, and thus with this construction the package is heated at the bottom as well as at the top.

Except for these differences the structure of FIGS. 6 and 7 is the same as that of FIGS. 1–5.

Thus, with the structure of the invention it is possible to thermostatically control the heating of elements **118** while relating this heating to the speed of travel of the packages provided by the speed control of the conveyor means, and with these latter two factors preferably interrelated it is possible to achieve optimum shrink during treatment of a package as it travels through the heat tunnel of the invention.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above constructions without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

**1.** In a heat tunnel for heat shrink packaging operations, a tunnel assembly having an open bottom, a pair of opposed side walls, and a top wall extending between said side walls, said tunnel assembly having an inlet end and an opposed outlet end, elongated base means carrying said tunnel assembly and extending beyond said inlet and outlet ends thereof, endless conveyor means carried by said base means and also extending beyond said inlet and outlet of said tunnel assembly, said conveyor means having an upper run extending through said tunnel assembly along said open bottom thereof and said upper run having a receiving end extending forwardly beyond said inlet end of said tunnel assembly for receiving a package and a discharge end extending rearwardly beyond said outlet end of said tunnel assembly from which a treated package can be removed, said conveyor means conveying a package through said tunnel assembly to be heated therein, and air-directing means communicating with the interior of said tunnel assembly for directing heated air currents into engagement with a package traveling through said tunnel assembly and along a substantially closed circuit so that air for heating a package is continuously circulated along a given path, said air-directing means directing the heated air currents downwardly from said top wall only in a pair of oppositely inclined streams substantially meeting at said conveyor means and extending from said opposed side walls at the

region of said top wall inwardly toward each other transversely of the direction of movement of said upper run of said conveyor means between said inlet and outlet ends to provide a pair of streams of heated air currents directly engaging a package.

**2.** The combination of claim **1** and wherein said air-directing means includes fans and heaters communicating with the interior of said tunnel assembly through said top wall thereof at a location between said ends thereof for directing heated air currents downwardly in the interior of the tunnel assembly between said ends thereof into engagement with a package conveyed through said tunnel assembly by said conveyor means, and said air-directing means including ducts communicating with the interior of said tunnel assembly adjacent said ends thereof and communicating with said fans and heaters for directing back to the latter air drawn out of the interior of said tunnel assembly through said ducts by said fans.

**3.** In a heat tunnel for heat shrink packaging operations, a tunnel assembly having an open bottom, a pair of opposed side walls, and a top wall extending between said side walls, said tunnel assembly having an inlet end and an opposed outlet end, elongated base means carrying said tunnel assembly and extending beyond said inlet and outlet ends thereof, endless conveyor means carried by said base means and also extending beyond said inlet and outlet of said tunnel assembly, said conveyor means having an upper run extending through said tunnel assembly along said open bottom thereof and said upper run having a receiving end extending forwardly beyond said inlet end of said tunnel assembly for receiving a package and a discharge end extending rearwardly beyond said outlet end of said tunnel assembly from which a treated package can be removed, said conveyor means conveying a package through said tunnel assembly to be heated therein, and air-directing means communicating with the interior of said tunnel assembly for directing heated air currents into engagement with a package traveling through said tunnel assembly and along a substantially closed circuit so that air for heating a package is continuously circulated along a given path, said air-directing means including a fan and heater communicating with the interior of said tunnel assembly through said top wall thereof at a location between said ends thereof for directing a heated air current downwardly in the interior of the tunnel assembly between said ends thereof into engagement with a package conveyed through said tunnel assembly by said conveyor means, and said air-directing means including ducts communicating with the interior of said tunnel assembly adjacent said ends thereof with said fan and heater for directing back to the latter air drawn out of the interior of said tunnel assembly through said ducts by said fan, said fan, heater and ducts of said air-directing means being situated at said top wall of said tunnel assembly adjacent one of said side walls thereof, and a second fan, heater and set of ducts forming part of said air-directing means and being carried by said top wall adjacent the other of said side walls of said tunnel assembly.



**4.** The combination of claim **3** and wherein said top wall has downwardly sloping side portions connected to said side walls of said tunnel assembly and carrying said fans, heaters, and ducts of said air-directing means, for directing air diagonally downwardly along the interior of said tunnel assembly from opposed upper portions thereof toward a central lower interior portion thereof through which a package is conveyed by said conveyor means.

**5.** The combination of claim **4** and wherein said endless conveyor means is composed of an endless sheet material and end rollers carried by said base means and around which said endless sheet material extends.

**6.** The combination of claim **4** and wherein said conveyor means is foraminous so that air can pass therethrough, and said air-directing means including additional ducts respectively extending along the opposed side walls of said tunnel assembly downwardly from the fans and heaters to an elevation lower than said upper run of said conveyor means and directing heated air currents upwardly through said upper run into engagement with a package conveyed through said tunnel assembly by said conveyor means.

**7.** The combination of claim **6** and wherein said endless foraminous conveyor means is in the form of a chain belt, and said conveyor means including sprockets for driving said chain belt.

**8.** The combination of claim **2** and wherein slit flexible curtains are hung at said inlet and outlet ends of said tunnel assembly to be deflected by a package during movement thereof into and out of said tunnel assembly while minimizing the escape of heated air from the interior of said tunnel assembly.

**9.** The combination of claim **2** and wherein an outer shell is carried by said base means and with the exception of said inlet and outlet ends of said tunnel assembly completely encloses the latter and said air-directing means for shielding the latter and the interior of said tunnel assembly from the exterior.

**10.** The combination of claim **9** and wherein a drive means is operatively connected with said conveyor means for driving the latter, said drive means being located within said shell and base means so as to be also completely enclosed.


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U.S. Cl. X.R.

34—225; 53—184