

Feb. 22, 1966

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3,236,160

METHOD OF BONDING CONTAINER CLOSURES

Filed Dec. 21, 1961

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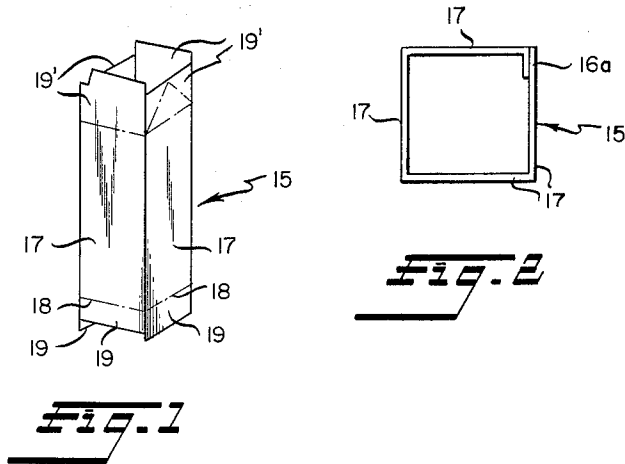
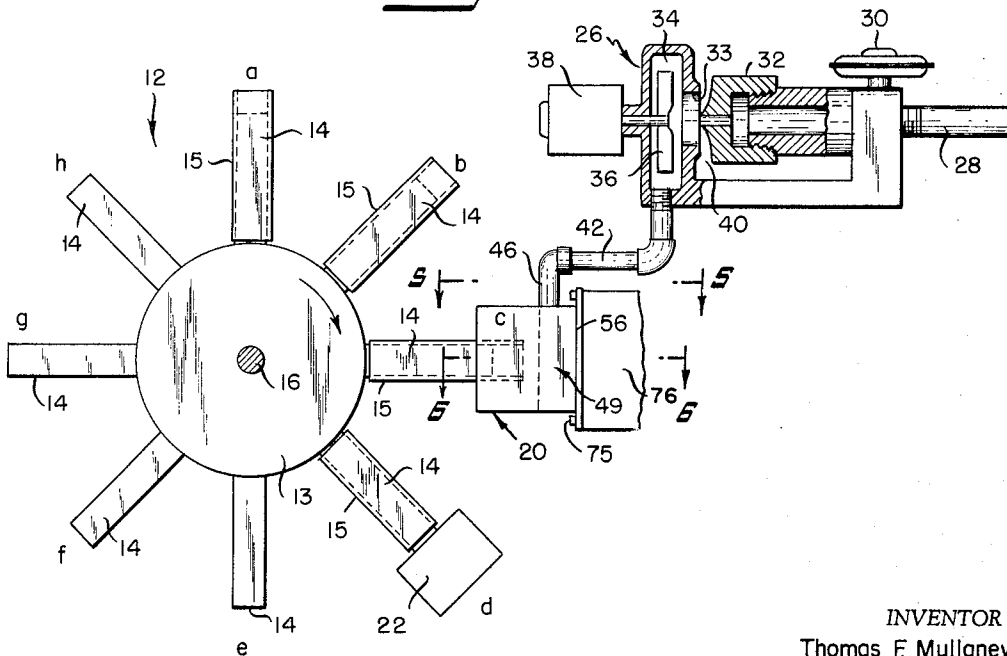


Fig. 3



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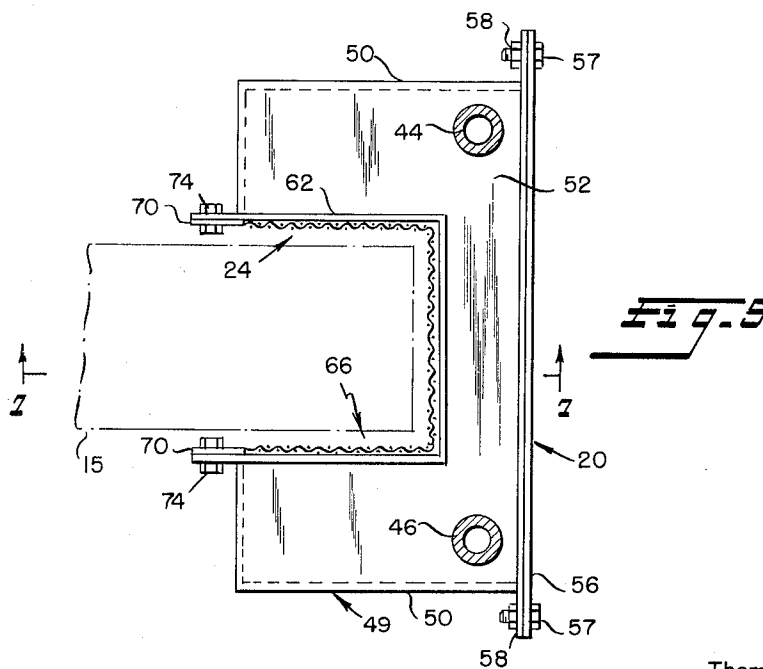
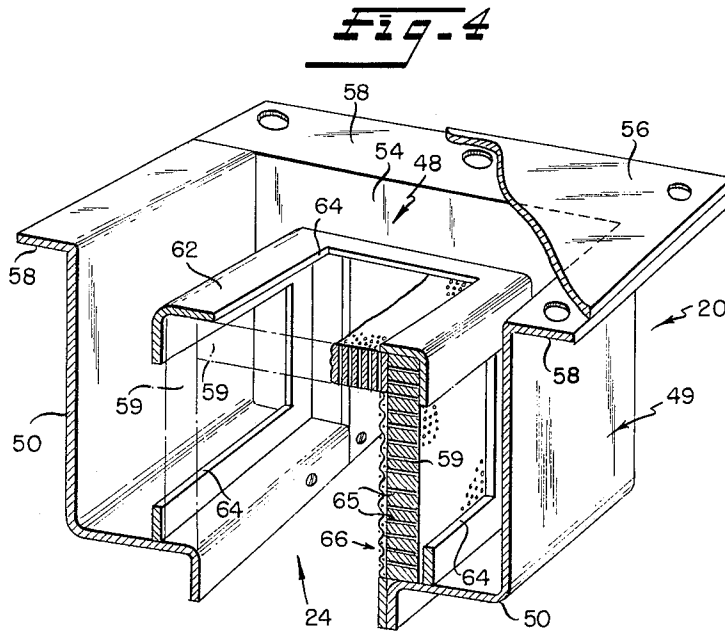
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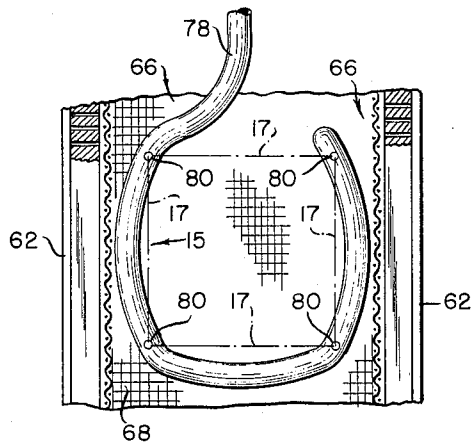


Fig. 12

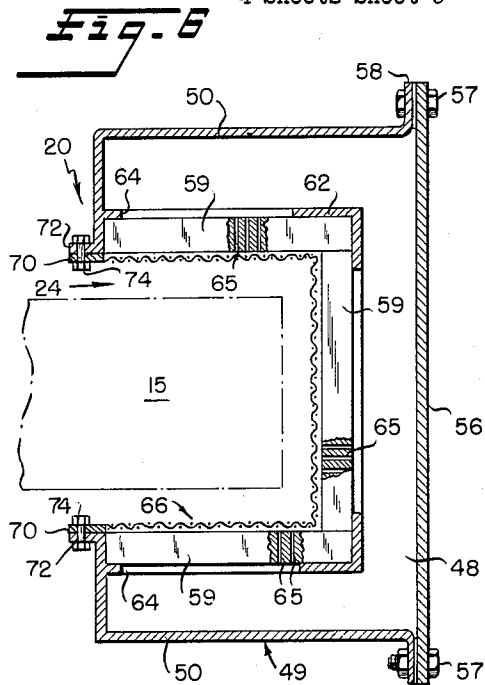


Fig. 6

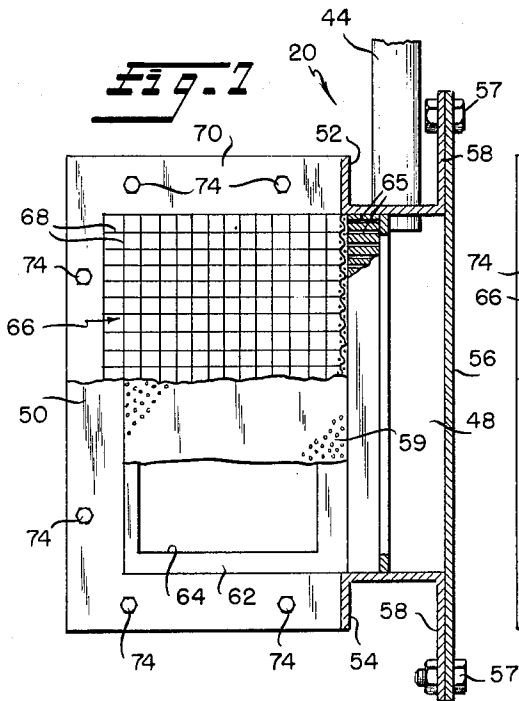


Fig. 1

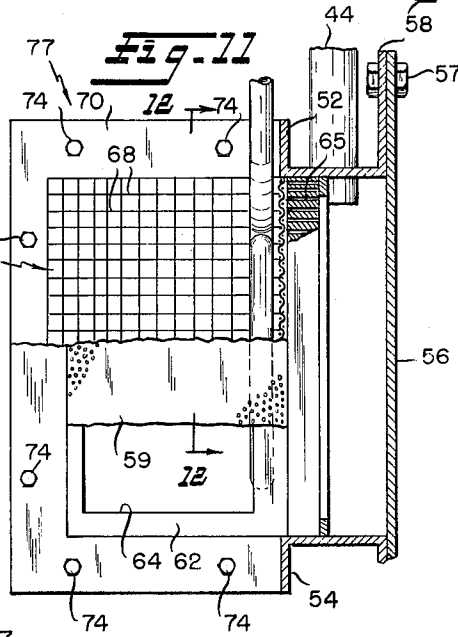


Fig. 11

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METHOD OF BONDING CONTAINER CLOSURES

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4 Sheets-Sheet 4

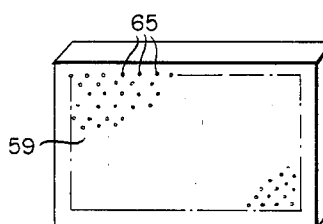
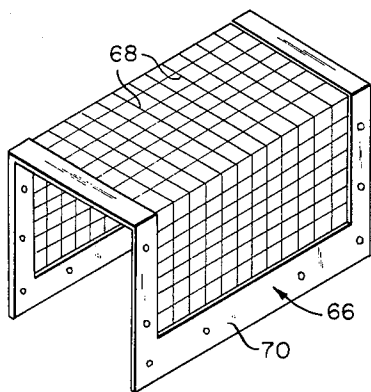
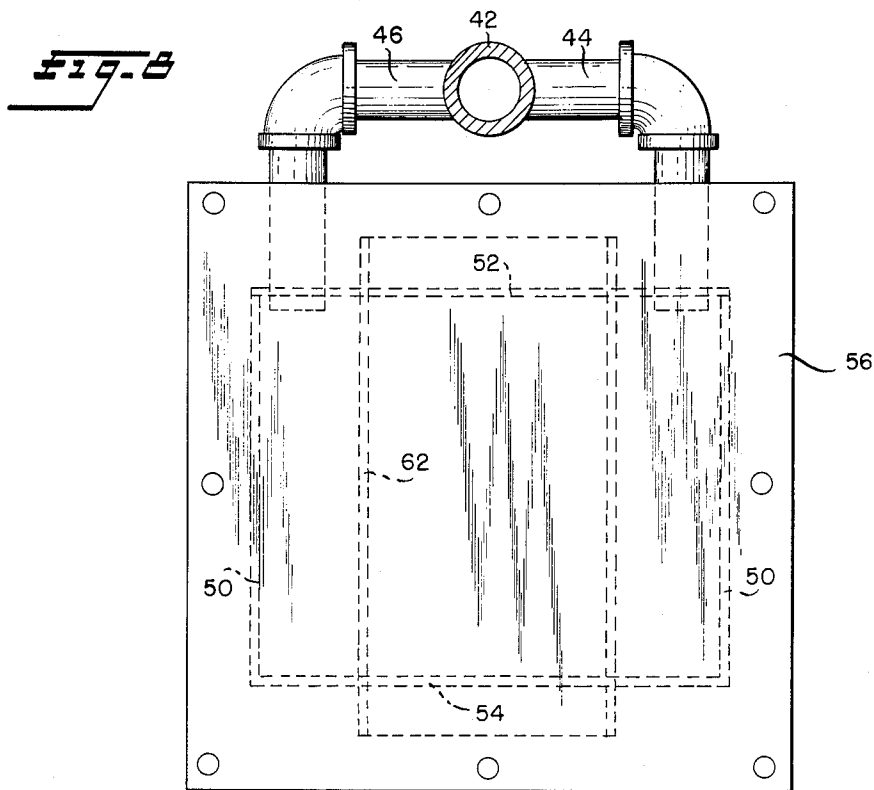


Fig. 10

Fig. 9

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METHOD OF BONDING CONTAINER CLOSURES
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5 Claims. (Cl. 93—44.1)

This patent relates to industrial heating equipment and, more specifically, to gas-fired, infra-red heating units for heating plastic coated container closure elements to seal the container and to methods for sealing plastic coated containers.

It is, at the present time, a common practice to deliver milk, orange juice, and other liquid foods to the consumer in paper containers. These containers are made of a single piece of coated paper stock, folded and sealed to form a four-sided box with a flat bottom and a gabled top.

The containers are delivered to the dairy as flattened tubes. In the dairy plant, they are placed in machines which automatically open each container to form a square tube, heat the end to be folded to soften or plasticize the coating, to fold the stock at one end of the tube to form a flat bottom, and apply pressure to the heated and folded stock to seal the end. Following the sealing operation, the machine sequentially delivers the container in an upright position to a filling unit where it is filled with a measured amount of the liquid it is to contain, closes the top to form a gabled end, and applies pressure to the gabled top to seal it.

Such containers were formerly coated with wax which was plasticized by heating the end of the container to be sealed with electric resistance heaters. Recently, however, it has been found that plastic coated paper provides a much more suitable container for liquid foods and this material is rapidly superseding wax coated paper for this purpose. The plastics commonly employed, however, soften at much higher temperatures than the waxes formerly used and, as a result, electric heating units cannot soften the coating fast enough to maintain the desired production speed.

In the type of machine described above, containers are commonly filled at a rate of about one per second, with about half of this time being used to advance the container from one machine station to the next. Thus, only about one-half second is available to heat the plastic to the softened stage necessary to provide a satisfactory bond when pressure is subsequently applied to the closure elements of the container. As a result of exhaustive experimentation looking toward a solution of this problem, it has been discovered that a suitably designed, gas-fired, infra-red heating unit will heat the coating to the desired temperature in this brief time interval of one-half second.

It is, therefore, the primary object of this invention to provide container sealing apparatus having a gas-fired, infra-red heating unit which will uniformly distribute radiant heat over that portion of the container to be sealed at such a rate that the coating will be heated to a temperature suitably plasticizing the coating in a time interval on the order of one-half second.

In fulfilling this object, a combustible gas-air mixture is distributed to a large area surface on which it burns, heating the surface to incandescence whereby the surface will radiate heat to the portion of the container on which it is desired the coating be plasticized. It is a requisite to obtaining the desired degree of softening in the allotted time that the radiant heat be uniformly distributed to this portion of the container. It has been found that uniform heat distribution can best be achieved by locating the container end (or other opening) to be sealed and those

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portions of the sides of the container adjacent that end within a channel-shaped structure having a radiant heating surface maintained at a temperature ranging from 1500° to 1700° F.

It is, therefore, a further object of this invention to provide a gas-fired, infra-red heating unit having radiant surfaces maintained at temperatures ranging from 1500° to 1700° F. with said surfaces being shaped to provide a channel in which that part of the container which is to form the bottom or other closure can be positioned with said surfaces being closely adjacent and surrounding the sides and end of the container.

To plasticize the coating in the allotted time interval, the radiant surface must be maintained at the above-mentioned high temperatures. However, as temperatures appreciably higher than 1700° F. will rapidly deteriorate the material forming or defining the radiant surface, it is necessary to maintain a highly uniform temperature distribution over the radiant surface to avoid hot spots. To accomplish such uniform temperature distribution, it is necessary that the gas-air mixture be uniformly distributed over the radiant surface.

It is, therefore, a further object of the invention to provide, in conjunction with the channel-shaped radiant heating surface, a U-shaped distribution chamber enclosing the outside of the radiant surface defining structure for distributing the gas-air mixture uniformly to all parts of the heating surface.

While, for the reasons discussed above, the radiant surface must be maintained at a uniformly high temperature, the distribution chamber must be kept relatively cool to avoid flashback and consequent ignition of the gas-air mixture within this chamber.

It is, therefore, a further object of the invention to provide a gas-fired, infra-red radiant heating unit having a high-temperature, channel-shaped, radiant surface surrounded by a distribution chamber with means for reducing the flow of heat from the radiant heating surface to the distribution chamber and additional means for dissipating heat from the distribution chamber to the surrounding atmosphere.

While a heating unit constructed pursuant to the foregoing objects and having the above-described features is, in general, eminently satisfactory, there are containers where closure elements are so configured and/or physically related that radiant heat will not envelope all of the coated surfaces with that degree of uniformity necessary to satisfactorily plasticize the coating in the allotted time interval and wherein additional heating is therefore required.

Accordingly, it is a further object of this invention to provide, in apparatus for sealing coated containers, burners providing both radiant and convective heating elements for plasticizing the coating on the container closure element.

The space available for burner installation is very limited in the standard commercial machines used for preparing coated containers for filling.

Accordingly, a further object of the invention is to provide a suitable heater which is very compact and, therefore, readily installed in the limited space available.

Further objects of the present invention include the provision of a heater of the type described above which is practical, which is economical to manufacture, which will have a long life, and which will require a minimum amount of servicing.

Further novel features and other objects of the present invention will become apparent from the following detailed description, discussion, and the appended claims taken in conjunction with the accompanying drawings showing preferred structures and embodiments in which:

FIGURE 1 is a perspective view of a paper tube to

be made into a container for transporting liquids by apparatus constructed in accordance with the principles of the present invention;

FIGURE 2 is an end view of the tube of FIGURE 1;

FIGURE 3 is a schematic illustration of a portion of a machine for closing and sealing the bottom of the container including a heating unit constructed in accordance with the principles of the present invention and a premixer for supplying the heating unit with a combustible fuel-air mixture;

FIGURE 4 is a sectional perspective view of the heating unit with said heating unit being oriented in a manner somewhat differently than in its normal operative position to better show its internal construction;

FIGURE 5 is a plan view of the heating unit with the container to be sealed in heating position and is taken substantially along line 5—5 of FIGURE 3;

FIGURE 6 is a horizontal sectional view through the heating unit taken substantially along line 6—6 of FIGURE 3;

FIGURE 7 is a vertical sectional view through the heating unit taken substantially along line 7—7 of FIGURE 5 with certain of the heating unit components being broken away to better show its internal construction;

FIGURE 8 is an elevational view of the heating unit viewed from the right of FIGURE 3;

FIGURE 9 is a perspective view of one of the ceramic blocks providing the radiant energy emitting surfaces of the heating unit;

FIGURE 10 is a perspective view of the radiant screen located adjacent the ceramic blocks;

FIGURE 11 is a view similar to FIGURE 7 but showing an alternative embodiment of the present invention;

FIGURE 12 is a vertical sectional view of the embodiment of FIGURE 11 and is taken substantially along line 12—12 of that figure.

Referring now to the drawings and, in particular, to FIGURE 3, a typical container forming machine 12 incorporates a revolving indexing head or table 13 having a plurality of equally spaced, container-supporting arms 14 extending therefrom. Table 13 is advanced intermittently rotatably in the direction indicated by the arrow about an axle or shaft 16 on which it is rotatably supported by suitable bearings (not shown). More specifically, at the end of equal time intervals, the table 13 is advanced through an angle equal to the angle between adjacent arms 14, coming to rest after each advance with one of the arms 14 at each of the work stations *a*, *b*, *c*, *d*, *e*, *f*, *g*, and *h*. After each advance, table 13 remains stationary for a time interval of sufficient duration for completing the slowest of the operations performed at the several work stations. In a typical machine of this type, 0.5 second is required to advance arms 14 from one station to the next and the arms dwell or remain at each station for 0.5 second.

While the table 13 is at rest, a partially completed container 15 is slid over the arm 14 at station *a* to the position shown in FIGURE 3, by suitable automatic mechanism (not shown) or manually, this operation being the initial step in the container forming, filling, and sealing sequence. As is shown in FIGURES 1 and 2, container 15 at this stage is formed from a single piece of material folded to provide a hollow, rectangular, open-ended, tube-like structure. The side edges of the material from which the container is formed are overlapped and sealed together as indicated generally by the reference character 16*a*. The side walls 17 of the as yet embryonic container 15 thus formed are scored along the lines 18 to provide foldable closure forming elements or flaps 19 which, when folded into juxtaposition and bonded together, will form a bottom end wall for the container. Similar flaps 19' are formed at the upper ends of container side walls 17 to provide a top wall for the container after it is filled.

In order to adapt containers fabricated from paper or similar materials for carrying liquid food products such as milk, juices, and the like, the interior and exterior surfaces of container side walls 17 and/or flaps 19 may be coated with a suitable thermoplastic material to prevent distintegration of the container and to prevent it from leaking. Further advantage may be taken of the thermoplastic coating material by utilizing it to bond together flaps 19 to form the container bottom wall. To this end, a gas-fired, infra-red heating unit 20 is positioned at station *c*. When the open-ended container 15 is carried by the arm 14 on which it is disposed to station *c*, the end position of the container comprised of the flaps 19 is moved into the heating zone of the heating unit 20 where it will remain for the operation-performing dwell period of 0.5 second. In this interval, the coating on the flaps is heated to a temperature sufficiently high to plasticize it. By the term plasticize, it is to be understood, is meant that the thermoplastic material is reduced to a soft viscous state wherein it may be employed as a bonding and/or sealing agent.

Following the heating operation, the container 15 with the coating on its flaps 19 now plasticized is carried to station *d* where mechanism indicated generally by reference character 22 folds the flaps 19 and applies pressure to them to complete the sealing operation. At the next station *e* the sealed end of the container 15 is cooled by any suitable means (not shown). At subsequent stations the container is ejected from the arm 14, turned to an upright position, and moved to stations for filling the container and sealing its upper end. It is to be understood that the present invention is not limited in use to closing the bottom end of rectangular containers. On the contrary, it may, with minor modifications which will readily occur to the average mechanic familiar with the art, be used to seal a wide variety of closures on containers of many different shapes.

Referring now to FIGURE 5, when container 15 is at station *c*, the flaps 19, which will subsequently form the container's bottom end, are positioned within a channel-shaped recess 24 of heating unit 20 which is open at both ends to facilitate movement of the container into and out of the channel as it is advanced by arm 14. As will be described in detail later, the side and end surfaces of the recess are heated to incandescence so that they will emit infra-red radiant energy to the container to plasticize the coating thereon.

Turning again to FIGURE 3, a combustible mixture of gas and air is supplied to heating unit 20 from a premixer 26 connected to a gas supply line 28. Gas flowing through the supply line is maintained at a fixed pressure by a pressure regulator 30, and flows through a nozzle 32 threaded on the end of line 28 and an inlet port 33 into a chamber 34 in the premixer. Mounted in chamber 34 is a radially bladed impeller or fan 36 driven by a motor 38. Fan 36 induces a flow of air into chamber 34 through an air gap 40 between the end of nozzle 32 and the right-hand side wall of the distribution chamber and mixes the air and gas to form the combustible mixture which it delivers under pressure to the burner through a pipe 42 having branches 44 and 46 which divide the gas flow equally between the two sides of the heating unit 20 (see FIGURE 8). As is conventional, the position of the nozzle can be adjusted to regulate the proportion of air to gas by rotating it and thereby causing it to move toward (or away from) port 33.

The combustible mixture flows from pipe branches 44 and 46 to a U-shaped distribution chamber 48 (see FIGURE 4). Chamber 48 has an outer shell 49 formed of two side members 50, a top 52, and a bottom 54 (see FIGURE 8), welded together or connected in any other suitable manner into a rigid unit, and a back plate 56, fastened to flanges 58 formed on members 50, 52, and 54 of the welded shell assembly 49 by bolts 57. The inner side of the distribution chamber is formed by the channel

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24 which consists of three ceramic blocks 59 (FIGURE 9), a channel-shaped screen 66 (FIGURE 10), and a box-like support 62 (FIGURE 4) welded or otherwise rigidly secured within the outer shell 49.

As is best shown in FIGURE 4, the side and end walls of support 62 are cut away to form openings 64 of somewhat smaller dimensions than the ceramic blocks 59. The ceramic blocks 59 are cemented or otherwise suitably retained within support 62 adjacent openings 64 and form three sides of the channel 24, which, as was mentioned above, is open on the fourth side and at both ends. Blocks 59 have a large number of small through apertures 65 uniformly distributed over their face and extending through their thickness. The gas-air mixture passes from distribution chamber 48 through openings 64 in support 62 and through apertures 65 to the inside of the channel 24 where it burns as it emerges from the through apertures to the channel-defining surfaces of the ceramic blocks. This surface combustion heats the faces to a temperature on the order of 1700° F., causing them to emit infra-red radiation within the channel. Ceramic radiant heating blocks of the type used in this burner are described in detail in United States Patent No. 2,775,294 issued December 25, 1956, to G. Schwank for Radiation Burners to which reference may be had if it is deemed necessary.

Located within channel 24 adjacent ceramic blocks 59 is a U-shaped screen 66 (see FIGURE 10), fabricated of heat-resisting wires 68 such as nichrome attached to a frame 70 also made of heat-resisting metal. Preferably, the screen is located not more than ¼ inch away from the adjacent parallel faces of the ceramic blocks. As may be seen from FIGURES 5 and 6, the screen is so dimensioned that it will closely surround the end of the container to be sealed when the latter is positioned in channel 24.

The screen has several functions. The nichrome wires, which are heated to a high temperature by the heat emitted from ceramic blocks 59, reradiate heat to the faces of the blocks, helping to maintain them at a uniform high temperature and increasing the emission of radiant energy therefrom. The screen, in addition, adds to the radiating surface, prevents disturbance of the flame, and confines the flame close to the faces of the ceramic blocks. The frame 70 supports the screen from flanges 72 on support 62, to which it is attached by bolts 74. Frame 70 also protects these flanges from the heat radiated from the ceramic blocks and reduces the amount of heat transferred from the blocks to support 62, thereby helping to prevent flashback of the burning mixture from the faces of the blocks through apertures 65 to distribution chamber 48. To further reduce the transfer of heat to the shell 49 of distribution chamber 48, the ceramic blocks 59 are insulated from support 62 by strips of high-temperature insulating material (not shown) such as Carborundum Co.'s Fiberfrax cloth #970-J, cemented in place with an appropriate high-temperature cement such as Fiberfrax cement #OF-180.

While the above-described embodiment of the present invention employs perforated ceramic blocks to provide radiant surfaces, other radiant surface providing structures such as a series of wire screens may be employed and are considered to be within the scope of the present invention. Suitable screen burners are disclosed in co-pending application Serial No. 50,421 filed August 18, 1960, by John V. Fannon. The burner may be ignited by a conventional spark, hot wire, or pilot flame igniter, or may be lit manually; and safety controls to prevent escape of gas in case of flame failure or to prevent excessive temperature of the ceramic blocks may be provided. Such control systems may be of any of the several types common in the prior art. The heating unit 20 may be mounted on the container closing and sealing machine in any desired manner, the particular mounting arrangement depending on the construction of the unit to which

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it is attached. In the above-described embodiment, the heating unit is attached to the machine 12 by bolts 75 connecting back plate 56 of distribution chamber housing 49 to a pedestal 78 formed on the machine (see FIGURE 3).

Referring next to FIGURE 11, the gas-fired, infra-red heating unit 77 illustrated therein is similar to the heating unit 20 described above, and like reference characters have, therefore, been employed to designate like parts. As was discussed above, in some circumstances it is desirable to heat the container closure elements by convective as well as radiant heat transfer in order to more uniformly distribute heat to the coating. Heating unit 77 includes additional structure for heating a gaseous medium and causing it to flow over and into intimate contact with coating on the container closure elements to assist in plasticizing it. To this end, heating unit 77 is provided with a gaseous medium supply pipe 78 which extends upwardly through channel 24 closely adjacent the back of the screen 66. Referring next to FIGURE 12, the lower portion of supply pipe 78 is bent in a configuration substantially coextensive with the rectangle formed by the four side walls 17 of the container 15 on which it is desired to plasticize the coating. Formed in the side walls supply pipe 78 opposite screen 66 are four spaced apart jet apertures 80 which are located substantially on lines comprising extensions of the four intersections of or container corners formed by the side walls 17 of the container 15.

In use, supply pipe 78 is connected to a suitable pressurized source of gas, normally air. As the compressed air flows downwardly through supply pipe 78 and around the path provided by the bent lower portion of the pipe, it will be heated to a high temperature since it is located in close proximity to the incandescent ceramic block 59 forming the back of channel 24. The heated air then escapes at high velocity through the jet apertures 80 and sweeps across the interior, apposed surfaces of the closure elements of the container 15 positioned in channel 24, giving up its heat content to the coating on those elements. This blast of hot, compressed air insures an adequate supply of plasticizing heat will be distributed to the interior surfaces of the closure elements 19 so that a firm bond will be established when the closure elements 19 are subsequently brought into juxtaposition and sealed at station *d*.

The flow of compressed air through supply line 78 may be controlled by a suitable valve actuated by an automatic control (not shown) responsive to the indexing of table 13 of the closing and sealing machine. Normally, this control would be arranged to actuate the flow-controlling valve to the open position to permit a blast of heated air from the jet apertures 80 during the dwell period when a container is positioned in the heating channel 24 and to actuate the flow-controlling valve to the closed position to discontinue the blast of air at the end of this period.

It has been discovered that an additional benefit accrues from employing a blast of compressed air in the manner described. As was discussed above, the combustible mixture burns closely adjacent the faces of the ceramic blocks 59, the zone of burning being there confined by the heat resistant screen 66. As a result of the combustion process, a blanket of combustion products comprising, in the main, carbon monoxide, carbon dioxide and minute incandescent particles of unburned carbon is formed adjacent the faces of the ceramic blocks. When the blast of hot compressed air emerges through the jets 80 in the supply line 78, it entrains these combustion products, which retain a high heat content, and sweeps them along with the compressed air into contact with the coating on the container closure elements where an appreciable amount of the heat content of the entrained combustion products is given up to the coating, raising its temperature and assisting in plasticizing it.

The sweep of hot compressed air and entrained combustion products across the container closure elements assist in uniformly distributing heat to the internal surfaces of these elements, thereby assuring that a firm seal will be obtained when pressure is applied to the closure elements at folding and sealing station *d*.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by Letters Patent is:

1. In the method of sealing a container or the like having enclosure defining wall structure and closure forming portions coated with a thermoplastic material and forming prolongations of said wall structure, the steps of:

- (a) reducing said coating to a plasticized state by positioning the closure forming portions adjacent the radiant surfaces of a gas-fired infrared generator;
- (b) directing a stream of gas serially adjacent said radiant surface to heat said gas and entrain therein combustion products emanating from said generator and into contact with said closure portions to additionally heat the coating thereon;
- (c) bringing said closure elements into juxtaposition while said coating is in said plasticized state; and
- (d) applying pressure to said juxtaposed portions to form a bond therebetween while said coating is solidifying.

2. In the method of bonding together closure forming elements coated with a thermoplastic material to form a container closure, the steps of:

- (a) reducing the coating of thermoplastic material to a plasticized state by positioning the closure forming elements adjacent to the radiant surfaces of a gas-fired infrared generator;
- (b) providing for a source of heated gas;
- (c) distributing said heated gas in the form of jets directed toward said closure forming elements;
- (d) entraining with said jets of heated gas hot combustion products produced by operation of said generator;
- (e) sweeping said jets of heated gas with the entrained hot combustion products into intimate contact with said coating to assist in plasticizing said coating;
- (f) bringing said closure elements into juxtaposition while said coating is in its plasticized state; and
- (g) applying pressure to said juxtaposed elements to form a bond therebetween while said coating is solidifying.

3. The method defined in claim 2 comprising the step of heating said gas with said generator prior to distribution thereof in the form of jets.

4. In the method of bonding together thermoplastic coated, closure forming elements of a container to form a closure therefor, the steps of:

- (a) advancing the container to be sealed to a first station and retaining it at said first station for a predetermined dwell period;
- (b) reducing the thermoplastic coating to a plasticized

state by heating the closure forming elements with radiant energy emanating from the radiating surfaces of a gas-fired infrared generator disposed at said first station;

- (c) providing for a source of heated gas;
- (d) distributing said heated gas in the form of jets directed toward said closure forming elements only during the dwell period of said container at said first station;
- (e) entraining with said jets of heated gas hot combustion products produced by operation of said generator;
- (f) sweeping said jets of heated gas with the entrained hot combustion products into intimate contact with said thermoplastic coating to assist in plasticizing said coating;
- (g) transferring said container to a second station after the coating is plasticized;
- (h) bringing said closure elements into juxtaposition while the coating is in its plasticized state at said second station; and
- (i) applying pressure to the juxtaposed elements to form a bond therebetween while said coating is solidifying.

5. In the method of sealing a container or the like having a closure defining wall structure and closure forming elements coated with a thermoplastic material and forming prolongations of said wall structure, the steps of:

- (a) providing an infrared generator having at least one radiant surface for producing a zone of infrared radiant energy;
- (b) positioning said closure forming elements adjacent to said radiant surface to heat and thereby plasticize the coating of thermoplastic material thereon;
- (c) directing a continuous stream of gas through said zone to be heated by the radiant energy therein;
- (d) directing said stream of gas passing out of said zone through the interior of said container in intimate wiping contact with said closure forming elements to assist in plasticizing the coating thereon;
- (e) bringing said closure forming elements into juxtaposition while said coating is in a plasticized state; and
- (f) applying pressure to the juxtaposed elements to form a bond therebetween while said coating is solidifying.

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