(12) UK Patent Application (19) GB (11) 2 094 707 A

(21) Application No **8117022**
(22) Date of filing **3 Jun 1981**
(30) Priority data
(31) **8108436**
(32) **18 Mar 1981**
(33) **United Kingdom (GB)**
(43) Application published **22 Sep 1982**
(51) **INT CL^3 B29C 27/02**
(52) Domestic classification **B5K 3**
(56) Documents cited
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GB 0954970
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(58) Field of search **B5K**

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(54) Process and apparatus for providing a sealed package

(57) Plastic bags 4 are sealed in the neck region by ballooning of the neck region and exposure of the ballooned neck portions to infra-red radiation emitted by heating units 13, 14, Figure 1, or 37, 38, Figure 2A. The thus heated neck region is then collapsed onto itself to seal upon contact.

The mouth region of each bag is held by yieldable members 33, 35 so that air can escape slowly from the interior thereof but cannot re-enter. Shrinking heat is applied to the bag 4 by activation of fan motors 8, 9 and heating elements 10, 11 so that trapped air holds the bag ballooned out. Radiation from units 37, 38, protected by wire screens 39, 40, heats the bag material to its softening point. A heated wire 48 of saw-tooth or sinusoidal shape cuts the bag neck to allow escape of air from the bag and vertically movable clamping bars 45, 46 come together to effect the seal, the units 37, 38 being swung aside. A blade 47 cuts away surplus bag material. The bag may be made of a laminated film of ethylene-vinyl acetate, polyvinylidene chloride and irradiated ethylene-vinyl acetate.

Fig.2A.

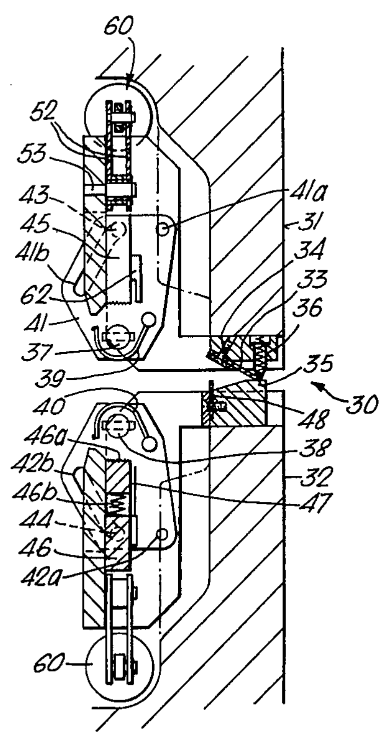

Fig.1.

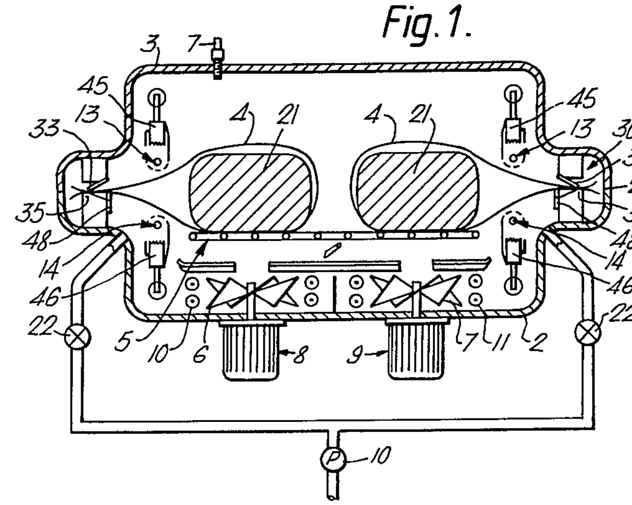

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Fig. 1.

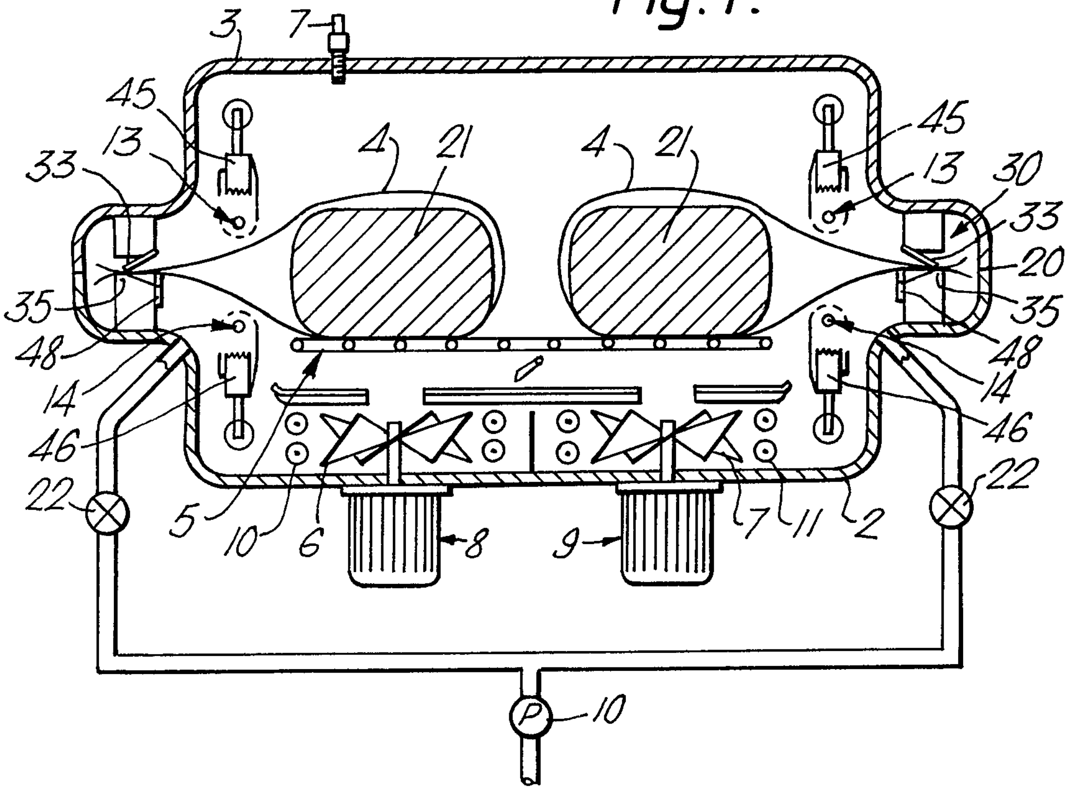


Fig. 3.

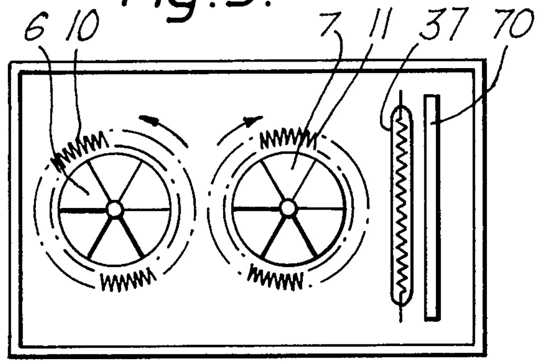


Fig. 4.

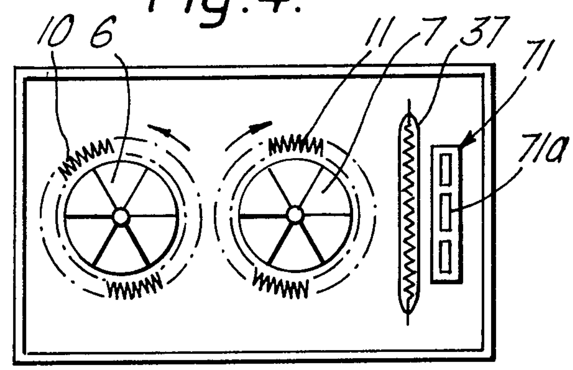


Fig. 5.

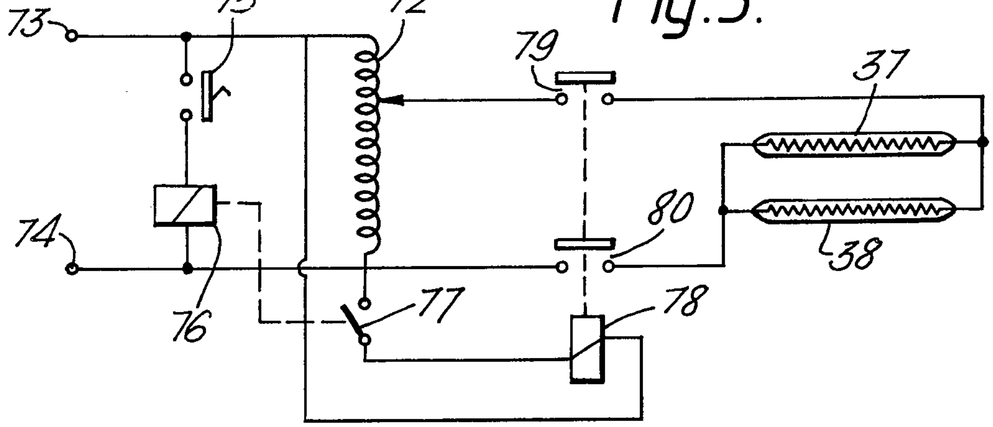
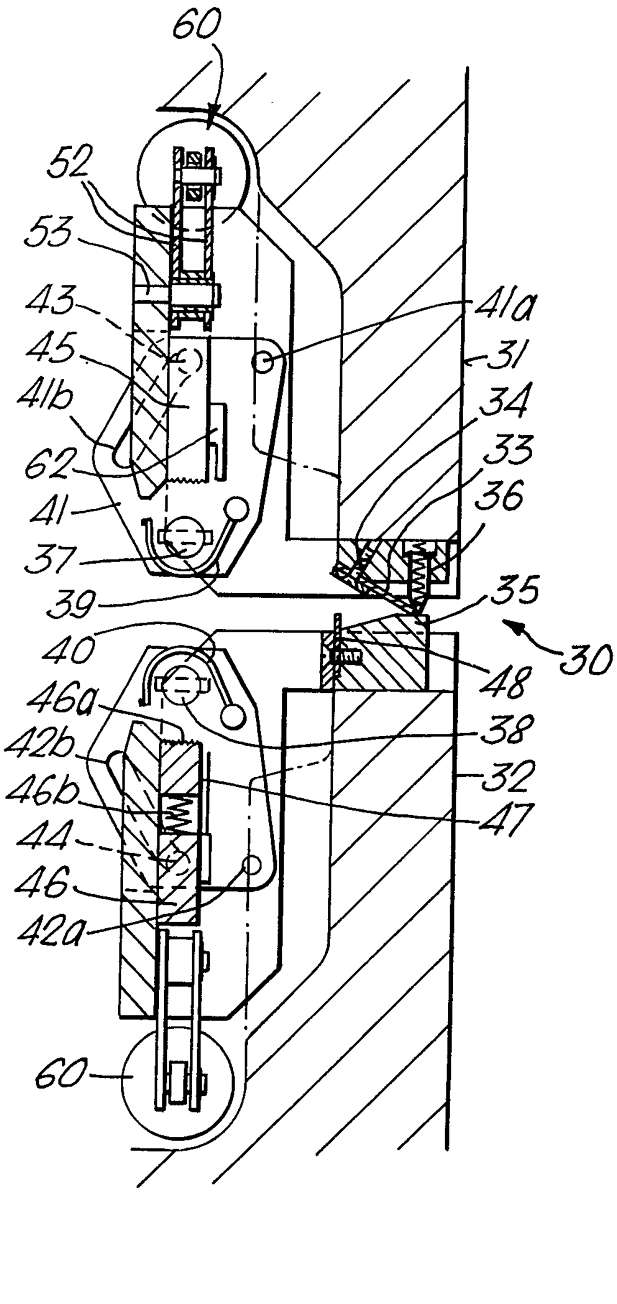


Fig.2A.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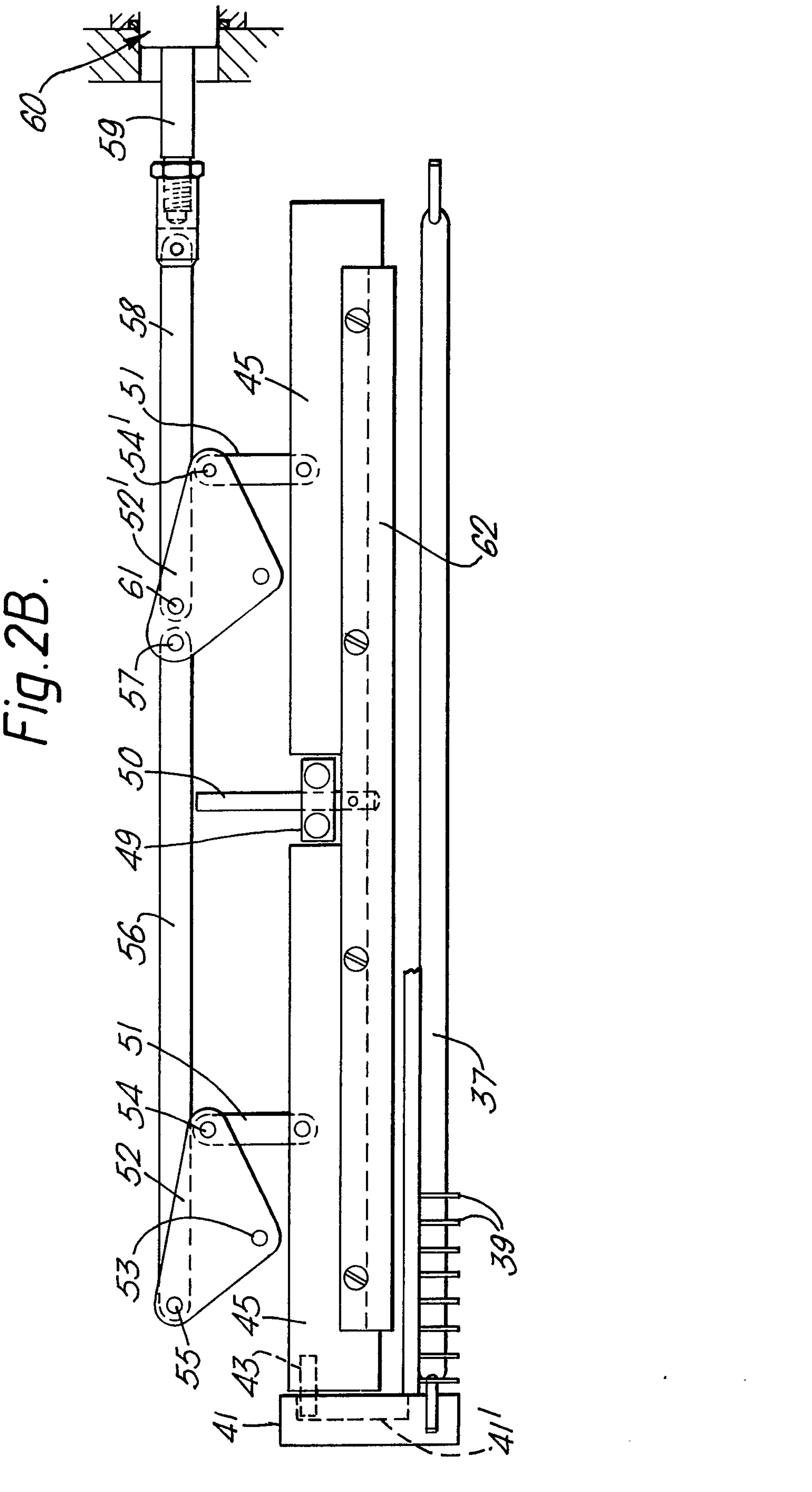

Fig. 2B.

SPECIFICATION

Process and apparatus for providing a sealed package

The present invention relates to a process and apparatus for forming a sealed package, in particular by fusing together layers of film material (which may themselves be bonded multi-ply film structures) to seal a package. Such a package may, for example, be a vacuum pack, but equally could contain an inert gas which assists in preserving the contents of the package, particularly where the contents are perishable.

Various methods are known for sealing films. In widespread use at the moment are:- clipping to close off the neck of a bag formed of the film material, heat-sealing by the simultaneous application of heat and pressure to press two layers of the film together into fusing contact, and adhesive sealing, for example by coating one or both of the surfaces which are to come into contact for sealing together with an adhesive composition so that the contacting surfaces seal when pressed together.

In addition to heat sealing by pressing films together using heated mechanical clamping bars, it is also known from U.S. Patent Specifications Nos. 3989778 and 4069080 to irradiate clamped layers of film with energy from a laser to promote localised fusing of the surfaces in contact with one another. It is also known, from U.S. Patent Specifications Nos. 3477194 and 3247041, to irradiate clamped layers of film with infra-red radiation from an adjacent source for the purpose of bonding them together.

These prior art specifications all rely on the application of heat to portions of the films which are already clamped in sealing relation, so the application of such a system requires careful registration of the clamped film portions with the path of emission of energy from the infra-red source or laser, as the case may be. Furthermore, particularly with regard to the use of infra-red radiation, it is difficult to avoid having distances between the infra-red source(s) and the clamped film portions which (in order to provide ample room for manipulation of the packed product and the material therearound) are so great that the radiation losses which vary inversely in proportion to the square of the distance from the heat source, become considerable.

In order to overcome the disadvantages of the prior art systems using radiant heat to seal plastics material, the present invention provides a process for forming a package, comprising enveloping goods in a plastics film arranged with corresponding film portions which will be brought into contact with one another to seal the package, maintaining said corresponding film portions out of contact with one another before sealing, heating said corresponding film portions with infra-red radiation, then bringing said heated film portions into contact with one another to fuse together on contact.

Another aspect of the present invention provides apparatus for forming a package, comprising a support for goods and an enveloping plastics film, at least one infra-red radiation source positioned to irradiate corresponding film portions of such a supported enveloping film, means for maintaining said corresponding film portions out of contact with one another during operation of said infra-red radiation sources, and means for subsequently bringing said corresponding film portions into contact with one another to close the package.

Although the process and apparatus of the present invention find application in various different types of packaging, they are particularly suitable for the vacuum packaging of products in a chamber.

Accordingly, a further aspect of the present invention provides a process for forming a vacuum package, comprising enveloping a product in plastics film, placing the enveloped product within a vacuum chamber, evacuating the chamber to reduce the pressure within and around the plastics film, and sealing corresponding portions of the enveloping film to form a vacuum package, wherein the step of sealing the film portions comprises irradiating said corresponding film portions within the chamber with infra-red radiation, and bringing said heated film portions into contact with one another to fuse on contact.

Yet a fourth aspect of the present invention provides apparatus for forming a vacuum package, comprising a vacuum chamber, a support within the chamber for a loaded plastics bag, means for constricting the neck of the bag within the chamber, means for ballooning the neck of said bag supported on the support with its neck constricted by said neck-constricting means, infra-red radiation-emitting means in said chamber energisable for irradiating the ballooned neck of said bag to heat the ballooned neck material, and means for releasing gas from within the said bag to remove the bag neck from its ballooned configuration after heating of the bag by said infra-red radiation-emitting means and for causing the heated ballooned neck material to contact itself and to seal upon contact.

The invention also provides a package formed by either of the above processes, or using either of the above apparatuses.

In order that the present invention may more readily be understood the following description is given, merely by way of example, with reference to the accompanying drawings in which:-

Figure 1 is a side elevational view, in schematic form, of one form of vacuum chamber in which the process of the present invention can be carried out;

Figure 2A is a detail, in sectional form, of the sealing mechanism incorporated in the chamber of Figure 1;

Figure 2B is an end elevational view of the sealing mechanism of Figure 2A;

Figure 3 is a top plan view, in schematic form, of an alternative form of vacuum chamber in which the process in accordance with the present invention can be carried out;

Figure 4 is a view, similar to Figure 3, but showing yet a further embodiment of vacuum chamber in which the process can be carried out; and

Figure 5 is a circuit diagram of a simple form of control system for the infra-red heat sources used in Figures 1 to 4.

Referring now to Figure 1, there can be seen a vacuum chamber 1 comprising a base portion 2 and a cover 3 which are closed together and seal around their rims 20 to form a sealed enclosure within which two plastic bags 4 (in this case formed of a heat-shrinkable material) enclosing product articles 21 can be evacuated and sealed.

Shrinking heat is imparted to each bag 4 by means of two fans 6 and 7 driven by respective motors 8 and 9 and circulating air by way of circular heating elements 10 and 11 which, while shown in side elevation in Figure 1, are identical to the construction of the corresponding heating elements 10 and 11 shown in plan view in Figures 3 and 4. The radially outward airflow from the centrifugal fan rotors 6 and 7 passes over the heating elements 10 and 11, becomes heated thereby, and then contacts the bags 4 above a support grid 12 in the chamber. The bags then acquire heat from the air and shrinks to the desired extent, depending on the extent to which the film was oriented during manufacture.

The chamber further includes upper and lower heating units 13 and 14 incorporating infra-red heat-emitting strip lamps (37 and 38 in Figure 2A) which radiate heat to the spaced film portions of the neck regions of the bags 4 and heat the neck regions to a sufficient extent so that when these film portions subsequently contact one another, for example, during repressurisation of the chamber 1, the film layers automatically fuse together.

The detailed construction of these upper and lower heating units 13 and 14 will be described with reference to the detailed drawings of Figures 2A and 2B.

The mouth region of each bag is clamped by a yieldable bag holding means having upper and lower members 33 and 35, also shown in Figures 2A and 2B, in such a way that air is able to escape from the interior of the bag 4 between the upper and lower heating units 13 and 14 and the upper and lower members 33 and 35, but by virtue of the yieldable bag holding action air is not able to re-enter the bag through the mouth region.

The evacuation cycle used in the chamber of Figure 1 can be one of several different forms.

As a first example, it is possible for the shrinking heat to be applied to the bag 4, by activation of the fan motors 8 and 9 and the heaters 10 and 11, before evacuation of the chamber 1. This will result in the heat-shrinking of the bag material. This heat-shrinking tends to compress the air trapped between the product 21 and the bag 4 and the trapped air holds the bag "ballooned" out of contact with the relatively cold product while the tension in the heat-shrinking bag 4 builds up.

The air trapped within the bag 4 is then released when its pressure overcomes the resilient blade 33, allowing the shrink energy pent up in the taut bag to force the bag material down onto the product 21. The vacuum pump is then started and evacuation of chamber 1 takes place. After a suitable delay, the shaped wire 48 is energised rupturing the bag neck to allow further evacuation of the bag through the neck. The chamber 1 continues to be evacuated in order to extract the remaining air from within the bag 4 and to allow the bag to be sealed. Such a cycle is the one described in relation to Figures 2A and 2B, and is in any case described and claimed in our copending British Patent Application No. 81.17021 (Folio 33484).

An alternative operating cycle for the chamber in Figure 1 is one in which the evacuation of the chamber 1 starts simultaneously with the activation of the heaters 10 and 11 and of the fan motors 8 and 9 and proceeds in such a way that the restriction of the bag mouth by the yieldable bag holding means results in delayed extraction of air from within the bag 4. This causes the bag 4 to balloon outwardly away from the product 21 as the pressure in the chamber around the bag 4 drops more rapidly than the pressure of the air within the bag 4. Once the bag has ballooned to a desired extent (as can be detected either by having a cycle timer which relies on the fact that a batch of similar product articles packaged in a similar film and subject to chamber evacuation at a similar rate will take the same time to balloon, or as detected by means of mechanical sensors responsive to ballooning bag 4), the evacuation of the chamber ceases so that the ballooned state of the bag is held during circulation of the remaining air in the chamber 1 by way of the fan rotors 6 and 7. This circulation of hot air causes further heat transfer to the material of the bag 4 with resulting recovery of the shrink energy in the bag 4 because the bag is still maintained out of contact with the product article 21 therein. Once this heating of the bag 4 has proceeded to a desired degree, evacuation of the chamber resumes and then the bag neck is eventually sealed when the interior of the bag has reached a sufficiently low residual pressure (high vacuum). Such a process is described and claimed in our British Patent Application No. 8023465.

Other possible operating cycles can be envisaged, for example in which the evacuation and hot air circulation begin simultaneously and continue uninterrupted until a sufficiently low residual pressure (high vacuum) is obtained, and the bag is then sealed.

With each of the above forms of operating cycle, the chamber of Figure 1 will preferably include the upper and lower heating units 13 and 14 shown in Figures 2A and 2B.

As shown in Figure 2A, the yieldable bag-holding means 30 is supported by an upper support member 31 forming part of the chamber cover 3 and a lower support member 32 of the lower chamber part 2. As the cover 3 closes onto the lower chamber 2 the upper support member 31 descends towards the lower support member 32 to adopt the configuration shown in Figure 2A.

A resilient bag-holding blade 33 of suitable rubber-like material is carried by the upper support member 31 and is secured thereto by a set of screws 34. Along its lower edge, the reslient blade 33 contacts a counter member 35 carried by the lower support member 32. The counter member may alternatively be a blade similar to the blade 33. After the neck of a plastics bag is placed on the counter member 35 while the chamber cover 3 was in the raised position, lowering of the chamber cover 3 to bring the upper and lower support members 31 and 32 into the Figure 2A configuration automatically causes the bag neck to be held on the counter member 35 such that any build-up differential air pressure within the bag above a certain value can be vented by displacement of the blade 33. Retraction of the bag neck leftwardly between the blade 33 and the counter member 35 is resisted by spring-loaded plungers, one (36) of which is shown in Figure 2A, pressing the back neck firmly onto the counter member 35.

The angle of inclination of the yieldable blade 33 is such that air under a sufficient differential pressure is able to escape from within the bag at least in the mouth regions between successive plungers 36.

Sealing of the bag neck, in such a way that the minimum of air space results within the bag around the neck, is achieved by means of upper and lower heat sources 37 and 38, in the form of strip lamps which radiate infra-red heat at a wavelength which gives optimum heat absorption by the plastics composition of the bags 4 within the chamber.

The wavelength of the light emitted by the lamps 37 and 38 is advantageously chosen to coincide with the wavelength most readily absorbed by the material of the bag. Conveniently the wavelength in question is in the range from 3 to 4 microns for most plastics films, including multi-ply films and laminates such as a heat-shrinkable (i.e. oriented) three-ply laminate of ethylene-vinylacetate, polyvinylidene chloride and irradiated ethylene-vinylacetate.

A brief exposure of the bag neck region to the radiation from the heat emitters 37 and 38 will be sufficient to heat the bag material to its softening point so that when the panels of bag material are pressed together they will seal at the mouth and neck regions.

Contact of the bag material with the upper and lower heat sources 37 and 38 is prevented by means of wire screens 39 and 40 carried by respective upper and lower pairs of carrier plates 41 ad 42 pivoted on pins 41*a*, 42*a*. Each carrier plate 41, 42 has a slot 41*b*, 42*b*, which slidably co-operates with a respective cam pin 43 or 44 carried at the associated end of a vertically movable upper or lower clamping bar 45 or 46, respectively. The lower clamping bar 46 includes a main body having a resiliently biased jaw member 46*a* connected thereto by means of helical compression springs 46*b* which ensure that as the two pressure bars 45 and 46 come into contact with one another the jaw member 46*a* yields.

The holding means 30 furthermore includes a shaped wire 48 carried by the counter member 35 and which in the Figure 2A configuration of the holding means contacts the ballooned bag neck. When energised with a current pulse the wire ruptures the bag neck to allow escape of the gas (usually air) within the ballooned neck before sealing. The wire 48 may, for example, have a saw-tooth shape or a sinusoidal undulating shape.

As the upper clamping bar 45 descends, its cam pins 43 slide down the slots 41*b* and causes the upper pivotable carrier members 41 to pivot in the anti-clockwise direction to swing the heat source 37 and its wire screen 39 rightwardly away from the path of descending travel of the upper clamping bar 45.

Similarly, as the lower clamping bar 46 ascends its cam pins 44 co-operate with the slots 42*b* of the lower carriers 42 to swing those carriers aside and to move the lower heat source 38 and its wire screen 40 away from the path of travel of the rising clamping bar 46. This allows the film material to be clamped beween the two clamping bars 45 and 46. At the same time, a blade 47 carried by the main body portion of the lower clamping bar 46 is exposed above the yieldable jaw 46*a* due to yielding of the compression springs 46*b* and is able to cut the surplus bag material from the neck during sealing.

Figure 2B shows the drive mechanism by virtue of which the upper clamping bar 45 is driven for its vertical movement.

As shown in Figure 2B, the upper clamping bar 45 is in two separate parts supported by a central bearing portion 49 on a vertical guide pin 50 to allow vertical sliding of the two parts of the upper clamping bar 45.

The two clamping bar parts are connected to the lower ends of respective thrust links 51 which in turn have their upper ends articulated to respective double bell-crank assemblies 52, 52′ of which one, 52, can be seen in Figure 2A.

The lefthand of the bell-cranks 52 has a fixed pivot pin 53 at one corner, a pivot pin 54 at another corner articulating it to the thrust link 51, and a further pivot pin 55 at the third corner articulating it to one end of a secondary drive strut 56.

The other end of the secondary drive strut 56 is articulated at 57 to a corresponding corner of the righthand double bell-crank assembly 52′ which also has counterpart pivot pins 53′ and 54′ to correspond to the pins 53 and 54 above-described.

A primary drive strut 58 is connected between the piston rod 59 of a ram 60 and a further articulation pin 61 on the righthand double bell-crank assembly 52′. Extension and retraction of the piston rod 59 causes anti-clockwise or clockwise motion, respectively, of the bell-crank assemblies 52, 52′ and consequently raising and lowering movement of the clamping bars 45.

A similar drive linkage and drive ram will be provided to drive the main body of the lower clamping bar 46 upwardly and downwardly.

As also shown in Figure 2B, the upper clamping bar 45 has a guard member 62 screwed thereto, for the purpose of defining a gap into which the blade 47 can enter when the upper and lower clamping bars 45 and 46 come together.

The holding means 30 of Figure 2A and Figure 2B operate at several stages during the cycle of the entire machine as will be described later.

The operation of the apparatus shown in Figure 1, when using bags 4 formed of a heat-shrinkable, i.e. orientated, film material is as follows:-

A loaded but unsealed bag 4 of heat-shrinkable packaging film is placed in the vacuum chamber 1, and the chamber cover 3 is driven downwardly to close the chamber and to allow sealing of the chamber at its rim 20.

One form of heat shrinkable (i.e. oriented) film used for the bag 4 may be a three-ply laminate of ethylene vinyl acetate, polyvinylidene chloride and irradiated ethylene-vinylacetate, as disclosed in United States Patent No. 3,741,253 and as sold by W.R. Grace & Co, under the Trade Mark "Barrier Bag".

As explained above, the lowering of the chamber cover 3 brings the resilient blade 33 down against the bag neck to hold the neck firmly on the top surface of the counter member 35. At this stage the upper and lower clamping bars 45 and 46 are retracted and the heat sources 37 and 38 are in the configurations shown in Figure 2A.

Shrinking heat is applied to the exterior of the bag before any substantial evacuation of air from the interior of the chamber and the applied heat causes the bag material to begin to shrink. The air enclosed within the effectively sealed bag (held by the resilient blade 33) resists the shrinking action and holds the bag material "ballooned" away from the surface of the product (for example a cut of fresh red meat) therein. While the bag is thus maintained clear of the surface of the product, the circulation of hot air around the outside of the ballooned bag material imparts further heat to the bag material and completes the heat-shrinking operation to draw the film material back down against the surface of the product. However, the bag material will have been ballooned away from the surface of the product for long enough to allow adequate heat transfer to the ballooned film which is not able to give up any appreciable heat to the product 21, and to have raised the film to its shrinking temperature so that a very high proportion of the shrink energy can be recovered.

During this time, the heat sources 37 and 38 will either be de-energised or more preferably energised to a low heating level which will not enable them to heat the film material of the bag neck to a temperature sufficient to achieve fusion.

The constriction of the bag mouth when engaged by the yieldable holding means 30 ensures that, as the application of heat by convection to the exterior of the bag proceeds, any excessive pressure differential built up within the bag can be controlled by venting of gas (usually air) from the interior of the bag 4 to an extent which will still maintain the bag material "ballooned" away from the surface of the product 21 therein. Since the ballooning action will depend upon factors common to a particular batch of products 21 (for example the surface temperature, the amount of air contained within the product, and the surface nature, -e.g. tackiness - of the product) it may be convenient to determine, by observation, when ballooning is likely to occur and then to time the process such that the evacuation begins at the same time for all the products of a batch and is timed by a suitable timer. Any other control means may be employed, as desired.

Because, during the heat-shrinking step, the bag is still yieldably held across its neck, further escape of air from within the bag may occur through the neck in the unlikely event of an excessive pressure differential across the bag material, while the remainder of the bag will shrink back onto the surface of the product article 21 so as to provide a substantially wrinkle-free surface covering to the product article 21 and nevertheless leave the bag neck capable of sealing when the clamping bars 45 and 46 close together to contact one another.

At the end of the ballooning phase, and before evacuation of the bag is to commence, the shaped wire 48 is briefly energised to rupture the bag neck and to release the trapped gas therewithin.

Evacuation of the chamber atmosphere (and of the now ruptured bag 4) proceeds until the desired vacuum level has been reached. At, or slightly before, the end of the evacuation phase the lamps 37, 38 can be energised to their maximum level to emit radiant heat at the desired wavelength for optimum heat absorption by the film material, and thereby to heat the pierced bag neck to fusion temperature.

The rams 60 are then operated to bring the upper and lower clamping members 45 and 46 together, simultaneously swinging away the sources 37 and 38 and their associated wire screens 39 and 40.

Once the upper clamping bar 45 has come into contact with the biased clamping jaw 46*a*, further operation of the rams 60 results in the blade 47 severing the bag neck to detach the surplus material therefrom. The clamping members 45 and 46 ensure firm holding of the neck alongside the blade 47 to effect sealing. Throughout this operation, the mouth portion of the bag will still have been clamped between the yieldable blade 33 and the counter member 35 so that the bag will still be securely located within the holdng means 30.

The retraction of the upper and lower clamping bars 45 and 46 will bring the heat sources 37 and 38 and their wire screens 39 and 40, respectively, back into the Figure 2A configuration. The evacuation of the chamber takes place after this retraction of the clamping bars 45, 46 so that unhindered escape of any residual air from the bag can take place.

When the vacuum chamber is re-pressurised upon opening, the heated neck portions of the bag to the left of the clamping members 45 and 46 are thrust together to achieve fusion welding and to reduce the size of any surplus bag material around the sealing zone to achieve a tidy appearance to the finished pack.

The surplus bag material severed by the blade 47 is still held between the resilient blade 33 and the counter member 35 and can be removed during or after removal of the package from the opened chamber.

The above-described process is particularly convenient for use with wet products such as fresh red meat in heat-shrinkable bags because the pressure increase on the surface of the meat, during the bag-ballooning action, tends to hold the moisture in the product and avoids misting of the inner surface of the bag when in the ballooned condition. Furthermore, the rapid venting of the trapped air upon bag piercing allows the bag material to contact the product rapidly and before any such misting occurs. Consequently, the appearance of the finished package is particularly attractive in the case of moist products such as fresh red meat.

In the case of all products packed by this process, the wrinkle-free nature of the product is enhanced through the adoption of a preliminary shrinking step followed by subsequent evacuation (as opposed to the conventional sequence of vacuum-sealing first and shrinking afterwards).

The finished package in accordance with the present invention is moreover much improved over prior art shrink-tidied packages in which a water shrink bath is used in order to alleviate the "heat-sink" effects of the relatively cool and high thermal capacity product, because shrinking of the film in contact with air allows a greater recovery rate of the shrink energy, and consequently a greater increase in thickness, with the result that the barrier properties of the bag (important in order to maintain hermetic sealing of the product and freshness up to the time of consumption) are more effective. Furthermore, the abuse-resistance of such a bag is better because of the increased thickness.

Because the air pocket trapped inside the bag during the pre-heating shrink phase resists the collapsing of the bag and postpones contact of the bag with the cold product, this thickness-increasing effect is even more noticeable and so also is the wrinkle-free appearance of the bag which again depends on the extent of recovery of latent shrink energy in the film material. Moreover, because the shrink is provoked by air currents moving around the whole of the product, the shrinkage of the bag will be uniform around the product and this will eliminate risk of entrapment of air pockets behind the "equator" of the product (i.e. the area of the largest cross-section in a plane perpendicular to the longitudinal axis of the bag).

Furthermore, the above-mentioned characteristic of having little or no water vapour in the air between the product and the shrinking bag (caused by the onset of shrink before any pressure reduction and even causing a slight pressure increase) ensures that less shrink heat is required because the dry air on the inside of the bag absorbs less heat than would moisture-laden air.

Because the lower and upper support members 32 and 31 of the yieldable holding means 30 are carried by the lower chamber portion 2 and the chamber cover portion 3, respectively, they automatically close together to contact one another when the chamber is closed and all that the operator needs to do is to ensure that the neck of each bag 4 is placed on the respective counter members 35 before the chamber closes.

If desired, where the loaded bags are introduced by a conveyor into the chamber 1 the conveyor may be one which ensures that, when the bag 4 is stopped, the bag neck is correctly positioned for constricted clamping without the need for careful positioning by an operator.

As indicated above, other bag closing mechanisms may be provided for use with the radiant heat sealing units 13 and 14 described above.

For example, the bag neck may be closed by a conventional trim-sealing bar 70 (Figure 3) which both cuts off excess material and seals the bag mouth along the line of pressure between upper and lower clamping bars (by means of a resistance heater). The application of heat to the neck region between the trim-sealing unit 70 and the product 21 has the result that when the chamber 1 is re-pressurised the bag material in the neck region will have been heated to an extent that it will fuse to itself on collapsing, leaving a much tidier neck region to the package.

Alternatively, the bag neck may be placed in a gathering unit 71 (Figure 4) so as to be gathered in a vacuum chamber when the chamber closes, and has a clip attached to the neck of the bag by the clipping unit 71*a* after the evacuation and shrinking operations have been completed. Such in-chamber clipping means is for example disclosed in our British Patent Specification No. 1,353,157.

Yet a further possibility is for the clipping unit 71*a* to be omitted from Figure 4 and for the gathering action to be carried out after the energisation of the infra-red heat sources has achieved heating of the bag neck in the region which is about to be gathered. When the thus heated and softened bag neck regions are drawn together by operation of the gathering unit 71 (which may for example be of the kind described and claimed in British Patent Specifications Nos. 1,353,157, 1,361,142 and 1,496,740) the gathering action is sufficient to cause the neck material to adhere to itself and to resemble the configuration of a clipped neck but without a clip. The mere heat-softening of the bag neck region will be sufficient to cause intimate contact and sealing of the gathering neck region.

The schematically illustrated gathering unit 71 may for example operate in two stages, as disclosed in British Patent Specification No. 1,353,157, in that it first of all gathers the bag into a horizontal slot-like configuration as the chamber closes, and achieves sufficient restriction of the flow of gas from the bag interior to promote the desired ballooning effect before energisation of the infra-red radiation sources. Then the second stage of gathering reduces the length of that slot to bunch the bag neck into a self-adhering gathered configuration. Alternatively, some other bag mouth-constricting action may be exerted on the bag and the gathering unit 71 then operated to completely gather the bag neck after the ballooning heating action.

The above description of the various cycles of operation possible with the chamber 1 of Figure 1 refers throughout to the use of a heat-shrinkable film. However, it may be possible to use the process according to the present invention with other films, for example self-welding films which are heat-softened and will then weld when they come into contact with one another.

Likewise, the alternative chamber constructions shown in Figures 3 and 4 can be used with any suitable film, including heat-shrinkable film and self-welding film.

Figure 5 shows a schematic view of one possible control circuit for energisation of the radiant heat-emitting lamps 37 and 38. A variable transformer 72 is connected across input terminals 73 and 74, and across the same two terminals 73 and 74 there is connected a shunt line including a microswitch 75 and a timer 76. A further shunt line includes a switch 77 and a circuit breaker 78, the circuit breaker being itself connected to switch contacts 79 and 80 in the secondary circuit of the variable transformer 72. Thus the two switch contacts 79 and 80 control energisation of the infra-red emitting lamps 37 and 38 which are connected in parallel in the secondary circuit of the variable transformer 72.

The variable transformer is permanently energised, and the start of the cycle is triggered by operation of the microswitch 75, responsive to some moving mechanical component, for example the closing of chamber cover 3. Closing of the microswitch 75 starts the timing cycle of the timer 76 so that the switch 77 immediately closes, energising the circuit breaker 78 which closes contacts 79 and 80 to energise the lamps 37 and 38.

After a time delay determined by the timer 76, the switch 77 is opened, breaking the circuit to the circuit breaker 78 which then opens contacts 79 and 80 to de-energise the lamps 37 and 38.

In a particularly convenient modification of the circuit of Figure 5, arrangements may be made for the lamps 37 and 38 to be reduced to a standby power setting (for example at 20% of their full power) rather than be completely de-energised when the circuit breaker 78 is de-energised. This may, for example, be achieved by having a two way switch system at the contacts 79 and 80 so that in one position of the moving contacts a "standby" circuit is completed to energise the lamps 37 and 38 at their standby power setting, and in the other position of the movable contact the main circuit shown in Figure 5 may be energised.

Adjustment of the variable transformer 72 can allow the power of the lamps to be varied, and similarly the timer 76 may be adjustable to allow a time delay, for example of from 2 to 6 seconds, for the operation of the lamps 37 and 38.

One preferred type of lamp for use as lamps 37 and 38 is a Philips type 13195 X/98 lamp, obtainable from the Philips Electrical Company.

Advantages of using the fusion sealing system described and illustrated herein include the fact that the thermal inertia of the infra-red lamps 37 and 38 is very low so it is possible to turn them on only when fusion sealing is required. Furthermore, fusion sealing has the advantage that there is no physical contact between the lamps supplying the heat and the plastics material to be bonded.

It is a particularly important advantage of the present invention that the heat is applied by radiation to the films before they are put into contact with one another, thereby ensuring that the shortest possible radiant energy path from the lamps to the clamped films can be provided without the lamps 37 and 38 needing to be placed close together. Instead the lamps may be quite widely spaced and the bag neck material ballooned into the vicinity of the lamps so as to cut down the distance from the heat source to the bag material. This provides a much less cumbersome apparatus from the point of view of (a) loading the bag into the chamber, or (b) more generally (where the fusion sealing of a film enclosure to form a package is carried out without the use of a vacuum chamber) positioning any two film portions to be welded in a position ready for fusion heating with the apparatus in accordance with the present invention.

Furthermore, the amount of energy imparted to the films can quickly and easily be adjusted either by varying the supply voltage to the lamps, or by varying the time for which they are "on", or by adjusting both parameters.

If desired, the neck region of the bag may be printed with a material which has a high absorption co-efficient so as to provide even more intense localised heat uptake.

The vacuum levels envisaged for the processes described above will be of the order of 5 Torr. However, the vacuum can be much softer (higher residual pressure) if desired (for example when packaging products such as so called high-gassing cheeses which will naturally exude gas - for example carbon dioxide - and will do so at a much higher rate if packed under high vacuum conditions).

In Figures 1, 3 and 4, the means for applying heat to the bag material comprise fans circulating hot air. Alternatively, other bag heating means may be used in association with the radiant heat-emitting heating units 13 and 14.

Temperatures of 90°C to 140°C in the ballooned film will be required in order to achieve heat-shrinking in the case of a biaxially oriented shrinkable film. However, higher temperatures may be imparted by the radiant heat-emitting heating units 13 and 14 in the neck region of the film to promote fusion sealing.

The above description generally refers to the action on an individual bag 4 in the chamber, although it is made quite clear that in Figure 1 two separate bags 4 are provided. The method and apparatus of the invention can be conceived for use with one package, or with two or more packages sealed simultaneously, and this versatility will apply equally to the three separate embodiments depicted by Figures 1, 3 and 4, as well as to any other embodiments falling within the scope of the claims.

CLAIMS

1. A process for forming a package, comprising enveloping goods in a plastics film arranged with corresponding film portions which will be brought into contact with one another to seal the package, maintaining said corresponding film portions out of contact with one another before sealing, heating said corresponding film portions with infra-red radiation, then bringing said heated film portions into contact with one another to fuse together on contact.

2. A process according to claim 1, wherein said plastics film in the form of a bag having a neck defining said film portions to be sealed together.

3. A process for forming a vacuum package, comprising enveloping a product in plastics film, placing the enveloped product within a vacuum chamber, evacuating the chamber to reduce the pressure within and around the plastics film, and sealing corresponding portions of the enveloping film to form a vacuum package, wherein the step of sealing the film portions comprises irradiating said

corresponding film portions within the chamber with infra-red radiation and bringing said heated film portions into contact with one another to fuse on contact.

4. A process according to claim 3, wherein said plastics film is in the form of a bag held with its neck constricted so as to retard escape of gas from within the bag and subjected to a ballooning action, and said infra-red radiation is emitted by sources placed close to the neck of the bag to heat the neck ballooned by the retarded escape of gas from within the bag, following which the gas is allowed to escape from the bag and the neck portions contact with one another to seal upon contact.

5. A process according to claim 4, wherein said escape of gas from the bag is achieved by yieldably holding the bag neck to restrict escape of gas until the pressure differential between the interior and exterior of the bag reaches a value at which the bag neck holding yields to allow escape through the bag mouth.

6. A process according to claim 4 or 5, wherein said ballooning of the bag neck is caused by heating of the bag material usng additional heating means, and said escape of gas from the bag is effected by rupturing the ballooned bag neck to allow substantialy unhindered escape of gas from the bag interior.

7. A process according to claim 6, wherein said additional heating means comprise forced convective heaters circulating hot air around the exterior of the bag.

8. A process according to claim 6 or 7, wherein said film material is a heat-shrinkable film.

9. A process according to any one of claims 4 to 8, wherein said ballooning of the bag is caused by heat-shrinking of the bag material while the bag neck is held constricted.

10. A process according to claim 4 or 5, wherein said ballooning of the bag neck is caused by the evacuation of air from within the chamber causing a differential pressure across the bag film material by virtue of the constricted bag neck.

11. A process according to any one of the preceding claims, wherein the film material is a multi-layer film comprising at least an ethylene-vinyl acetate layer, a layer of polyvinylidene chloride, and a layer of irradiated ethylene vinyl acetate, and the wavelength of the infra-red radiation is from 3 to 4 microns.

12. A process for forming a package, substantially as hereinbefore described with reference to the accompanying drawings.

13. Apparatus for forming a package, comprising a support for goods and enveloping plastics film, at least one infra-red radiation source positioned to irradiate corresponding film portions of such a supported enveloping film, means for maintaining said corresponding film portions out of contact with one another during operation of said infra-red radiation sources, and means for subsequently bringing said coresponding film portions into contact with one another to close the package.

14. Apparatus for forming a vacuum package, comprising a vacuum chamber, a support within the chamber for a loaded plastics bag, means for constricting the neck of the bag within the chamber, means for ballooning the neck of a said bag supported on the support with its neck constricted by said neck-constricting means, infra-red radiation-emitting means in said chamber energisable for irradiating the ballooned neck of said bag to heat the ballooned neck material, and means for releasing gas from within the said bag to remove the bag neck from its ballooned configuration after heating of the bag by said infra-red radiation-emitting means and for causing the heated ballooned neck material to contact itself and to seal upon contact.

15. Apparatus according to claim 14, wherein said neck-restricting means comprise a bag neck gathering unit adapted to constrict the bag neck by gathering to achieve sealing.

16. Apparatus according to claim 15, wherein said gathering unit is programmed to gather the bag neck after energisation of said infra-red radiation-emitting means.

17. Apparatus according to claim 15, and including a clipping unit operable to apply a clip to close the bag neck after removal of the bag neck from its ballooned configuration.

18. Apparatus according to any one of claims 14 to 17, wherein, said means for removing the bag neck from its ballooned configuration include means for rupturing the ballooned bag neck.

19. Apparatus according to claim 18, wherein said means for removing the bag neck from its ballooned configuration include holding jaws positioned adjacent said bag neck rupturing means, on the side of said rupturing means nearer the said bag support, for clamping said bag neck to reclose it after escape of gas through the ruptured neck portion.

20. Apparatus according to any one of claims 14 to 19, wherein said infra-red radiation-emitting means comprise a pair of strip lamps positioned parallel to one another to either side of the intended location of the ballooned neck material of the said bag.

21. Apparatus according to claim 20, wherein said neck-constricting means comprise a pair of parallel clamping bars arranged adjacent the space between said strip lamps and capable of clamping the neck of a said bag therebetween.

22. Apparatus according to claim 21, wherein at least one of said clamping bars is yieldable in its clamping action so as to allow escape of gas from within the pack in the event of excessive pressure differential building up across the film material of the bag.

23. Apparatus according to any one of claims 20 to 22, when claim 20 is appendant to claim 19, wherein said holding jaws move towards and away from one another along a path of action, and said strip lamps are mounted for movement between an operative position in which they are disposed along said path of movement between spaced apart positions of said holding jaws and an inoperative position in which they are clear of said path of action to allow said holding jaws to close together.

24. Apparatus according to claim 23 and includng screens associated with said strip lamps for preventing physical contact of said strip lamps with

said ballooned bag neck material during heating.

25. Apparatus according to any one of claims 20 to 24, wherein said strip lamps include reflectors to direct all the radiation from each strip lamp towards the space between the two strip lamps.

26. Apparatus according to claim 25, wherein each said reflector comprises a reflective coating applied to a surface portion of the strip lamp for reflecting back radiation which would not naturally be directed towards said space between the strip lamps.

27. Apparatus according to any one of claims 20 to 26, and including means for energising said strip lamps at a first level in which they emit infra-red radiation with an intensity sufficient to achieve heating of said film portions, and a second level in which they are operating at a much reduced power consumption in standby condition.

28. Apparatus according to any one of claims 20 to 27 and including a timer for timing the duration of emission of infra-red radiation from said strip lamps, and means for adjusting the intensity with which they emit said bag heating infra-red radiation.

29. Apparatus according to any one of claims 14 to 28 including at least one air-circulating fan within said chamber and a heater for heating the air circulated thereby.

30. Apparatus according to any one of claims 14 to 29, and including means for severing surplus bag neck material from the package after operation of the infra-red radiation-emitting means.

31. Apparatus for forming a package, substantially as hereinbefore described with reference to, and as illustrated in, Figure 1 or Figure 3 or Figure 4, when taken in conjunction with Figures 2A, 2B and 5.

32. A package formed by the method of any one of claims 1 to 12 or using the apparatus of any one of claims 13 to 31.

Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1982.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.