July 1, 1947. A. B. HASLACHER 2,423,237

METHOD OF HEAT SEALING

Filed Nov. 1, 1941 2 Sheets-Sheet 1

Fig. 1.

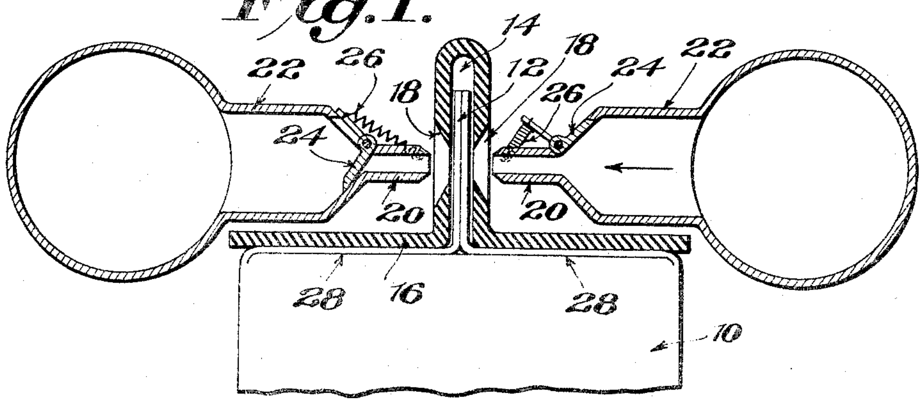


Fig. 2.

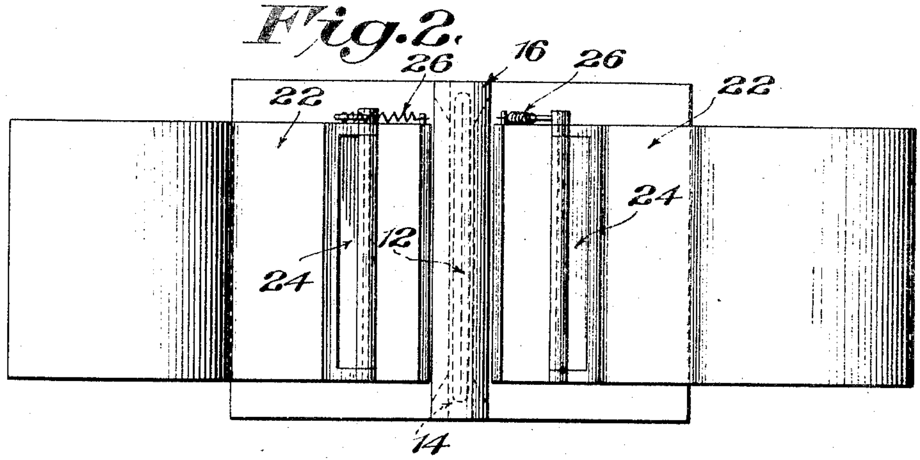


Fig. 3.

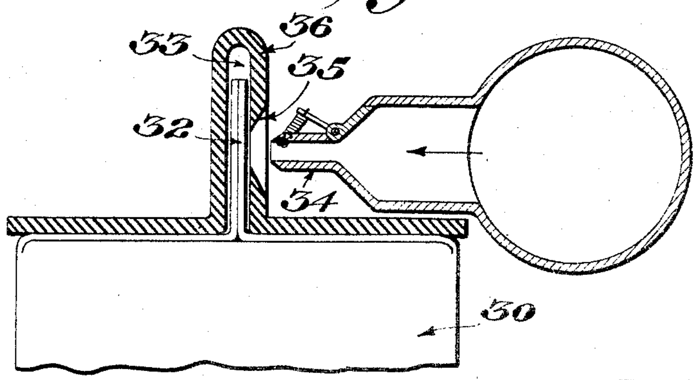


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Fig. 4.

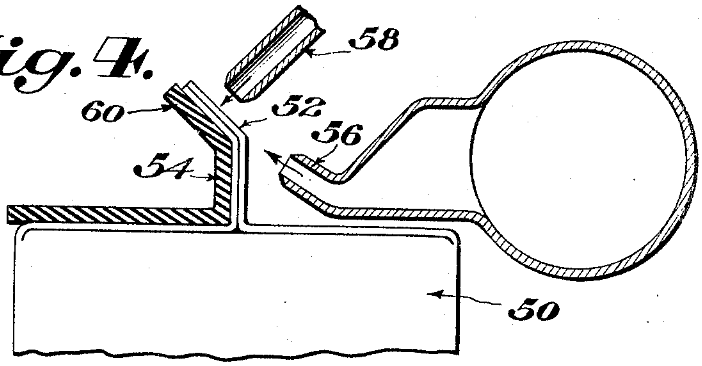



Fig. 5.

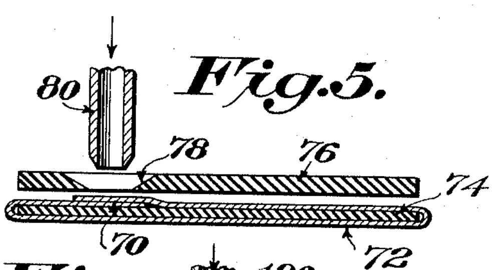



Fig. 6.

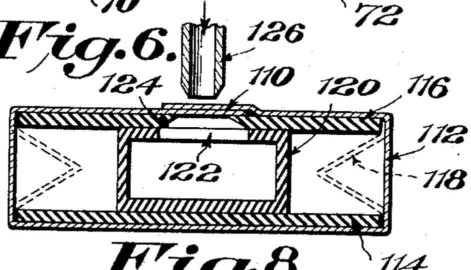



Fig. 7.

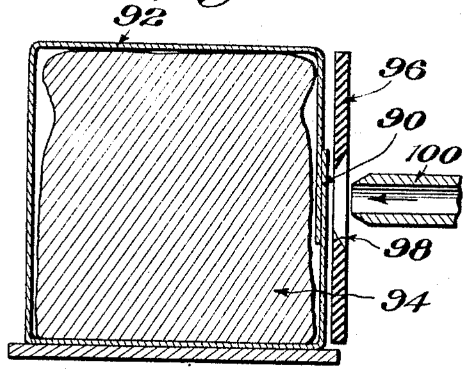



Fig. 8.

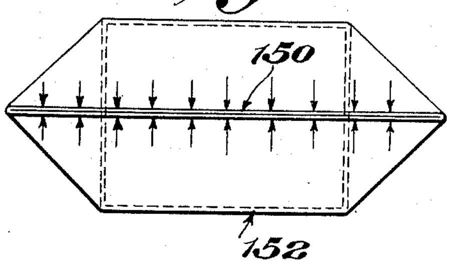



Fig. 9.

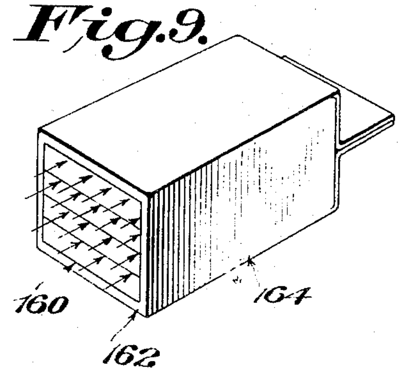
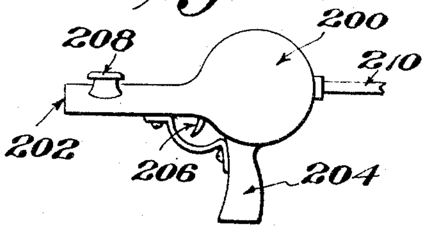



Fig. 10.

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2,423,237

# UNITED STATES PATENT OFFICE

2,423,237

## METHOD OF HEAT SEALING

Alfred B. Haslacher, New York, N. Y.

Application November 1, 1941, Serial No. 417,566

6 Claims. (Cl. 154—42)

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It is the primary object of my invention to improve the art of heat sealing by the elimination or reduction to minimum of those factors which in all of the processes used heretofore operate to prevent complete reliability and uniformity of results.

It is a further object of my invention to provide a method of heat sealing in which substantially perfect control of the heat sealing factors of temperature and pressure may be exercised and in which pressure is substantially perfectly distributed over the area to be sealed.

A further object of my invention is to provide a method of heat sealing in which there is no limit to the relative speed with which packages may be moved past a sealing unit.

These and other objects will be clear from the following detailed description, particularly when taken in connection with the annexed drawings, in which—

Figure 1 is a section on the line I—I of Fig. 2;

Fig. 2 is a plan view of a guide for the collapsed mouth of a filled, gusseted bag, and of opposed nozzles directing jets of heated gas on opposite sides of the collapsed mouth;

Fig. 3 is a view similar to Fig. 1 illustrating the application of a jet to one side only of the material;

Fig. 4 illustrates the application of one or more jets to a single side of the material, where the direction of the jet is utilized to avoid heating the material adjacent the parts to be sealed;

Fig. 5 illustrates the application of a jet to the formation of a longitudinal seam on the tuber of a bag machine;

Fig. 6 is a view similar to Fig. 5 but illustrating the application of jets to both sides of the longitudinal seam;

Fig. 7 illustrates the application of a jet to the longitudinal seam of a wrapped package in which the contents of the package affords backing for the seam in the area of the jet;

Fig. 8 illustrates a desirable form of end closure for a wrapper placed in accordance with Fig. 7;

Fig. 9 illustrates the application of a jet of relatively large area against the bottom of a filled bag; and

Fig. 10 is a sectional view illustrating a manually operated tool or "gun" for the application of a jet to any desired portion of a relatively large package.

In connection with the above-identified drawings, it is to be understood that these are provided purely for convenience of illustration and are not intended in any way to limit the scope

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of the method as described and claimed hereinafter.

The heat sealing of flexible materials has become of practical importance only comparatively recently. Thus far, heat sealing has been accomplished in one of the following manners:

(a) Coincident heat and substantial pressure;

(b) An application of heat followed by an application of substantial pressure;

(c) The application of heat alone or in conjunction with or followed by relatively very slight pressure.

In most cases, heat has been applied by bringing a heated solid member into contact with the members to be sealed, although in a few cases a heated member has merely been juxtaposed to the members to be sealed and the heat is moved from the heated member to the sealable members almost entirely by radiation. Pure radiation, however, tends to become impracticable when the necessary sealing temperature is high. It is comparatively easy to raise paraffin to its melting point of 129° F. It is a very different matter with a synthetic material having a softening point of 375° F. The hot, radiating body would have to be almost incandescent in the latter case if the temperature rise is to be accomplished in a reasonable time.

Where the members to be sealed are heated through positive contact with a heated solid member, the process is subject to inherent disadvantages. In the first place, it is a practical impossibility to assure that every portion of a heated solid of any substantial size has the same temperature as every other portion, and from this flows the distinct possibility that localized portions of the heated member may be either too hot or too cold, and any attempt to overcome this by increasing the overall temperature as a factor of safety increases the danger of localized over heating. In the second place, mechanical perfection in the finish, not only of the heated member, but also of the work in contact therewith is simply not obtainable and therefore the mechanical contact between the heated member and the members to be sealed will always be subject to localized conditions of excessive or insufficient pressure with consequent excess or insufficiency of heat transmission. Once again, and precisely as in the case of temperature control, any attempt to overcome this by adding pressure as a factor of safety intensifies the possibility (and the effect, when it occurs) of localized excessive pressure, with consequent localized excessive transmission of heat.

The application of high mechanical pressure just when the sealable surfaces have been softened by heat is very apt to destroy the efficacy of the seal either by producing wrinkles or by extruding the softened material away from the area under pressure.

As the pressure between the heated member and the members to be sealed decreases, conditions approach the limiting point at which there is no contact between said members, and the transmission of heat occurs wholly by radiation from the heated member. At this limiting point the amount of heat actually absorbed by the members to be sealed depends not only upon the temperature of the heated radiating member but upon the square of the distance between each particle of the members to be heated and the nearest adjacent particle of the radiating member, as well as upon every whim of temperature, barometric pressure and moisture content of the surrounding atmosphere. Changes in the conditions mentioned above probably will not occur with a combination of sufficient velocity and sufficient amplitude to have a serious combined effect upon any particular set of sealable members passing through the sealing station. It must be borne in mind, however, that in general heat sealing is resorted to for an extreme perfection of closure and this perfection is measured not by the approach to perfection of each individual package but by the percent of packages which approach perfection out of millions of such packages. Where the standard of acceptability is extremely high and the volume of material subjected to the standard is extremely large, a comparatively small increment in the percent of commercially acceptable packages represents a great forward step in the art.

It is a fundamental in the science of control that control is only possible if there is available an excess of the quantity to be controlled. This is true with a thermostat governing the temperature of a heated member, or the Tirrill regulator controlling the output voltage of a generator, or of a governor controlling the speed of a steam engine. An automatic control produces an accurate average by an oscillation between excess and insufficiency. The true measure of the accuracy of control of any quantity lies not in the maintenance of a theoretically proper average, but in narrowing the margins of the extremes of excess or deficiency on either side of the average. For this purpose anything which tends to minimize or eliminate effects in the nature of inertia will contribute to the perfection of the control. In short, as we reduce inertia we increase the permissible frequency of control operations and therefore decrease the amplitude of deviations from the average between control operations.

When we seek to control the temperature of a member having substantial size and mass, and the member is formed of a substance having a substantial specific heat and some resistance to thermal conductivity, the product of the mass of the member, its specific heat and its conductivity represent the inertia which must be overcome if control is to be effected. The member will lose heat by transfer to the members to be sealed and by radiation to the atmosphere, and the rate at which it will lose heat will be a function of the pressure between it and the members to be sealed and the coefficient of emissivity of the surface of the member. As a succession of members to be sealed are brought into contact with the heated member, there will be a series of rapid departures of heat from the surface of the member in contact with the succession of members to be sealed. There will be a time lag between the drop in temperature of the surface of the member and the corresponding drop in temperature of its interior, and the latter temperature is the one which must affect the thermostatic controlling means and which must first be affected by a change in temperature of the heat source occurring as a result of the actuation of the thermostatic control member. Time will then be required for the change in temperature of the heating element to penetrate from the interior of the contact member to the exterior where it becomes effective as a part of the sealing process.

The foregoing effect of "thermal inertia" becomes more pronounced as the physical dimensions of the heated member increase and yet the dimensions, particularly length, must increase as the speed past the heating member of the members to be sealed increases. It is accordingly axiomatic in the packaging industry that increased speed of heat sealing operations inevitably entails an increase in the percentage of defective packages.

I have found that a moving column or current of gas may be controlled and applied to the task of heat sealing with greater accuracy of regulation than any other medium. The term "gas" as used herein is intended to include air, or a mixture of air with special gases or vapors, or special gases or gas mixtures which in turn may be mixed with vapors. It may, for example, be desirable to utilize a gas which is wholly inert toward the materials to be sealed, or, conversely a gas which reacts chemically with one or more of the materials to be sealed. Similarly, in the case of vapors, it may be desirable to incorporate in the gas vapor which will react with one or more of the materials to be sealed or which is capable of absorption by or is miscible with one or more of such materials. In addition, any column of gas for the purposes of my process may, if desired, carry in suspension solids which will contribute to the sealing effect or serve to prevent or minimize "blocking" of adjacent material under a temperature increase.

The fundamental factors of all heat sealing operations are time, temperature and pressure, and the heat sealing of the prior art has usually been accomplished by direct mechanical application of both temperature and pressure for whatever time is necessary under the circumstances. When, in accordance with my invention, a current of gas is utilized, these fundamental factors are still present but are subdivided into the more or less interrelated factors of temperature, velocity and direction of the moving gas. In the sense of pure thermo-dynamics, velocity is a function of both temperature and pressure. In the practical application of my invention, however, there is no occasion to employ extremely elevated temperatures or pressures, and within the ranges of temperatures and pressures encountered the interrelationship may be disregarded, and velocity may be postulated squarely upon pressure.

In essence, my invention comprises directing a jet or jets of heated gas against the material to be sealed, whereby to raise the temperature of such material to a point at which sealing takes place. Preferably, each jet should have sufficient velocity so that the impact of the stream of gas against the material to be sealed will supply sufficient pressure to enforce a sealing of the material when it has been sufficiently softened by the action of the warm gas.

The amount of heating of the material will depend, of course, upon the temperature of the gas and upon its velocity or impact against the material and upon the length of time to which the material is subjected to such action. All of these factors may be further modified by adjustment of the direction of the jet relative to the plane of the material against which it strikes, but this factor of direction is of minor importance in this connection and assumes major importance in connection with other factors to be discussed hereinafter. The effect of velocity is important not only in producing a pressing effect, but in facilitating the transfer of heat to the material to be sealed. Under ordinary heat and pressure conditions, pressure is frequently raised purely in order to shorten the time necessary to transfer sufficient heat to raise the temperature of the sealable members to the desired point. The quantity of heat available in my jet depends, for any given gas temperature, upon the volume of gas supplied. This volume, for any given jet, depends on the velocity of the gas. Increased velocity will, therefore, shorten the heating time, but, due to perfect uniformity and its yielding application, the resultant increased pressure has not the detrimental effect of increased mechanical pressure.

The great advantage in employing a jet of heated gas lies in the fact that localized overheating becomes virtually an impossibility. It is only in a body of gas in turbulent motion that a temperature reading at any point of the body accurately reflects the temperature of all parts of the body. This is true because when heat is added to a body of gas, molecular activity disseminates the heat, thereby tending to raise all of the molecules to substantially the same temperature. There exists, therefore, in a moving column of gas an inherent tendency to establish a true average temperature without substantial deviation throughout all portions of the mass. This is not, and cannot, be true of any solid body. It must further be kept in mind that I am using a moving column of gas and that I regulate its temperature while the column is in motion. This means that I am adding heat to only a very small mass of gas at any particular instant, and this small mass of gas which is, for the instant, under the influence of the heating element may have its temperature raised or lowered substantially instantaneously. There is, therefore, no occasion for operating between substantial extremes of temperature in establishing the desired average.

It is an important element of my invention that the column of gas should not have its movement interrupted, and if, for any reason, it is desired to discontinue a jet at its point of activity, this is preferably accomplished by altering the direction of the jet and not by stopping it. As a result, the temperature gradient of the system will remain constant at all times, and it will be impossible to develop an isolated portion of gas which is either overheated or underheated.

When a jet of gas is directed against the material to be sealed, the jet will, if it has anything approximating a substantial velocity, exert a pressure against the material. Preferably, I carry out my process by applying such jets in opposition to each other and on opposite sides of the material to be sealed. It is, however, entirely possible to direct a jet against one side



only if the opposing side be given adequate support. In any event, the impingement of the jet against the material creates a pressure within the projected area of the jet which is uniform irrespective of variations in the contour or thickness of the material, and such uniformity of pressure is impossible of achievement in any other manner. This necessity for uniformity of pressure in heat sealing has long been recognized in the prior art, particularly where the material to be sealed contains portions of differential thickness, and the prior art has resorted to the use of pressure or backing members formed of resilient material and adapted to deform in conformity with variations in thickness of the material to be sealed. No such backing members, however, can even approximate the perfect uniformity of pressure which I attain by means of my process.

I recognize that on certain particular seals, care must be taken to avoid overheating in areas adjacent the desired line or point of sealing, since otherwise sealing or at least sticking or "blocking" might take place at undesirable points. In the use of my process, I control the area of application in either or both of two ways: first, the jet may be so directed that the gas leaving the material after impact flows away from the areas which it is not desired to heat; and second; the material may be shielded except for those portions in which a seal is to be formed. This shielding should, of course, be thermal, as well as mechanical, and the shield should therefore be formed of suitable insulating or non-conductive material such as plastic or wood or asbestos, etc., and the orifice through which the gas emerges should be so located with respect to the shield as to allow the spent gases freely to flow away from the material being sealed. The shielding may also be accomplished by the use of a supplementary jet or jets intersecting or opposing the heating jet, and at lower temperature. Such a supplementary jet can also be used to cool areas adjacent the area of impact of the heated jet and thus to prevent the heating of these areas. This latter effect does not necessarily depend on the intersection of the cooler jet with the heated jet.

Exhaust fans may be used to remove the spent gas. For many purposes this will be desirable in any event, but where the gas is reactive, or contains reactive vapor, or a dusting powder, the exhaust fan will usually be essential.

The use of my process is particularly advantageous where the parts to be sealed must be treated while in motion. The problem of heat sealing parts in motion has long been one of the most vexatious problems in the heat sealing field. The problem is particularly acute in connection with the application of suitable pressure to rapidly moving parts. The prior art attempts to solve this problem are largely confined to divorcing the application of heat from the application of pressure, so that the heat is applied substantially by radiation and during a substantial distance of travel, while the pressure is usually applied by a rotary rolling action. Pressure applied by this latter means is inevitably highly concentrated and, when employed transverse the length of tubular structures, almost inevitably produces a wrinkling at the trailing end sufficient to destroy the impervious character of the seal. If, on the other hand, no pressure at all is applied and the material to be sealed is relatively stiff, the chance of securing a perfect seal by heat alone is not sufficiently good to produce a practicable percentage of commercially acceptable packages in any sizable run.

While in the case of a few materials, the application of substantial pressure is an indispensable element of the heat sealing process, with most materials, if the correct temperature be obtained, pressure merely assures complete contact between the sealable surfaces, and the seal itself is attributable primarily to fusion or affinity of the surfaces in contact. While by regulation of the velocity of the jet and adjustment of the proximity of its delivery to the surfaces to be sealed, sufficient pressure may be attained to seal any materials which I have thus far encountered, my invention unquestionably has its greatest utility in connection with the usual case in which pressure is an assurance of perfection rather than an indispensable element of the sealing action.

Whatever method of heat sealing be used, results are improved if temperature and pressure be reduced and time increased. With my process, the velocity factor permits a reduction of temperature without a commensurate increase in time. Moreover, when the material is to be sealed while in motion, the absence of friction between the jet and the moving work permits a more prolonged application of the jet so that actual time of application is increased without slowing down the process of manufacture.

The materials to be sealed will usually fall into one of the following classes:

(*a*) Sheets of inherently thermoplastic material such, for example, as Pliofilm;

(*b*) Non-thermoplastic sheets coated or impregnated with thermoplastic material; for example, moisture proof Cellophane and lacquered papers;

(*c*) Laminated sheets in which a non-thermoplastic material, such as paper or vegetable parchment, is adhesively secured to the thermoplastic sheet such as Pliofilm; and

(*d*) Multi-ply structures in which the inner ply is formed of a thermoplastic material such as Pliofilm, the outer ply is formed of a non-thermoplastic material such as paper, and the two plies, except perhaps for certain spots and lines, are free of each other.

Clearly the requirements of temperature and pressure will differ depending on the nature of the particular material, its thickness, and the size of the desired sealed area. No general rule can be established, and the requirements of any particular case must always be determined experimentally.

The copending applications of Dr. Karl R. Karlson, Ser. Nos. 395,305; 395,306; and 395,308, all filed May 26, 1941, now patents numbered 2,340,127 dated January 25, 1944, 2,376,256 dated May 15, 1945, and 2,353,311 dated July 11, 1944, respectively, disclose a material and a bag structure to which my process is particularly applicable, and my own copending applications Ser. Nos. 395,303 and 395,304, filed May 26, 1941, and Ser. No. 395,855, filed May 29, 1941, disclose other forms of bags suitable to be sealed for the use of this process, and in which any of the above classified materials may be used. The process is, of course, equally applicable to the sealing of wrapped packages and to the formation of seams and closures on envelopes both of the ordinary and of the double side seam type. It is to be noted, moreover, that while this process has been developed primarily for use in the packaging and package manufacturing industries, it is applicable



to any use in which heat sealing is desired; for example, securing thermoplastic fabrics to the wings of gliders, and sealing the seams of rain garments, umbrellas, shower curtains, seat covers, etc.

In the use of gas or gas-like jets, my invention contemplates the use of steam, either moist or superheated; the use, in the jet, of vaporized adhesive, and, as previously mentioned, the use of a reactive vapor or gas to activate an adhesive in place on the material. A situation in which steam would be particularly advantageous is where the parts to be sealed have been imprinted with starch base adhesives. Such adhesives activate very quickly in the presence of heat and moisture. The starch cells tend to absorb the moisture and thus to eliminate the presence of free moisture in the form of water. Accordingly, condensate, far from being objectionable, would, in such case, be absorbed by the adhesive material.

Adhesives are available which can be so finely atomized as to exist substantially as a fog, and the jets may carry such adhesive and direct it against the work. A jet carrying such adhesive may well be followed by a jet of warm dry air which will serve to set the adhesive which has been applied in the form of fog.

Referring now to the annexed drawings, I show in Figs. 1 and 2 a filled, gusseted bag **10** having its mouth **12** collapsed and guided in a channel **14** in a member **16** preferably formed of material having a low thermal conductivity. The member **16** acts not only to guide the collapsed mouth **12** of the bag **10**, but also operates as a shield to prevent the heating of any undesired portions of the bag **10**. Slots **18** are formed in opposite sides of that portion of the member **16** forming the channel **14**, and nozzles **20** are located to direct jets of gas through the slots **18** and against the collapsed mouth **12** of the bag **10**. The nozzles **20** receive the gas through conduits **22** which are preferably of a cross-sectional area which is large relative to that of the nozzles **20**. Each nozzle **20** is provided with a shunt valve **24** normally held in inoperative position by a spring **26**. When the valve is in the position shown at the right-hand side of Fig. 1, the nozzle **20** is operative and the jet impinges against the collapsed mouth **12**. When, for any reason, it is desired to interrupt the impingement of the jet upon the work, the valve **24** takes the position illustrated at the left-hand side of Fig. 1, closing off the nozzle **20**, but permitting uninterrupted flow of the gas through the conduits **22** and thence to the atmosphere. This maintains the column of gas in constant motion and thereby maintains constant the temperature gradient of the system. The valves **24** may be manually operated or may be made automatically responsive to various contingencies such as a stoppage in the packaging or bag-making machine.

If desired, the shield **16** may be dispensed with and the nozzles **20** inclined upwardly from the shoulders **28** of the bag **10**. In this manner the heated gas will be led away from the shoulders of the bag and will thus avoid undesired heating of predetermined portions of the structure.

It is entirely within the purview of my invention to operate one of the nozzles **20** with gas of a lower temperature than that of the other. By differentiating the temperatures of the jets, an extreme nicety of control may be attained, and one of the jets may even be operated at a temperature low enough to produce a cooling effect. Where such cooling is desired, it is entirely possible to use consecutive sets of jets, the first pair serving to heat the work and the second pair serving to cool the work and thereby to set the seal.

Fig. 3 is generally similar to Figs. 1 and 2 and shows a filled, gusseted bag 30 with its collapsed mouth 32 guided in a channel 33 formed in a shielding member 36. The member 36 is formed, preferably, of material having a low thermal conductivity. One wall of the channel 33 is slotted at 35 and a nozzle 34 directs a jet of warm gas through the slot 35 and against the collapsed mouth 32 of the bag 30. Everything said with respect to Figs. 1 and 2 concerning the direction of the nozzles and the possible elimination of the shield applies to the showing of Fig. 3. It is clear, however, that when the jet is directed from one side only, some form of support must be applied to the upstanding collapsed mouth of the bag 30 in order to hold it against the impetus of the jet merging from the nozzle 34.

In Fig. 4 I illustrate the use of multiple, directed jets. In this figure, a bag 50 has its collapsed mouth 52 supported at one side by a guide 54. A nozzle 56 directs a heated jet against the collapsed mouth 52, but at an angle to the vertical. A supplementary jet 58 is directed against the upper portion of the collapsed mouth 52 to flex the same into contact with a bent portion 60 of the guide member 54. The resultant flexure of the collapsed mouth 52 results in pressing together the internal surfaces of the collapsed mouth and thereby assists in the formation of a seal under the effect of the heated jet merging from the nozzle 56. If desired, the jet merging from the nozzle 58 may either be heated or cooled. In the latter case the cooling jet would have the effect of shielding the upper portion of the mouth against sealing under the influence of the warm jet merging from the nozzle 56.

While Figs. 1–4, inclusive, illustrate the application of my method of sealing to the collapsed mouth of a gusseted bag, it is clear that the method is equally applicable to the collapsed mouth of a non-gusseted bag or to sealing a simple upstanding seam of the type disclosed in my application aforesaid Serial No. 395,303, filed May 26, 1941, and may be applied to the formation of a closure on a flattened tube in course of manufacture, as well as to the mouth of a filled bag.

In Fig. 5, I show the application of my process to the formation of the longitudinal seam 70 of a flattened tube 72 while the same is traveling along the former plate 74 of an ordinary tuber. A non-conducting shield 76 is mounted above the former plate and is slotted at 78 to give access to the seam 70. A nozzle 80 is mounted above the slot 78 and directs a jet of heated gas against the seam 70. Proper regulation of the velocity of the jet will reduce the pressure of the seam 70 against the former plate 74 to a point at which no serious frictional drag will occur.

An arrangement similar to that of Fig. 5 is illustrated in Fig. 7 as applied to the seam 90 of a wrapper 92 which has been placed around a commodity 94 such, for example, as a loaf of bread. The wrapper is shielded by a member 96 slotted at 98 to give access to the seam 90, and a nozzle 100 is mounted above the slot 98 to direct a jet of heated gas against the seam 90. In this case the contents 94 moves with the wrapper 92 and there is accordingly no question of frictional drag between the wrapper and the contents.

In Fig. 6 I illustrate a method of treating both sides of the seam 110 of a bag 112 being formed over former plates 114 and 116 of a conventional tuber. This arrangement of former plates may be used to produce either a flat bag 112 or a gusseted bag 118. The plates 114 and 116 are separated by a conduit 120 which is slotted at 122, the slot coinciding with a slot 124 in the former plate 116. A nozzle 126 directs a jet of heated gas against the outer surface of the seam 110, and the conduit 120, through the slots 122 and 124, directs heated gas against the under side of the seam 110. This gas may be exhausted through the open leading end of the tuber. If desired, the gas supplied through the conduit 120 may be cooler than the gas supplied by the nozzle 126. The provision of exterior shields to protect the portion of the bag 112 adjacent the nozzle 126 is optional, depending upon circumstances. In using this arrangement, it may be highly advantageous to incorporate in the gas supplied through the conduit 120 a quantity of dusting powder which will eliminate, or at any rate minimize, all "blocking" tendencies of the interior of the bag 112.

The material used in forming bags or wraps as shown in Figs. 5, 6 and 7 may be of the type disclosed in the patent aforesaid of Karl R. Karlson, Patent No. 2,340,127. In such case the seam formed will be of the type disclosed in the patent aforesaid of Karl R. Karlson, Patent No. 2,376,256.

Fig. 8 schematically illustrates the application of opposed jets to the extended and collapsed mouth 150 of a flat bag 152, and Fig. 9 illustrates the application of a current of heated gas of rather large cross-sectional area against the restricted portion 160 of the bottom 162 of a filled bag 164. This application is particularly useful in utilizing a package such as is shown in the patents aforesaid of Karl R. Karlson, numbered 2,376,256 and 2,353,311.

In Fig. 10 I have illustrated a manual tool 200 having a nozzle 202, a pistol grip 204 and a controller trigger 206. The trigger operates a shunt valve indicated generally at 208 which functions similarly to the valve 24 illustrated in Fig. 1. Heated gas is supplied to the tool by means of a flexible tube or pipe 210. A tool of this sort permits my process to be carried out at points and areas of large packages or miscellaneous products where spot or seam sealing is desired, but where the product is not adapted to passage through an automatic machine.

The precise mechanisms used to control temperature and pressure are immaterial to the use of my process, and the prior art contains many items of such equipment which are readily adaptable to this purpose, and it is considered unnecessary to illustrate such mechanisms.

In the claims the sequence in which the steps are recited is not to be considered a limitation unless, by the terms of any particular claim, such sequence is expressly made material.

What is claimed is:

1. A process of forming hermetic heat seals which comprises superimposing predetermined areas of flexible sheet material suitable for packaging, at least the meeting surfaces of which are thermoplastic; directing opposed currents of warm gas against opposed exterior surfaces of said predetermined areas to bring said thermoplastic surfaces to their temperature of fusion, while maintaining the velocities of said opposed currents sufficiently high to produce an effective sealing pressure between said thermoplastic surfaces.

2. A process of forming hermetic heat seals which comprises providing opposed currents of warm gas; superimposing predetermined areas of flexible sheet material suitable for packaging, at least the meeting surfaces of which are thermoplastic; and moving said predetermined areas between said opposed currents to bring said thermoplastic surfaces to their temperature of fusion, while maintaining the velocities of said opposed currents sufficiently high to produce an effective sealing pressure between said thermoplastic surfaces.

3. A process of forming hermetic heat seals which comprises providing opposed currents of warm gas; superimposing predetermined areas of flexible sheet material suitable for packaging, at least the meeting surfaces of which are thermoplastic; moving said predetermined areas between said opposed currents to bring said thermoplastic surfaces to their temperature of fusion, while maintaining the velocities of said opposed currents sufficiently high to produce an effective sealing pressure between said thermoplastic surfaces; and shielding predetermined portions of said areas from the heating and pressing effect of said currents.

4. A process of forming hermetic heat seals which comprises superimposing predetermined areas of flexible sheet material suitable for packaging, at least the meeting surfaces of which are thermoplastic; directing a current of warm gas against at least one exterior surface of said predetermined areas to bring said thermoplastic surfaces to their temperature of fusion but below the melting point of such surfaces, the velocity of said current being sufficiently high so that its component normal to said exterior surface will exert an impact pressure sufficient to seal said meeting surfaces together; and supporting said predetermined area against the kinetic energy of said current to cause said impact pressure to be exerted.

5. A process of forming hermetic heat seals which comprises superimposing predetermined areas of flexible sheet material suitable for packaging, at least the meeting surfaces of which are thermoplastic; directing a current of warm gas against at least one exterior surface of said predetermined areas to bring said thermoplastic surfaces to their temperature of fusion but below the melting point of such surfaces, the velocity of said current being sufficiently high so that its component normal to said exterior surface will exert an impact pressure sufficient to seal said meeting surfaces together; supporting said predetermined area against the kinetic energy of said current to cause said impact pressure to be exerted; and moving said predetermined areas across said current while said areas are thus supported.

6. A process of forming hermetic heat seals which comprises superimposing predetermined areas of flexible sheet material suitable for packaging, at least the meeting surfaces of which are thermoplastic; directing a current of warm gas against at least one exterior surface of said predetermined areas to bring said thermoplastic surfaces to their temperature of fusion, the velocity of said current being sufficiently high so that its component normal to said exterior surface will exert an impact pressure sufficient to seal said meeting surfaces together; supporting said predetermined area against the kinetic energy of said current to cause said impact pressure to be exerted; and shielding predetermined portions of said areas from the heating and pressing effect of said current.

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