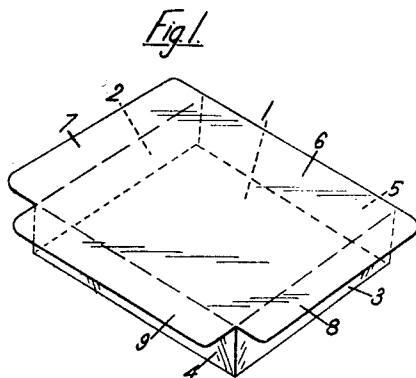
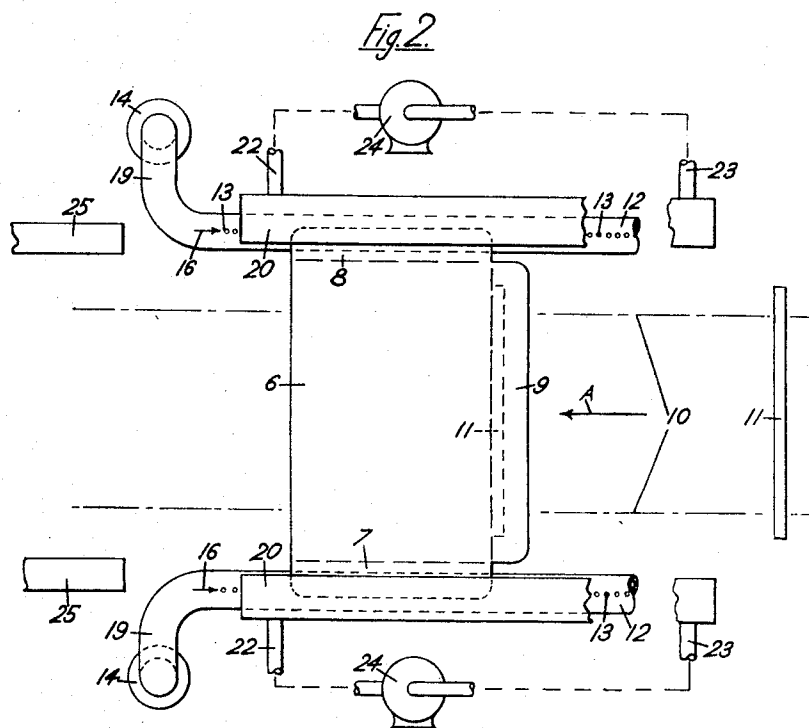


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SEALING OF CARTONS

3 Sheets-Sheet 1



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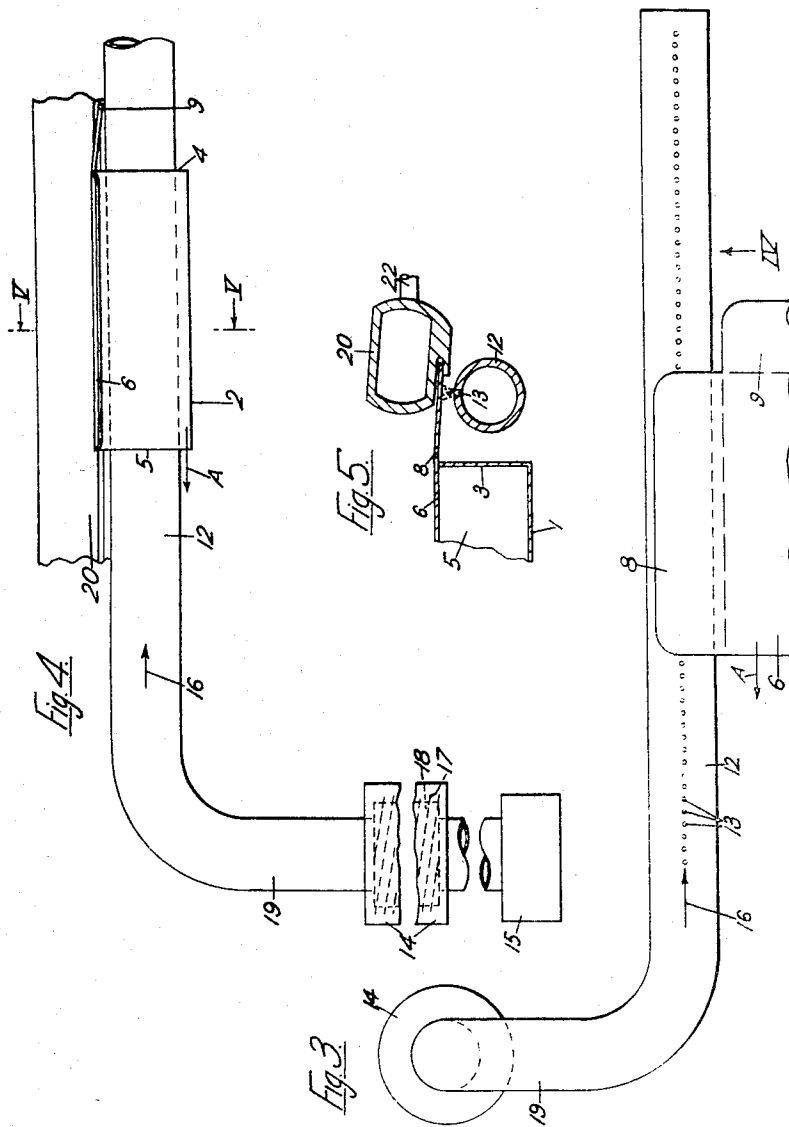
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SEALING OF CARTONS

3,471,995

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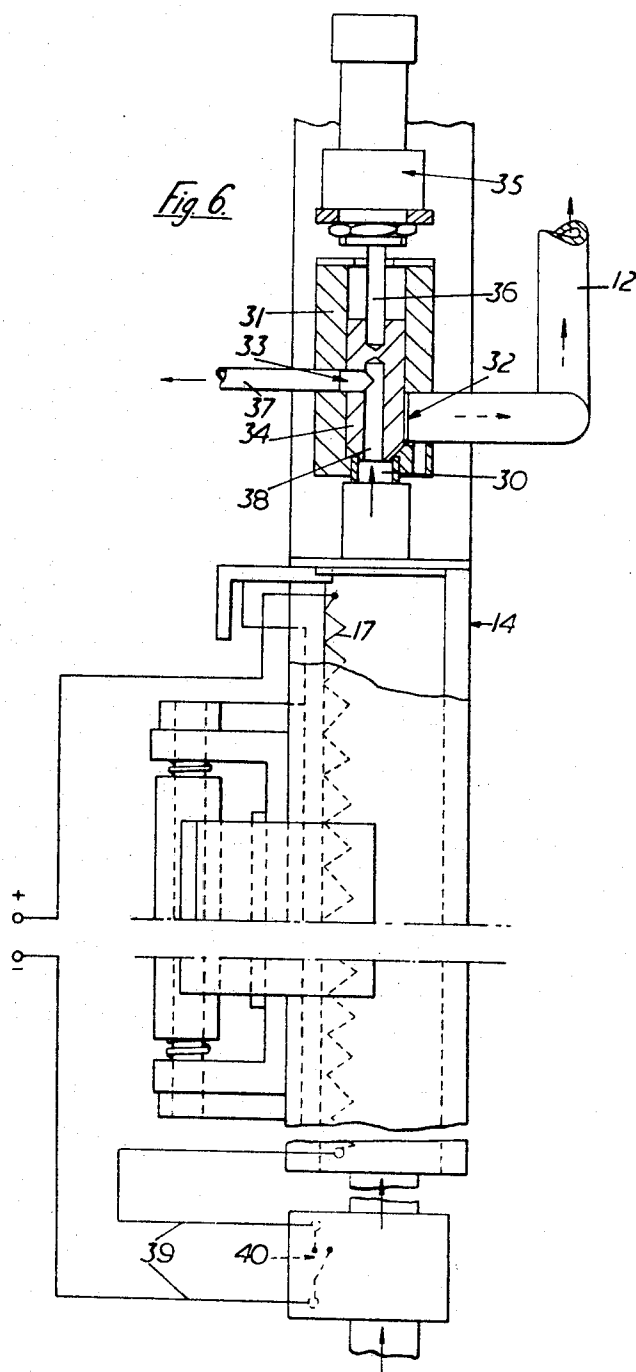
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3 Sheets-Sheet 5



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SEALING OF CARTONS

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3 Claims

ABSTRACT OF THE DISCLOSURE

The apparatus for securing an overlying to an underlying portion of a carton by heat-sealable material applied to one of said portions comprises a conveyor means for moving cartons in succession along a predetermined path and a tubular member which extends along the path and is connected with a heat exchanger which heats low pressure air to a high temperature. The tubular member is provided with apertures which extend through the side thereof and are located in close proximity with the heat-sealable material of a carton moving past the member and the cross-section of the tubular member, the number of the apertures, the spacing thereof along the tubular member, and the cross-section thereof in relation to that of the tubular member is so selected that high temperature flows through the apertures at a rate such that it impinges on the heat-sealable material and effects softening thereof preparatory to folding and pressing of the overlying portion into engagement with the underlying portion.

This invention relates to the sealing of cartons and in particular to the sealing of cartons provided with heat-sealable closure flaps which are movable into heat-sealing relation with the carton portions to which they are to be sealed.

Some forms of carton are made of cardboard or similar material coated with a heat-sealable material, such as polyethylene or a polyethylene/wax mixture, and sealing thereof, following the insertion of the contents into the carton has been effected by applying heat to the portions of the carton which are to be sealed one to the other. It has been proposed to prepare the heat-sealable flaps of cartons, preparatory to movement of the flaps into heat-sealing relation with the carton portions to which they are to be sealed, by moving the cartons in succession past radiant heaters or burning gas jets and while the flaps extend laterally from the cartons subjecting the heat-sealable surfaces of the flaps to the action of the radiant heaters, or to the action of the burning gas jets, to soften the heat-sealable surfaces sufficiently to permit sealing thereof to the portions of the cartons against which the flaps are subsequently sealed. With each of these prior proposals, however, there is a safety problem arising from, in the one case, exposed radiant metal wire or strips and, in the other case, naked gas flames. Further, when using gas burners critical settings are necessary to ensure that the flaps are not burned by the flames. It is one object of the present invention to provide a method and an apparatus which avoids these disadvantages of the prior proposals.

Further, when using devices according to the said prior proposals it is necessary to ensure that the length of the heater devices is such as to effect the desired softening of the heat-sealable surfaces, this being determined by the speed at which the cartons are moved past the heater devices, and it is a further object of the invention to provide a method and an apparatus the heater devices of which for any given speed of movement of cartons past the devices can be of considerably reduced length thereby resulting in a reduction of the size of the sealing machine

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or alternatively in an increase of operating speed for a machine of given size.

According to the invention there is provided apparatus for securing a closure flap to a side of a carton by heat-sealable material applied to one of the overlying portions to be secured thereby, said apparatus comprising conveyor means operable to move the carton along a predetermined path, a tubular member extending lengthwise of said path and provided with apertures which extend through the wall of the tubular member and are arranged substantially in line lengthwise of the tubular member to be in close proximity with the heat-sealable material, a heat-exchanger connected with said tubular member and with air supply means operable to direct low-pressure air through the heat-exchanger and into the tubular member, said heat-exchanger being arranged to heat air passing therethrough to a high temperature, the interior cross-section of the tubular member, the number of the apertures, the spacing of the apertures lengthwise of the tubular member, and the ratio of the cross-section of the apertures to that of the tubular member being so selected that high temperature air delivered to the tubular member will flow through the apertures at a rate such that air impinging against the heat-sealable material effects softening thereof, guide means extending lengthwise of the tubular member and operable to engage the overlying portion and to support it in a manner such that it extends laterally from the underlying portion to which it is to be secured, and means operable while the heat-sealable material is still in the softened condition thereof to fold and press the overlying portion into engagement with the underlying portion to effect adhesion of the overlying portion to the underlying portion by said material.

In order that the invention may be clearly understood one embodiment thereof will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

FIG. 1 is a pictorial view of one kind of carton which can be prepared for sealing by the method and apparatus according to the invention,

FIG. 2 is a diagrammatic plan of apparatus according to the invention,

FIG. 3 illustrates a part of the apparatus of FIG. 2 to an enlarged scale, some parts being omitted for clarity,

FIG. 4 is an elevation of FIG. 3 looking in the direction of arrow IV, FIG. 3,

FIG. 5 is a section on line V—V, FIG. 4, and

FIG. 6 illustrates a modified embodiment of the apparatus.

Referring to FIG. 1, the carton therein illustrated comprises a body consisting of a bottom 1, side walls 2, 3, a front wall 4, a rear wall 5, a lid 6 hingedly connected to the top of rear wall 5, and side flaps 7, 8 and a front flap 9 hingedly connected to the lid 6. The undersides of the flaps 7, 8, 9, which respectively are to overlie and be secured to the underlying portions 2, 3, 4, are coated with a heat-sealable material, not shown, such as polyethylene or a polyethylene/wax mixture, and the flaps are to be folded against and heat-sealed to the walls 2, 3, 4.

The apparatus illustrated in FIGS. 2 to 5 comprises conveyor means, shown as endless chains 10 provided with pusher elements 11, FIG. 2, operable to move cartons in succession along a predetermined path, in the direction of arrow A, FIGS. 2, 3 and 4, and a tubular member 12, preferably of circular cross-section, which extends lengthwise of said path and which is provided with apertures 13 which extend through the wall of the tubular member 12, see FIG. 5, and are arranged substantially in line, see FIG. 3, lengthwise of the tubular member 12. A heat-exchanger 14 is connected with the tubular member 12 and with air supply means, for example a pump 15, FIG. 4, which is operable to direct low pres-

sure air through the heat-exchanger 14 and into the tubular member 12 in a direction opposed to the direction of movement of the cartons, as indicated by arrow 16, FIGS. 2, 3 and 4. The heat-exchanger includes a 2500 w. coiled wire heater element 17 mounted on a ceramic former 18 in such a way as to permit maximum contact between the heater element 17 and air passing through the heat-exchanger so that the air is heated to a high temperature of the order of 500° C. Connection between the heat-exchanger 14 and the tubular member 12 is by a pipe 19 the length of which is kept to a minimum to avoid heat loss between the heat-exchanger and the tubular member.

Guide means which extend lengthwise of the tubular member 12 are operable to engage an overlying portion of each carton and to support it in a position thereof in which it extends laterally from the underlying carton portion to which it is to be sealed. The heat-sealable surface of the overlying portion is located in close proximity with the apertures 13, see FIG. 5. As shown in the drawings, the guide means comprises a hollow member 20 which includes a notch 21 in which an edge portion of the overlying portion is engaged during movement of the carton past the tubular member 12, see FIG. 5. Pipes 22, 23, FIG. 2, are connected with the hollow member 20 and with means, for example a pump 24, arranged to circulate a cooling medium, for example water, through the hollow member 20 so that the outer face of the overlying portion engaged in notch 21 is kept cool.

The cross-section, spacing, and number of the apertures 13 and the ratio of the cross-section of the apertures to that of the tubular member 12 is important to the satisfactory operation of the apparatus because at a very low air flow rate the air temperature is high but the low mass flow results in low energy transfer whereas as the flow is increased the energy transfer passes through an optimum and falls again when the flow causes a large fall in air temperature. The optimum flow rate has been found to be of the order of 110 litres per minute (4 cubic feet per minute). The cross-section of the apertures 13 should strike a balance between being small enough to produce a high velocity jet and yet large enough to enable a sufficient air flow rate. By experiment it has been found that the most advantageous apertures have a diameter of $\frac{3}{4}$ inch. The spacing and number of the apertures is governed by the fact that heat losses from the tubular member 12 cause a fall in temperature along the length of the member 12 measured from the air entry point. Excessive length of member 12 results in the air jets being at a temperature less than that necessary to soften the heat-sealable material on the overlying portion. With apparatus as described herein, and with overlying carton portions coated with polyethylene, it has been found that 12 inches is the optimum length for the tubular member 12. The number of apertures and the ratio of the cross-section thereof to that of the tubular member 12 governs the relationship between the flow of air through a given aperture 13 and its position along the tubular member 12. If the aperture diameter/tubular member diameter and ratio is large, a large proportion of the air will issue through the first few apertures and therefore reduce the effective length of the air flow system. As the tubular member diameter is increased while the aperture 13 diameter remains fixed the aperture size ratio becomes less and the distribution of air along the tubular member 12 becomes better balanced. The limit is reached when the large surface area of the tubular member 12 causes large heat losses and the size of the member 12 can no longer be accommodated within the critical dimensions of the machine or of the carton to be sealed. It has been found by experiment that the apertures 13 are best spaced at $\frac{1}{8}$ inch between centres and that the tubular member should have a diameter of about 1 inch.

From the foregoing description it will be understood that the cartons are moved in succession past a flow of high temperature air extending lengthwise of the path of

cartons and that while the cartons are being moved towards the source of the flow of air an overlying portion of each carton is supported in a position thereof in which the overlying portion extends laterally from the underlying carton portion with the heat-sealable surface of the overlying portion located in close proximity with the flow of air so that the heat-sealable surface is softened by the jets of high temperature air to an extent sufficient to permit sealing thereof to the underlying portions 2, 3, 4, as appropriate, of the carton against which the overlying portion, while the heat-sealable surface is still softened, is folded and pressed, in known manner, as by plough-type folders 25, FIG. 2.

In the modified form of the apparatus shown in FIG. 6 the connection between the heat-exchanger 14 and the tubular member 12 is effected by a nipple 30 and a valve having a hollow valve body 31 one end of which is connected to the nipple 30. The body 31 has an outlet port 32 through which high temperature air passes via nipple 30 into the tubular member 12, and an exhaust port 33 through which the high temperature air is directed away from the path of the carton when the conveyor means, not shown, ceases to operate. The outlet port 32 and exhaust port 33 are spaced apart axially of the body 31 and are selectively exposed or obturated by a piston 34 by control means operable on stopping and starting of the conveyor means. As shown in the drawing the control means is an air cylinder 35 the piston, not shown, of which is connected by a rod 36 with the piston 34 of the valve.

When the conveyor means is stopped the air cylinder 35 is operated to move the piston 34 to the position thereof shown in the drawing in which position the piston obturates the outlet port 32 to the tubular member 12 and opens the exhaust port 33 to a chimney 37 which directs the high temperature air from the heat-exchanger away from the path of the cartons. The high temperature air passes to the exhaust port 33 through a bore 38 in the piston 34. On restarting of the conveyor means the air cylinder 35 retracts the piston 34 so that the exhaust port 33 is obturated by the piston 34 and the outlet port 32 is exposed to permit the passage of the high temperature air through the outlet port 32 to the tubular member 12.

To avoid failure of the heater element 17 in the event that the air supply to the heat-exchanger should fail the electrical circuit 39 for the heater element 17 includes a switch 40 which is disposed in the path of air passing to the heat-exchanger and which is maintained in the closed condition thereof only when the pressure of air thereon exceeds a predetermined minimum, for example ten pounds per square inch. If it is desired to provide for the possibility of the heater element 17 being overheated due to the tubular member 12 becoming blocked, this may be done by providing a switch similar to switch 40 but which is maintained in the closed condition thereof only when the rate of flow of air past the switch exceeds a predetermined minimum, for example four cubic feet per minute.

It has been found that apparatus operating in the manner described herein with reference to the drawings produces commercially acceptable sealed cartons made from polyethylene-coated cardboard while the cartons are moving at a speed of 80 feet per minute. This compares with similar seals obtained when using a flat type radiant heater of similar length (1 foot) at a maximum speed of 40 feet per minute. Thus it will be understood that for a given length of heater it is possible by the method and apparatus according to the invention to obtain a sealing effect the equal of that obtainable prior to the invention but while moving the cartons at twice the maximum speed possible when using a radiant type heater which latter has the additional disadvantage of danger from the exposed radiant heater elements. With apparatus according to the invention and heating means is enclosed in a heat-exchanger

casing and is accordingly protected or shielded from persons attending or operating the sealing machine. Further, the heating element can be operated at high voltages, leading to possible economies in the provision of transformers.

In the foregoing description the heater means has been described as an electric wire heater element but it will be understood that, if desired, the heat-exchanger may be gas-fired.

Also in the foregoing description the heat-sealable material has been described as applied to the overlying portions but, if desired, the heat-sealable material may be applied to the exterior portions of the underlying portions of the carton to be engaged by the overlying portions, in which event the tubular members 12 will be so disposed that the apertures 13 are directed towards and are in close proximity with the underlying portions of the carton to which the heat-sealable material is applied. Alternatively, heat-sealable material may be applied both to the overlying portions and to the exterior of the underlying portions of the carton in which case apertures 13 will be provided in member 12 at positions such that high temperature air will be directed on to the heat-sealable material applied to the overlying portions and to the underlying portions of the carton.

It is further to be understood that while, as above described, it is preferred that the high temperature air be caused to flow in the direction indicated by the arrows 16, if desired the air may be caused to flow in the opposite direction, that is in the direction in which a carton is moved past the tubular member 12 by the conveyor means 10, 11.

I claim:

1. Apparatus for securing an overlying portion to an underlying portion of a carton by heat-sealable material applied to one of the said portions, said apparatus comprising conveyor means operable to move the carton along a predetermined path, a tubular member extending axially lengthwise of said path and provided with apertures which extend through the wall of the tubular member and are arranged substantially in line lengthwise of the tubular member to be in close proximity with the heat-sealable material, a heat-exchanger connected with said tubular member and with air supply means operable to direct low-pressure air through the heat-exchanger and into the

tubular member along the axis thereof, said heat-exchanger being arranged to heat air passing therethrough to a high temperature, guide means extending lengthwise of the tubular member and operable to engage the overlying portion and to support it in a manner such that it extends laterally from the underlying portion to which it is to be secured, and means operable while the heat-sealable material is still in the softened condition thereof to fold and press the overlying portion into engagement with the underlying portion to effect adhesion of the overlying portion to the underlying portion by said material, the connection between the tubular member and the heat-exchanger including a valve having an outlet port through which high temperature air passes into the tubular member, an exhaust port through which the high temperature air is directed away from the path of the carton, and control means operable on starting of the apparatus to expose the outlet port and to obturate the exhaust port and on stopping of the apparatus to obturate the outlet port and to expose the exhaust port.

2. Apparatus according to claim 1, wherein the valve comprises a hollow valve body one end of which is connected with the heat-exchanger and the outlet and exhaust ports are spaced apart axially of the body and extend through the sides thereof, and a piston operated by said control means and slidable axially in the body to effect said exposure and obturation of the outlet and exhaust ports.

3. Apparatus according to claim 2, wherein the control means comprises an air cylinder the piston of which is connected by a rod with the piston of the valve.

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