Abstract: A system is provided for filling and sealing bags and is especially useful with woven polybags formed of thermo-plastic material. The system includes a plastic welder having a folding device for folding over a portion of the filled bag which is sealed by a welding tip and pinch rollers. The welding tip may be moved between welding and non-welding positions based on a bag sensor or timer. A contact prevention member prevents the welding tip from contacting and damaging a coating on a portion of the bag. The system is configured to form a substantial seam without using hot melt adhesive.
as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(Hi))

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METHOD AND APPARATUS FOR TOP SEALING WOVEN BAGS

BACKGROUND OF THE INVENTION

1. TECHNICAL FIELD

The present invention is related generally to a seaming device and methods of seaming. More particularly, the invention is related to a seaming device for seaming filled bags. Specifically, the invention is related to a plastic welder and method of welding a filled woven thermoplastic bag, often referred to as a woven polybag.

2. BACKGROUND INFORMATION

A variety of seaming devices are known in the art, including plastic welders. In addition, it is known to close filled bags with a seaming device. However, there remains a need in the art for closing woven thermoplastic bags in a manner that provides an effective plastic welded seam, especially without the need for using hot melt or other adhesives to form the seam. The present invention addresses this and other concerns in the art.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

A preferred embodiment of the invention, illustrated of the best mode in which Applicant contemplates applying the principles, is set forth in the following description and is shown in the drawings and is particularly and distinctly pointed out and set forth in the appended claims.

Fig. 1 is a front elevational view of the filling and sealing system of the present invention and shows the filling and sealing of a woven polybag.

Fig. 2 is a front elevational view of the welder with the front panel of the upper housing removed.

Fig. 3 is a top plan view of the welder with the top panel of the upper housing removed.

Fig. 4 is a left or upstream end elevational view of the welder with the left panel of the upper housing removed and conveyor belt shown in dot dash lines.
Fig. 5 is an enlarged top plan view of the plastic welder in the region of the welding tip with portions shown in section.

Fig. 6 is a diagrammatic view showing the relationship between Figs. 6A and 6B.

Fig. 6A is an enlarged front elevational view of an upstream portion of the folding mechanism with portions shown in section and the front pinch belt assembly removed.

Fig. 6B is a front elevational view of a downstream portion of the folding mechanism, welding assembly, pinch rollers and pinch roller drive mechanism with the front pinch belt assembly and front pinch rolls removed.

Fig. 6C is a sectional view taken on line 6C-6C of Fig. 6A.

Fig. 7 is a sectional view taken on line 7-7 of Fig. 6B showing the various positions of the welding tip.

Fig. 8 is a diagrammatic top plan view of the pinch belts, bag sensor, downstream end of the folding mechanism, welding tip, pinch rollers and pinch roller cooling device.

Fig. 9 is an enlarged front elevational view of the bag.

Fig. 10 is a sectional view taken on line 10-10 of Fig. 9.

Fig. 11 is a sectional view taken on line 11-11 of Fig. 9 showing the open or unsealed bag with material therein.

Fig. 12 is a view similar to Fig. 6A showing a bag moving downstream with its upper end being folded over by the folding mechanism, and also illustrates the bag sensor sensing the leading edge of the bag at an earlier stage denoted by a vertical dot dash line.

Fig. 13 is a view similar to Fig. 8 showing the bag at the same stage as shown in Fig. 9.

Fig. 14 is an enlarged front elevational view similar to Fig. 6B showing the top of the bag in its fully folded position in the fully folded section of the folding device with the leading end of the bag adjacent the downstream end of the folding device and just prior to beginning the plastic welding of the top portion of the bag.

Fig. 15 is a sectional view taken on line 15-15 of Fig. 14 showing the welding tip in the welding position, the folded top portion of the bag and the contact
prevention member pushing the sub-seam portion of the bag rearwardly away from the welding tip.

Fig. 16 is an enlarged diagrammatic view showing the welding of the top section of the bag with the contact prevention member keeping the sub-seam section spaced rearwardly from the welding tip and the cooling device cooling the pinch rollers.

Fig. 17 is an enlarged front elevational view similar to Fig. 14 with the front pinch rollers removed and the bag being welded, at the same position as Fig. 16.

Fig. 18 is an enlarged sectional view taken on line 18-18 of Fig. 1 showing the sealed bag with material therein.

Similar numbers refer to similar parts throughout the drawings.

**BRIEF SUMMARY OF THE INVENTION**

The present invention provides a plastic welding system comprising: a folding device configured for folding over a top section of a bag as the bag moves in a downstream direction; a downstream end of the folding device; and a welding tip adjacent and downstream of the downstream end of the folding device.

The present invention also provides a plastic welding system comprising: a folding device configured for folding over a section of a bag as the bag moves in a downstream direction; a welding tip adjacent the folding device; a timer; and a controller which is in communication with the timer and controls movement of the welding tip.

The present invention further provides a method comprising the steps of: filling a woven polybag formed of a thermoplastic material with a fill material; and welding an open end of the bag to form a welded seam to close the bag with the fill material therein without using in the welded seam a hot melt adhesive which is distinct from the thermoplastic material.

**DETAILED DESCRIPTION OF THE INVENTION**

The filling and sealing system of the present invention is shown generally at 1 in Fig. 1. System 1 is configured for sealing an open end of a flexible woven thermoplastic bag or polybag 2. System 1 includes a filling mechanism 4, a
conveyor 6 and a plastic welder 8. System 1 has a front 7 and a back 9 (Fig. 4) defining therebetween an axial direction. Filling mechanism 4 includes a hopper 10 having a top entrance opening 12 and a bottom entrance opening 14. Arrows 16 represent downward movement of fill material 15 through opening 12 into hopper 4, from which it is subsequently released downwardly through opening 14 into bag 2 via its top entrance opening 17. Release of material 15 from hopper 4 is controlled by a suitable openable and closable door adjacent the bottom entrance opening 14. Conveyor 6 is configured to move or convey bag 2 with contents or materials 15 therein downstream from adjacent an upstream end 18 to adjacent a downstream end 20 of the conveyor and system 1. Ends 18 and 20 define therebetween a longitudinal direction of system 1. Although any suitable conveyor may be used, conveyor 6 typically includes a conveyor belt 22 having an upwardly facing conveying surface 23 and revolvably mounted on rotatable rollers including upstream and downstream rollers 24 adjacent ends 18 and 20. Rollers 24 are typically rotatably mounted about parallel horizontal axes on a frame which may include legs 26 extending downwardly therefrom and seated atop a typically horizontal support surface or floor 28. A drive mechanism 25 which typically includes an electric motor is operatively connected to one of rollers 24 in order to drive rotation of said roller 24 and the revolution of belt 22 about rollers 24.

Welder 8 includes a frame 30 including a rigid lower frame section 32 and a rigid upper frame section 34 which is vertically movable relative to lower section 32 as indicated at Arrows 36. A control panel or control 35 is mounted on the upper section 34 and includes a computer which runs a computer program for controlling the various functions of welder 8. A clock or timer for measuring passage of time is in communication with a logic circuit of control 35 and may be formed as part of control 35. Controller 35 is in electrical or other communication with drive mechanism 25, such as via electrical wires 37. Control 35 also includes a synchronizing mechanism which is operatively connected to drive mechanism 25 of conveyor 6 to control the rate of revolution of belt 22 and thus the downstream rate of travel of conveying surface 23. The synchronizing mechanism is also operatively connected to the drive mechanisms of the pinch belt assemblies and pinch rollers described further below in order to respectively control the rate of revolution of the
pinch belts and pinch rollers such that the rate of downstream movement of the bag engaging surfaces thereof is the same as the downstream rate of movement of conveying surface 23 and bags 2 carried thereon. Lower section 32 includes a generally horizontal base 38 with a plurality of releasably lockable ground-engaging wheels 40 rotatably mounted thereon for rollingly engaging floor 28 to facilitate movement of welder 8 along floor 28. Upper frame section 34 includes a pair of longitudinally spaced substantially vertical uprights 42 and an upper portion 43 secured to the upper ends of uprights 42. The upper portion 43 overhangs base 38 and includes various structures and mechanisms for guiding and sealing bag 2 as it moves atop surface 23 of belt 22 in a downstream direction (Arrows 44).

Along the upstream end of overhanging upper section 43 of upper frame section 34 is a bag receiving or bag closing structure 46. The present embodiment illustrates two different options for receiving or closing bag 2. Structure 46 includes a vertical plate 48 and may also include a parallel transparent vertical plate 170 which is spaced forward of plate 48 such that plates 48 and 170 define therebetween a relatively narrow vertical longitudinal space for receiving therein an upper portion of bag 2. Alternately, structure 46 may also include a horizontal plate 50 which is forward of vertical plate 48 such that the longitudinal vertical front surface of plate 48 and an angled or tapered rear surface 52 of plate 50 define therebetween a mouth or slot 54 which is generally triangular when viewed from above (Fig. 3) and has an upstream end or entrance opening 56 and a downstream end 58 such that entrance end 56 is wider than downstream end 58. Plate 48 is part of a rear section 45 of upper portion 43. Plate 50 is part of a front belt-supporting structure or portion 47 of upper portion 43 which is movable forward and rearwardly relative to rear section 45. More particularly, a pair of longitudinally spaced axially extending inverted U-shaped mounting arms 49 are rigidly secured at their front lower ends to plate 50 and are movably mounted adjacent their lower rear ends on a pair of corresponding axial tracks 51. A pair of linear actuators 53 such as piston cylinder combinations are attached at one end to rear section 45 and at the other end to arms 49 respectively whereby extension and retraction of the piston of said actuators drives the forward and rearward movement of arms 49 and front section 47.
Downstream of the downstream end 58 of structure 46 are a first or front pinch belt assembly and a second or rear pinch belt assembly which respectively include first or front and second or rear bag engaging pinch belts 60 and 62, each of which is revolvably mounted on front section 47. Rear belt 62 is revolvably mounted around and engages a rear roller 66 (Figs. 4, 8) which rotates about a vertical axis X1 and six front rollers 68 including upstream and downstream end rollers 68A and 68B. Rollers 68 rotate about respective parallel vertical axes X2 which are forward of axis X1 and lie within a common vertical longitudinal plane. Front belt 60 is revolvably mounted around and engages six rear rollers 70 including upstream and downstream end rollers 70A and 70B, and a front roller 72. The upstream end of belt 60 is adjacent the upstream end of belt 62 and the downstream end of belt 60 is adjacent the downstream end of belt 62. Rollers 70 rotate about respective parallel vertical axes X3 which are respectively directly in front of axes X2 and lie in another common vertical longitudinal plane parallel to the plane in which axes X2 lie. Front roller 72 also rotates about a vertical axis which is forward of axes X3. A pair of rotatable tension rollers 74 are rotatably mounted about respective vertical axes X5 which are forward of axis X4 whereby rollers 74 rotate to rollingly engage the outer periphery of belt 60 in contrast to rollers 70 and 72, which rollingly engage the inner perimeter of belt 60, and rollers 66 and 68, which rollingly engage the inner perimeter of belt 62. A motor or drive mechanism 80 (Figs. 2-4) is mounted on the frame and is rotationally coupled with rear roller 66 to drive rotation of roller 66 and thereby drive the revolving movement of belt 62. Drive mechanism 80 is in electrical or other communication with control 35 whereby control 35 controls the various functions of mechanism 80, including turning it on, turning it off and controlling the rate of rotation of its drive shaft and thus the rate of revolution of belts 60 and 62 such that the synchronizing mechanism of control 35 synchronizes or matches the downstream rate of surfaces 64 and 65 with the downstream rate of surface 23 of conveyor belt 22.

The closed loop belt 60 includes a straight longitudinal bag engaging segment which extends from upstream roller 70A to downstream roller 70B and is engaged by each of rollers 70. This straight bag engagement segment of belt 60 has a rearward facing straight longitudinally elongated bag engaging surface 64
formed along the outer perimeter of the belt extending from adjacent roller 70A to adjacent roller 70B. Similarly, the closed loop belt 62 includes a straight longitudinal segment extending from upstream roller 68A to downstream roller 68B which is engaged by each of rollers 68 along the inner perimeter of the belt. The straight longitudinal segment of belt 62 has a forward facing straight longitudinally elongated bag engaging surface extending from adjacent roller 68A to adjacent roller 68B which faces and engages surface 64 of belt 60. The rollers 70 which are respectively directly in front of roller 68 are positioned such that the straight longitudinal segments of belts 60 and 62 are pressed together between the adjacent pairs of roller 68 and 70 to consequently press the engaging surfaces 64 and 65 against one another, especially directly between each pair of adjacent rollers 68 and 70. Each of belts 60 and 62 can be formed of generally flexible elastomeric material. Alternately, the belts may be formed of flexible magnetic material so that the magnetic belts attract one another along engaging surfaces 64 and 65 whereby the magnetic attraction helps to secure the portion of bag 2 therebetween as it moves downstream between the surfaces 64 and 65, particularly in the regions between the longitudinally spaced rollers 68 and longitudinally spaced rollers 70.

Two sets of pinch rollers are generally adjacent and downstream of the downstream ends of belts 60 and 62. More particularly, front upstream and downstream pinch rollers 75A and 75B are rotatably mounted about respective vertical axes X6 which lie in or adjacent the common plane in which axes X3 lie. In addition, rear upstream and downstream rollers 77A and 77B are rotatably mounted about respective parallel vertical axes which lie in or adjacent the common plane in which axes X2 lie. Rollers 75 and 77 may be formed of various materials and in the exemplary embodiment are typically formed either of an elastomeric material or of a metal such as stainless steel such that the circular outer perimeters of the rollers is formed of these materials. Rollers 75A and 75B are directly in front of rollers 77A and 77B respectively whereby rollers 75A and 77A form a first or upstream set of pinch rollers and rollers 75B and 77B form a downstream set of pinch rollers which is closely adjacent and directly downstream of the upstream set 75A and 77A. Upstream rollers 75A and 77A are spaced downstream from and slightly higher
than the downstream rollers 68B and 70B and the downstream ends of belts 60 and 62 so that rollers 75A, 77A and the downstream ends of belts 60 and 62 generally define therebetween a longitudinally elongated space 78 which is at the height of rollers 75 and 78 and higher than belts 60 and 62 and rollers 66, 68, 70, 72 and 74.

A rigid folding mechanism 84 (described in greater detail further below) is provided for folding the top of bags 2 as they move downstream. The downstream portion of folding mechanism 84 is within space 78 with the upstream set of pinch rollers 75A, 77A adjacent and downstream of the downstream end of folding device 84.

With references to Figs. 3 and 5, front rollers 75A and 75B are rotatably mounted on a front roller supporting structure 172 which is mounted forward of rear section 45 and downstream of front section 47 and movable forward and rearward relative to rear section 45. More particularly, mounting arms 174 having the same structure as mounting arms 49 are at their front ends rigidly mounted on structure 172 and at their rear ends are movably mounted on tracks 176 to allow for the forward and rearward sliding of arms 174 and structure 172 relative to rear section 45. Extendable and retractable linear actuators 178 have their rear ends mounted on section 45 and front ends mounted on arms 174 to effect the forward and rearward movement of the arms and roller supporting structure. Like actuators 53, actuators 178 are in electrical or other communication with control 35. Drive mechanisms typically in the form of electric motors 180A and 180B are respectively mounted on structure 172 and rear section 45 adjacent the pinch rollers for respectively driving the rotation of the front pinch roller 75 and the rear pinch roller 77. In the exemplary embodiment, sprockets 182A-H are respectively mounted on the drive shafts of motors 180 and the pinch rollers 75 and 77. Closed loop belts or chains 184A-D are used to translate the rotational motion of the drive shafts of motors 180 to the pinch rollers via sprockets 182. More particularly, drive chain 184A is revolvably mounted on and engages sprockets 182A and 182B; chain 184B revolvingly engages sprockets 182C and 182D; chain 184C revolvingly engages sprockets 182E and F; and chain 184D revolvingly engages sprockets 182G and H. Other suitable drive mechanisms may be used for driving the rotation of rollers 75 and 77. Motors 180 are in electrical or other communication with control 35 whereby the synchronizing mechanism thereof controls the rotational
rate of the drive shaft and motors 180 in order to control the rotational rate of pinch rollers 75 and 77 such that the downstream rate of the circular outer circumferences of rollers 75 and 77 where each set contacts one another is synchronized with or matches the downstream rate of the engaging surfaces 64 and 65 of belts 60 and 62 as well as the downstream rate of surface 23 of belt 22.

System 10 further includes a cooling device 79 (Figs. 1, 2, 13, 16) adjacent and forward of the two sets of pinch rollers 75 and 77. Cooling device 79 is positioned to blow air toward and into contact with the various rollers 75 and 77 in order to facilitate cooling the pinch rollers. In the exemplary embodiment, cooling device 79 is in the form of an air knife which has a solid body defining an interior chamber with an exit port in the form of a very narrow vertical slit 81 and an entry port 83 connected to a conduit or hose 85 which is in communication with compressed air source 87 (Fig. 1). Device 79 is thus configured to receive compressed air from source 87 through hose 85 into inlet port 83 to provide pressurized air within the interior chamber of device 79, which exits the interior chamber via slit 81 to produce a well defined vertical sheet of laminar air flow represented by the dashed lines in Figs. 13 and 16. As shown in Fig. 16, the air flow from slit 81 follows the convexly curved outer surface from the front of device 79 to the flat vertical side surface thereof and rearwardly to direct the air flow generally at the pinch rollers and more particularly between the upstream and downstream set of pinch rollers.

A welding tip 86, most typically configured as the welding tip of a hot air welder, is mounted generally adjacent space 78 and is movable into and out of space 78. As best shown in Fig. 7, tip 86 is movable between an operational welding position (solid lines) within space 78 and a non-welding position (dot dash lines) out of space 78. Tip 86 in the welding position is generally adjacent and downstream of rollers 68B and 70B and the downstream ends of belt 60 and 62, and is closely adjacent the upstream portions of pinch rollers 75A and 77A, and may be positioned directly between portions of rollers 75A and 77A. Tip 86 in the welding position is intersected by or closely adjacent a vertical longitudinal plane defined by surfaces 64 and 65 of belts 60 and 62 where surfaces 64 and 65 abut
one another, and is likewise intersected by or closely adjacent a longitudinal vertical plane in the region of contact between the upstream set of pinch rollers 75A and 77A and/or the region of contact between the downstream set of pinch rollers 75B and 77B. In the welding position, tip 86 is typically higher than belts 60 and 62 and the various rollers which engage belts 60 and 62. In the non-welding position, tip 86 is typically forward of and downward of or lower than belts 60 and 62 and the welding position.

Welding tip 86 is part of a welding unit 88 which includes a hollow or tubular arm 90 which is pivotally mounted (Arrows 93 in Fig. 7) on a carriage 91 about a horizontal longitudinal axis X8 of a pivot 92 whereby tip 86 is lower than pivot 92 and pivots axially forward and rearward. Arm 90 typically includes electrical resistance heating elements which are encased by insulation. The heating elements are in electrical communication with control 35 such that control 35 controls electrical current to the heating elements and thus the temperature of the air passing through unit 88 and ultimately the temperature of the air which passes within and out of tip 86. An extendable and retractable actuator 186 drives the pivotal movement of welding unit 88. Carriage 91 is vertically slidably movably mounted upon a track 99 which is rigidly mounted on rear section 45 of the frame. A linear actuator comprising a cylinder 94 and piston 95 slides linearly up and down (Arrows 97) from cylinder 94 to likewise drive the linear upward and downward sliding movement of carriage 91 along with welding unit 88. Actuators 94 and 186 are in electrical and/or other communication with control 35 whereby control 35 controls the actuators and the movement of carriage 91 and welding unit 88 such that tip 86 may be moved in accordance with the computer program of control 35 to various positions including the welding and non-welding positions. Welding tip 68 is part of a hollow or tubular U-shaped or J-shaped component which includes a leg 96 secured to and extending downwardly from the larger diameter arm 90. A leg 98 of the U-shaped structure is secured to the bottom of leg 96 and extends generally perpendicularly rearwardly therefrom. Tip 86 serves a terminal leg which is secured to the rear end of leg 98 and extends perpendicularly upward therefrom. In the non-welding position, arm 90 angles downwardly and forward from adjacent pivot 92, leg 96 angles downwardly and forward from the bottom of arm 90, leg 98 angles
downwardly and rearwardly from the bottom of leg 96, and tip 86 angles upwardly and rearwardly from the front of leg 98 to its terminal upper end 101. In the welding position, arm 90 and leg 96 are substantially vertical, leg 98 extends substantially horizontally rearwardly from the bottom of leg 96, and tip 86 extends substantially vertically upwardly from the front of leg 98 to its terminal upper end 101.

Folding mechanism or device 84 extends continuously in the longitudinal direction and includes a fold forming section 84A and a fold retaining section 84B which is immediately downstream of section 84A. Thus, the fold forming section 84A is the area in which the upper portion of the bag is folded during downstream movement of bag 2 whereas the fold retaining section 84B is the area in which the fold created or formed within section 84A is retained during continued downstream movement of bag 2. Section 84B may also be referred to as a fully folded section inasmuch as the upper end portion of a given bag which is entirely within section 84B is fully folded from the leading to trailing ends, as discussed further below.

Section 84A includes an upstream portion 100 which is upstream of space 78 and extends longitudinally downstream from adjacent upstream rollers 68A and 70A about a third or half the longitudinal length of belts 60 and 62. Mechanism 84 also includes a downstream portion 102 which extends downstream from upstream portion 100. Retaining section 84B extends downstream from portion 102 to beyond the downstream ends of belts 60 and 62 and into space 78 to adjacent upstream rollers 75A, 77A and the downstream end of space 78. Section 84B has a terminal downstream end 103 (Figs. 6B, 13) which is within space 78, adjacent upstream rollers 75A and 77A, and closely adjacent and upstream of welding tip 68 when tip 68 is in the welding position. Generally, fold forming section 84A includes a longitudinally elongated structure which is twisted clockwise as viewed in the downstream direction to form a gradual spiral which an upper portion of bag 2 slidably engages during downstream movement to cause the top portion of bag 2 to fold over.

This longitudinally elongated structure (Fig. 6A) includes several longitudinally elongated tubes or rods 104 of upstream portion 102 and a longitudinally elongated flat metal strip 105 of downstream portion 102 wherein rods 104 and strip 105 are twisted clockwise as viewed in the downstream direction to
form a gradual spiral which serve as fold-forming surfaces. The rigid rods 104 are secured to longitudinally spaced rigid crossbars 107 which are rigidly secured to rear section 45 of the frame. Downstream portion 102 also includes a longitudinally elongated vertical clamping or pressure plate 106 which is parallel to, forward of and adjacent the front portion of belt 62 along the downstream portion of belt 62. Plate 106 lies along a vertical longitudinal plane and serves as a substantially vertical intermediate guide which is directly forward of a rigid substantially vertical rear guide 113 which is also longitudinally elongated and lies along a vertical longitudinal plane. Rear guide 113 is parallel to and adjacent intermediate guide 106. Portion 102 includes multiple U-shaped supports 108 which have a pair of spaced legs 109 (Fig. 6C) and 111 which are secured at their outer and/or lower ends to an intervening arcuate base 110 which serves as a free terminal end of each support 108. Each base 110 and legs 109 and 111 define therebetween a top edge receiving space 114 for receiving a top edge and top portion of bag 2 as it moves downstream through portion 102 of the folding mechanism. Supports 108 are longitudinally spaced from one another and are serially offset in a fashion which supports metal strip 105 in its spiraling configuration within spaces 114 with strip 105 secured by welding to legs 111. More particularly, the most upstream support 108 extends forward and outwardly in a more horizontal manner, broadly speaking, with its base 110 spaced outwardly from plate 106 and the front section of belt 62, while the most downstream support 108 extends downwardly in a substantially vertical manner with its base 110 forward of and adjacent plate 106 and the front section of belt 62. The terminal free end or base 110 of each support 108 and the front vertical surface of rear guide 113 or plate 106 define therebetween a respective horizontal axial distance. The supports 108 are arranged in the downstream direction to serially increase the downward angle thereof so that for each pair of adjacent supports 108 in which a first one of the pair is immediately upstream of a second one of the pair, the horizontal axial distance corresponding to the base 110 of the second support 108 is less than that corresponding to the base 110 of the first support 108.

Plate 106 and rear guide 113 define therebetween a space 116 (Fig. 6C) in which an overlapped portion of bag 2 is received as the upper portion of bag 2.
moves downstream through portion 102 of device 84. The top of space 116 communicates with or intersects the top of space 114 so that together spaces 114 and 116 form an inverted U-shaped or V-shaped space which has a top end region where spaces 114 and 116 communicate or intersect. The top of this U-shaped or V-shaped space is above a top 121 of intermediate guide 106 and below a horizontal top guide 123 which is rigidly secured to and extends outwardly and forward from the top of rear guide 113. Vertical space 116 has a bottom entrance opening 125 defined between a bottom 127 of intermediate guide 106 and the substantially vertical rear guide surface 113. Entrance opening 125 and space 116 are directly above bag engaging surfaces 64 and 65 of belts 60 and 62. The top ends of legs 111 are rigidly secured to top guide 123 typically by a respective weld. Similarly, legs 109 are secured at their upper or inner ends to intermediate guide 106 typically by a weld.

Fold retaining section 84B includes a front guide 129, which extends downstream from the downstream end of section 102 to the downstream end 103 of the folding device 84. Section 84B further includes a plurality of longitudinally spaced mounting rods 135 having upper ends which are secured to the bottom of top guide 123 adjacent the front thereof and bottom ends secured to the front of intermediate guide 106 adjacent the bottom of guide 106. Mounting rods 135 thus support front guide 129 and intermediate guide 106 within section 84B. Section 84B also includes a contact prevention member 137 (Figs. 15-16) which is adjacent the downstream ends 103 of intermediate and front guides 106 and 129 and also adjacent welding tip 68 when tip 68 is in its welding position. In the exemplary embodiment, member 137 is formed of a bent rod having a generally vertical segment 139, a generally horizontal segment 141 and a tip segment 143 which angles downwardly from horizontal segment 141. More particularly, vertical segment 139 at its upper end is secured to the bottom of top guide 123 adjacent the front thereof. Adjacent downstream end 103, segment 139 is also secured to the front of front guide 129 and extends downwardly below the bottom of guide 129 to a lower end. A front upstream end of segment 141 is secured to the lower end of segment 139 via a bend in the rod and extends rearwardly and downstream below the bottom of intermediate guide 106 and rearwardly thereof to a rear downstream
end, to which tip segment 143 is secured at a downward bend in the rod. Segment 141 may be secured to bottom 127 of intermediate guide 106. Tip segment 143 extends rearwardly, downwardly and downstream from the bend at which it is connected to segment 141 to a terminal end of member 137 having a rearward facing surface configured for contacting sub-seam portion 156 of bag 2 as it moves downstream in the region of downstream ends 103 and welding tip 86. Tip segment 143 extends rearwardly beyond the rear surface of welding tip 86 and the rear surface of intermediate guide 106.

A bag sensor 118 (Figs. 4, 8, 12) is mounted on the frame upper section 34 and is positioned to sense the leading edge of a given bag 2 to ascertain that a bag 2 has entered welder 8 at a sensing location upstream of welding tip 86 and space 78. Sensor 118 is in electrical or other communication with control 35 such as by electric wires 117 (Fig. 4). In the exemplary embodiment, a reflector 119 (Figs. 1, 2, 8) is spaced from sensor 118 on the opposite side of the pathway through which the upper portion of bag 2 moves during its downstream movement. Typically, sensor 118 includes a laser producing or light producing transmitter which transmits a laser or other light (dashed lines in Fig. 8) from sensor 118 to reflector 119 such that the light is reflected back to a receptor of sensor 118 absent an obstruction directly between the light transmitter and the reflective surface of reflector 119. Thus, introduction of bag 2 or another object directly between sensor 118 and reflector 119 interrupts the light transmission to reflector 119 whereby such interruption blocks reflected light back to the receptor and indicates the presence of bag 2 or other object in this area, whereby a signal is produced and sent to control 35. Any known sensor capable of indicating the presence of bag 2 in a predetermined location upstream of the welding tip may be used. In the exemplary embodiment, sensor 118 is positioned longitudinally intermediate the upstream and downstream ends of belt 62 for sensing a bag 2 within that region and typically within the region extending along upstream portion 100 of device 84.

Before describing the operation of system 1, bag 2 will be described in greater detail with primary reference to Figs. 9-11. Bag 2 has a substantially horizontal top edge or top 120, a substantially horizontal bottom 122, a substantially vertical leading or right edge or side 124 and a substantially vertical trailing or left
edge or side 126. In the exemplary embodiment, bag 2 is formed of a flexible thermoplastic material and more particularly a woven thermoplastic material. Thermoplastic materials which are well suited for forming such woven bags include polyvinylchloride (PVC), polypropylene, polyethylene and polyurethane, although this is not an exhaustive list. In general, bag 2 is typically formed entirely or nearly entirely of such a woven thermoplastic material although various additional components may be used as will be understood by one skilled in the art. Bag 2 includes a flexible front sheet or panel 128 and a flexible rear sheet or panel 130 which is substantially parallel to panel 128 prior to being filled with material 15 and broadly parallel to panel 28 after being filled with material 15. Various styles of woven polybags may be used. For example, front and rear panels 128 and 130 may simply be joined directly to one another along the left and right sides or edges although additional panels may be used as well. For instance, bag 2 often includes a leading or right sheet or panel 132 which is secured to and extends between the right edge of front panel 128 and the right edge of rear panel 130. Similarly, a flexible trailing or left panel 134 is secured and extends between the left edge of front panel 128 and the left edge of rear panel 130. All of panels 128, 130, 132 and 134 are formed of the woven thermoplastic material. Often, a single sheet of woven thermoplastic material is formed into a tubular structure with a vertical seam and then folded as illustrated in Fig. 10 to produce the above-noted panels. Thus, panel 132 may include various folded sections such as front section 136 and rear section 138 which intersect one another at a vertical intersection or fold, while front section 136 intersects the right edge of front panel 128 at a vertical intersection or fold, and rear section 138 intersects the right edge of rear panel 130 at a vertical intersection or fold. Similarly, left panel 134 may include folded sections such as front section 140 and rear section 142 which intersect one another at a vertical intersection or fold, with front section 140 intersecting the left edge of front panel 128 at a vertical intersection or fold and rear section 142 intersecting the left edge of panel 130 at a vertical intersection or fold. A generally horizontal seam is typically formed along bottom 122 of the bag whereby bag 2 is entirely or substantially closed except for the top entrance opening 17 along top 120 prior to
the sealing of the top open end by system 1. The various panels of bag 2 thus define an interior chamber 144 with top entrance opening 17.

As shown in Fig. 9, bag 2 may be divided into various sections including a generally horizontal top section 146 which extends from top 120 downwardly to a substantially horizontal lower imaginary border 148 which is generally adjacent top 120. Top section 146 may be divided into a top half 150 which will subsequently serve as a folded or overlapping portion, and a bottom half 152 which will subsequently serve as an overlapped portion. Top half 150 thus extends from top 120 to a substantially horizontal upper imaginary border or fold line 154 which is midway between top 120 and border 148, whereby bottom half 152 extends downwardly from border 154 to border 148 and thus has a height which is the same as that of top half 150. A sub-seam portion 156 extends downwardly immediately below border 148 and thus immediately below the bottom of bottom half or overlapped portion 152. Sub-seam portion 156 may be made up entirely of the woven thermoplastic material and may additionally include a coating or outer layer adhered to the outer surface of the woven thermoplastic material of panel 128. Such an outer coating or layer is indicated at 158 and often is an ink layer used in decorating or printing on the bag. This coating may or may not be formed of ink, but typically has a color which is different than the color of the woven thermoplastic material forming panel 128. Although coating 158 is denoted only in the sub-seam section, an outer coating 158 may substantially cover the entire front outer surface of front panel 128 and/or the rear outer surface of rear panel 130. Sub-seam section 156 is spaced upwardly of a top 160 of material 15 which is within interior chamber 144 during the seaming or sealing of the top open end of bag 2.

In operation (Fig. 1), top 120 of bag 2 is releaseably secured to the bottom of hopper 10 with top entrance opening 12 in communication with bottom entrance opening 14 so that particulate material 15 within hopper 10 may be fed via openings 12 and 14 into interior chamber 44 of bag 2. Top 120 of bag 2 is then released from hopper 10 and dropped or otherwise lowered onto the upper horizontal section of conveyor belt 22 with bottom 122 of bag seated atop surface 23 of belt 22, which drive mechanism 25 revolves to move bag 2 downstream (Arrows 44) from adjacent the upstream end of belt 22 to adjacent the downstream
end thereof. Bag 2 thus travels atop belt 22 with the vast majority of bag 2 including material 15 passing beneath belts 60 and 62. Bag 2 adjacent top 120 first passes between plates 48 and 170 or into slot 54 via entrance opening 56 whereby the front surface of plate 48 and rear edge 52 of plate 50 respectively engage and force the rear and front layers 128 and 130 (Figs. 6C, 10, 15) of bag 2 adjacent top 120 to move together as slot 54 (Fig. 3) narrows so that bag 2 closes adjacent downstream end 58 between the upstream ends of belts 60 and 62.

As bag 2 moves downstream into welder 8, sensor 118 senses (dashed lines in Figs. 8, 13) bag 2 (dot dash lines in Fig. 12) initially at front edge 124 to ascertain that bag 2 has entered welder 8 and has been engaged by and is being driven downstream by surfaces 64 and 65 of belts 60 and 62. Sensor 118 produces a signal indicative of the entry of bag 2 into welder 8 and more particularly of the leading edge 124 reaching the predetermined sensing location. Sensor 118 sends this signal to control 35, which in response controls operation of welding unit 88 via actuators 94 and 186 to move from its non-welding position (dashed lines in Fig. 7) to its welding position. Tip 86 is first pivoted rearward from the non-welding position to an intermediate position (dashed lines directly below the welding position) in which tip 86 is directly below and thus still external to space 78. The linear actuator connected to carriage 91 is then actuated to retract piston 95 to move carriage 91 and unit 88 upwardly so that tip 86 thereby moves upwardly into space 78 to the welding position. This movement of tip 86 allows tip 86 to be positioned at the welding position within a relatively small space immediately downstream of end 103 of guide 106 and closely adjacent the upstream set of pinch rollers 75A and 77A.

As bag 2 moves downstream from structure 46 into section 84A and with reference to Figs. 12 and 13, a portion of bag 2 which is spaced downwardly from top 120 below portion 152 is pressed and flattened between surfaces 64 and 65 of belts 60 and 62 while top section 146 above the pressed portion extends upwardly above the top of belts 60 and 62 so that top section 146 is not pressed between belts 60 and 62, but rather enters upstream portion 100 of folding mechanism 84 to begin folding the top portion over beginning at leading end 124. As the top of bag 2 is folded over within downstream section 102 of folding device 84 (Fig. 12), bottom half 152 of top section 146 passes between rear and intermediate guides 113 and
116 within space 116 while top half 150 moves downstream through spaces 114 of supports 108 as shown in Fig. 6C. During this downstream movement through downstream section 102, the rear outer surface of bottom half 152 slidably engages the front and vertical surface of rear guide 113, the front outer surface of bottom half 152 slidably engages the rear vertical surface of intermediate guide 106, a top horizontal longitudinal fold 162 between halves 150 and 152 slidably engages the horizontal downwardly facing surface of top guide 123 and top half or folded portion 150 slidably engages the downwardly and/or rearwardly facing surface of strip 105. The sliding engagement between top half 150 and metal strip 105 causes the top half 150 to fold over, thereby forming fold 162. At this stage, top half 150 has become the folded or overlapping portion of top section 146 while bottom half 152 has become the overlapped or partially overlapped portion thereof.

As shown in Fig. 14, bag 2 continues in the downstream direction (Arrow 44) so that it moves from the fold forming section 84A into the fully folded or fold retaining section 84B so that all of portion 150 is folded over from leading edge 124 to trailing edge 126 when leading edge 124 is adjacent downstream end 103 of section 84B. At this stage, top portion 146 is entirely downstream of fold forming section 84A and top portion 146 adjacent leading edge 124 has entered space 78. As bag 2 moves downstream through section 84B, bottom half 152 moves downstream within space 116 and top half 150 moves downstream within space 131. After the folding process is completed within section 84A and the final fold is retained within section 84B, sections 150 and 152 thus extend substantially vertically downwardly (Fig. 15) from top fold 162 so that fold 162 and portions 150 and 152 form a folded over inverted U-shaped top section 146 with sections 150 and 152 defining therebetween a space 164 within section 146. Intermediate guide 106 is received within space 164 as bag 2 moves downstream while top section 146 is within retaining section 84B. At this stage, fold 162 serves as the top of the bag whereas the former top 120 of bag 2 now faces downwardly and is below the top or top fold 162 such that the former top 120 is at the same height as imaginary border 148. Section 150 thus completely overlaps section 152 as viewed from the front. During the downstream movement of top section 146 within retaining section 84B, there is typically a sliding engagement between fold 162 and each of top guide
123 and top 121 of intermediate guide 106, a sliding engagement between portion 150 and each of a rear surface of front guide 129 and the front surface of intermediate guide 106, and a sliding engagement between portion 152 and each of the rear surface of intermediate guide 106 and the front surface of rear guide 113.

Figs. 15 and 16 show the operation of contact prevention member 137. In particular, as bag 2 moves downstream adjacent and past tip 86, tip segment 143 engages and pushes or diverts sub-seam section 156 rearwardly away from the rear surface of tip 186 to ensure that there is no contact between tip 86 and section 156 and layer 158 on section 156. Member 137 thus ensures that the heated tip 86 does not damage layer 158 by contacting it, which would typically occur without the use of member 137. The use of member 137 thus keeps layer 158 intact or undamaged. Without the use of member 137, layer 158 would typically contact the rear of tip 86 whereby layer 158 would be heated and marred such that the color of the thermoplastic material of bag 2 would show through the color of layer 158, thereby defeating the aesthetic appearance of layer 158 and producing a sealed bag which may be considered a reject.

As bag 2 moves downstream with portions 150 and 152 being pinched between the two sets of pinch rollers 75 and 77, cooling device 79 directs air flow generally toward and between the two sets of pinch rollers in order to provide cooling thereof. In addition, the air flow from cooling device 79 is directed toward top section 146 whereby the air flow may also directly provide cooling to section 146 adjacent the pinch rollers as shown in Fig. 16. Cooling device 79 is set up for continuous operation and thus will continue to provide air flow toward the pinch rollers to provide cooling thereto whether a bag is moving through the pinch rollers or whether there is no bag moving through the pinch rollers as illustrated in Fig. 13.

As leading edge 124 of a given bag moves beyond downstream end 103 of section 84B and the welding position of tip 86, as illustrated in Figs. 16 and 17, welding tip 68 is received within space 164. Welding tip 86 thus provides sufficient heat within space 164 to sections 150 and 152 for plastic welding sections 150 and 152 to one another. More particularly, once appropriately heated by welding tip 86, portions 150 and 152 exit space 78 and move between the first set of pinch rollers 75A and 77A and the second set 75B and 77B, which thus pinch or compress
layers or sections 150 and 152 together to create a plastic welded seam 166 therebetween, as shown in Figs. 16 and 18. Seam 166 has a vertical width W as measured from the top to the bottom of seam 166. In the exemplary embodiment, welder 8 is configured to provide a seam 166 in which width W is equal to or greater than two inches, thus providing a very substantial strength to the seam. In the exemplary embodiment, a seam with such a width is produced by the use of hot air welding tip 86. However, welding tip 86 may be any of the various types of welding tips known in the art. System 10 is configured for producing seam 166 with a relatively large vertical width by plastic welding the overlapping and overlapped sections 150 and 152 directly to one another without the use of any type of hot melt glue or other adhesive which is distinct and different from the thermoplastic material from which bag 2 is formed. Seam 166 is also suitably strong without the need for any additional seaming such as stitching or other reinforcing structures.

As previously noted, controller 35 is programmed to control the movement of welding tip 86. One aspect of this control relates to moving tip 86 out of the welding position and space 78 to prevent tip 86 from heating various components adjacent the welding position when bags 2 are not being welded or not about to be welded. In the exemplary embodiment, control 35 is programmed to move tip 86 from the welding to the non-welding position upon the occurrence of one or more conditions.

For instance, sensor 118 sends a signal to control 35 indicative of the presence of a first bag 2 at the sensing location. This signal may also serve as a trigger or initiator to initiate tracking of time. More particularly, control 35, using the clock or timer, is programmed to track passage of a predetermined specified time period and to move tip 86 from the welding to the non-welding position absent receiving a signal from sensor 118 indicative of the presence of a second bag 2 at the sensing location during the time period. In the exemplary embodiment, this predetermined time period is about 9 seconds and typically within the range of about 5 to 15 seconds although this may vary depending on the specific scenario. A different initiator may be used to initiate tracking of the time period. For example, another sensor may be used to determine that a given bag 2 has moved beyond welding tip 86 or has reached another specified destination during downstream travel, such that the other sensor may signal controller 35 to begin tracking time to determine
the specified time period upon the given bag reaching the specified destination. Alternately, for example, control 35 may control tip 86 to move from the welding to the non-welding position in response to other conditions. For instance, a sensor may sense that the trailing edge 126 of a given bag 2 has moved beyond the welding tip 86, such that the sensor signals control 35 to immediately move tip 86 out of the welding position essentially without a time delay or without using a timer to track a specified time period after which tip 86 is to be moved.

Regardless of how tip 86 is controlled to move out of the welding position, tip 86 will typically remain in the non-welding position until sensor 118 senses a subsequent bag 2 entering welder 8, at which time control 35 once again controls the welding assembly to move tip 86 from the non-welding position to the welding position. As noted above, tip 86 is moved from the welding position to the non-welding position when there is no bag being welded or there is no bag approaching the welding position in order to prevent heating or overheating various components adjacent the bottom position, such as the pinch rollers, especially the upstream rollers 75A and 77A, the downstream end of retaining section 84B, the downstream portions of belts 60 and 62 and the downstream rollers 68B and 70B. If the tip 86 were not moved out of the welding position in this manner, these various components could be damaged by overheating. In addition, the continued heating of these components which would occur if tip 86 were not moved out of the welding position may cause malfunctioning or difficulty in producing a proper weld inasmuch as these various components could themselves become hot enough to cause melting of the thermoplastic material of bag 2.

In the foregoing description, certain terms have been used for brevity, clearness, and understanding. No unnecessary limitations are to be implied therefrom beyond the requirement of the prior art because such terms are used for descriptive purposes and are intended to be broadly construed.

Moreover, the description and illustration of the invention is an example and the invention is not limited to the exact details shown or described.
CLAIMS

1. A plastic welding system comprising:
   a folding device configured for folding over a top section of a bag as the bag
moves in a downstream direction; a downstream end of the folding device; and
a welding tip adjacent and downstream of the downstream end of the folding
device.

2. The system of claim 1 further comprising a fully folded section of the folding
device configured so that the top of the bag is fully folded from a downstream end
of the bag to an upstream end of the bag when the bag is within the fully folded
section.

3. The system of claim 1 wherein the folding device adjacent the downstream end
includes a substantially vertical front guide, a substantially vertical rear guide and a
substantially vertical intermediate guide between the front and rear guides; the front
and intermediate guides define therebetween a substantially vertical front space; the
rear and intermediate guides define therebetween a substantially vertical rear
space; and the welding tip is directly downstream of the intermediate guide.

4. The system of claim 3 further comprising
   a bottom of the intermediate guide; and
   a bag-engaging contact prevention member which is adjacent the
downstream end of the folding device and extends rearwardly beyond the
intermediate guide and lower than the bottom of the intermediate guide so that the
contact prevention member is adapted to push rearward a sub-seam portion of the
bag immediately below the top section of the bag so that the welding tip does not
contact the sub-seam portion, the top section including a folded over overlapping
portion and an overlapped portion which is overlapped by the overlapping portion.

5. The system of claim 1 further comprising
a rear surface of the welding tip;
a bag-engaging contact prevention member which is adjacent the welding tip
and extends rearwardly beyond the rear surface of the welding tip so that the
contact prevention member is adapted to push rearward a sub-seam portion of the
bag immediately below the top section of the bag so that the welding tip does not
contact the sub-seam portion.

6. The system of claim 1 further comprising
a sensor positioned to sense a bag as the bag moves downstream; and
a controller which is in communication with the sensor and controls
movement of the welding tip.

7. The system of claim 6 wherein the controller controls the welding tip to move
from a non-welding position to a welding position in response to a signal from the
sensor.

8. The system of claim 6 further comprising a timer; wherein the controller is
programmed to control the welding tip to move from a welding position to a non-
welding position in response to a signal from the timer indicative of passage of a
specified time period.

9. The system of claim 8 wherein the controller is programmed to control the
welding tip to move from the welding position to the non-welding position in
response to the signal from the timer absent a signal from the sensor indicative of
sensing a bag at the sensing location within the specified time period.

10. The system of claim 1 further comprising
a timer; and
a controller which is in communication with the timer and controls movement
of the welding tip.
11. The system of claim 10 wherein the controller is programmed to control the welding tip to move from a welding position to a non-welding position in response to a signal from the timer indicative of passage of a specified time period.

12. The system of claim 1 further comprising a pair of pinch rollers downstream of the welding tip.

13. The system of claim 12 further comprising a cooling device positioned for cooling the pinch rollers.

14. The system of claim 13 further comprising a source of compressed air in fluid communication with the cooling device.

15. The system of claim 13 wherein the cooling device is configured for directing airflow toward the pinch rollers.

16. The system of claim 1 further comprising a bag-filling assembly upstream of the folding device.

17. The system of claim 1 further comprising

   a conveyor having a conveyor surface which is movable in the downstream direction and adapted to carry bags in the downstream direction;

   a pair of rotatable pinch rollers adapted for pinching therebetween an upper portion of a bag which moves in the downstream direction on the conveyor surface;

   and

   a synchronizing mechanism operatively connected to the conveyor and pinch rollers to control a downstream movement rate of the conveyor surface and a rotation rate of the pinch rollers in a synchronized manner so that a bottom of the bag and the upper portion of the bag move downstream at respective rates which are substantially identical.

18. The system of claim 1 further comprising
a conveyor having a conveyor surface which is movable in the downstream direction and adapted to carry bags in the downstream direction; a pair of revolvable pinch belts adapted for pinching therebetween an upper portion of a bag which moves in the downstream direction on the conveyor surface; and a synchronizing mechanism operatively connected to the conveyor and pinch belts to control a downstream movement rate of the conveyor surface and a revolution rate of the pinch belts in a synchronized manner so that a bottom of the bag and the upper portion of the bag move downstream at respective rates which are substantially identical.

19. A plastic welding system comprising:
   a folding device configured for folding over a section of a bag as the bag moves in a downstream direction;
   a welding tip adjacent the folding device;
   a timer; and
   a controller which is in communication with the timer and controls movement of the welding tip.

20. A method comprising the steps of:
   filling a woven polybag formed of a thermoplastic material with a fill material; and
   welding an open end of the bag to form a welded seam to close the bag with the fill material therein without using in the welded seam a hot melt adhesive which is distinct from the thermoplastic material.