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Sealing Device



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Field of the Invention

This invention relates generally to the field of automated fabrication devices and more particularly without limitation to a device and associated method for automatically sealing a flexible member such as a barrier bag.

Background of the Invention

Tremendous gains in manufacturing productivity and quality have been realized by the application of modern automation techniques to production processes. Most of the earliest advancements involved automating fabrication processes, such as by the use of numerically controlled tooling machines. Typically, the work piece was manually installed into a fixture, or "fixtured," the computer-controlled process performed, and then the work piece was manually removed from the fixture. Subsequent advancements improved the material handling aspects of the process, such as with the proliferation of robotics. Today, it's not unusual to see all aspects of the fabrication process from raw material to packaging performed by automated flexible manufacturing cells connected by automated material transfer devices.

Flexible manufacturing approaches are typically able to process different types of parts so that one cell can be used in the manufacture of different products. For example, a packaging cell might be able to receive different size containers for use in packaging different sizes or types of products. This flexibility furthermore aids the development of new and different products because the likelihood of consequential costly modifications and downtime to the manufacturing process are greatly diminished.

One such process that is particularly difficult to automate is the evacuating and sealing of barrier bags that are used to enclose work pieces. Typically, positioning the open end of the bag and stretching the open end taut to facilitate evacuating requires human handling. This is especially true where processing different sizes of bags is contemplated, such as in a cell processing different sizes or different types of work pieces. The penalty associated with relying on manual intervention can be very significant.

It has been determined that optimal automated sealing can be achieved by inserting moveable stretching members into the bag to stretch the open end of the bag taut before evacuating the bag. It is to these improvements and others as exemplified by the description and appended claims that embodiments of the present invention are directed.

Summary of the Invention

The embodiments of the present invention contemplate an apparatus and an associated method for sealing a bag enclosing a work piece, comprising a frame receivingly engaging the bag on a reference surface and presenting an open end of the bag, and means for automatically sealing the bag by detecting the position of the open end of the bag and responsively stretching the bag taut and then sealing the open end of the bag closed without human handling of the bag. The means for automatically sealing can be further or alternatively characterized by a sealing head supported by the frame and moveable in a first direction to clamp around the open end of the bag. The means for automatically sealing can be further or alternatively characterized such that the sealing head is moveable in a second direction substantially orthogonal to the first direction for clamping around different portions of the open end of the bag. The means for automatically sealing can be further or alternatively characterized by evacuating the bag after stretching and clamping and before sealing. The means for automatically sealing is characterized by centering the open end of the bag on the reference surface with respect to the first direction of sealing head travel. The means for automatically sealing can be further or alternatively characterized by heating a clamped portion of the open end of the bag to thermally form the seal.

The apparatus comprises a frame defining a reference surface adapted for supporting the bag and the work piece, wherein the bag is disposed around the work piece and open on a side. A sealing head is supported by the frame and moveable between a retracted position and an engaged position, whereat the engaged position the sealing head is adjacent the open portion of the bag. A conduit is supported by the

frame and comprises a distal end insertable into the open side of the bag in the engaged position of the sealing head. A negative pressure source is fluidly connected to the conduit to impart a negative pressure to the distal end, drawing the present atmosphere out of the bag. A stretching member is supported by the frame so as to be insertable into the open end of the bag and is moveable to stretch the open end of the bag taut. A clamping member is supported by the sealing head and is moveable between an open position and a clamped position. A closure member is supported by the clamping member and is adapted for sealingly joining the open side of the bag in the clamped position of the clamping member.

The apparatus can further comprise a lateral positioning device supported by the frame and having a moveable pusher engageable against the work piece selectively positioning the work piece on the reference surface. In some embodiments the lateral positioning device comprises opposing pushers moveable toward each other to opposingly engage the work piece for selectively positioning the work piece on the reference surface.

In some embodiments the lateral positioning device positions the work piece with the open side of the bag disposed substantially along a longitudinal axis of the reference surface, and the sealing head is moveably supported by the frame for positioning the sealing head at selected positions along the reference surface longitudinal axis.

The closure member can comprise a heating element supported by the clamping member and engageable against the bag in the clamped position of the clamping member to thermally seal the bag. The apparatus can further comprise a sensor indicating the height of the bag, and a controller responsive to the sensor and operatively controlling, in turn, the position of the reference surface relative to the clamping member.

The embodiments of the present invention further contemplate a method for sealing a barrier bag to enclose a work piece, comprising: disposing the work piece in the barrier bag; positioning the work piece and barrier bag on a reference surface with

an open end of the bag facing a preselected direction; inserting a stretching member into the open end of the bag; moving the stretching member to stretch the open end of the bag taut; closing a clamping member around the open end of the bag; withdrawing the stretching member from the bag; evacuating the environment from within the bag; and sealing the open end of the bag closed.

In some embodiments the method further comprises sensing the distance of the open end of the bag from the reference surface and responsively moving the clamping member around the open end of the bag. In some embodiments the method further comprises repositioning the clamping member after partially sealing the open end of the bag and then sealing another portion of the open end of the bag. In some embodiments the method further comprises centering the barrier bag relative to a direction of travel of the clamping member.

These and various other features as well as advantages which characterize the present invention will be apparent upon reading of the following detailed description and review of the associated drawings.

Brief Description of the Drawings

FIG. 1 is an isometric view of a sealing device constructed in accordance with embodiments of the present invention.

FIG. 2 is a diagrammatic elevational view of a portion of the device of FIG. 1 showing the sealing head in the retracted position.

FIG. 3 is a view similar to FIG. 2 but showing the sealing head in the engaged position.

FIG. 4 is a diagrammatic view illustrating the two-axis movement capability of the stretching member.

FIG. 5 is a diagrammatic view of a portion of the device of FIG. 1 showing the sealing head in the engaged position with the clamping member open and the stretching member extended into the open end of the bag.

FIG. 6 is a view similar to FIG. 5 but showing the clamping member in the clamped mode.

FIG. 7 is a view similar to FIG. 6 but showing the stretching member withdrawn from the bag while the conduit remains inserted within the open end of the bag.

FIG. 8 is a view similar to FIG. 7 but showing the conduit withdrawn and the closure member effecting a seal to retain the negative pressure inside the bag.

FIG. 9 is a view similar to FIG. 8 but showing the clamping member opened to release the bag.

FIG. 10 is a plan view of the carton as it randomly traverses the reference surface in the work zone.

FIG. 11 is a view similar to FIG. 10 but showing the pusher members orienting the carton along a reference surface longitudinal axis.

FIG. 12 is a view similar to FIG. 10 but shown a long carton sealed by a repositioning action of the sealing head.

FIG. 13 is a diagrammatic view illustrating a variable control of the reference surface relative to the sealing head for flexibly processing cartons of different heights.

FIG. 14 is a block diagram of a method for sealing a bag in accordance with the embodiments of the present invention.

Detailed Description

Referring to the drawings in general, and more particularly to FIG. 1, shown therein is a sealing device 10 for a sealing a bag (shown below) such as the type used as a barrier device in a packaging arrangement. The sealing device comprises a frame 12 receivingly engaging the bag on a reference surface 14 and presenting an open end of the bag for sealing. In the description below the reference surface comprises a roller conveyor for moving a work piece into and out of the reference surface 14.

The sealing device 10 further comprises means for automatically sealing the bag by detecting the position of the open end of the bag and responsively stretching the bag taut and then sealing the open end of the bag closed without human handling of the bag. In other words, the various embodiments of the present invention have in common the advantage of being able to engage and seal the open end of the bag automatically, meaning no human handling is necessary to first align and then stretch the open end relative to a sealing device.

In some embodiments the means for automatically sealing is characterized by a sealing head 16 supported by the frame 12 and moveable along a first axis 18 to clamp around the open end of the bag. In some embodiments the means for automatically sealing is characterized such that the sealing head 16 is moveable along a second axis 20 substantially orthogonal to the first axis for clamping around different portions of the open end of the bag. The second axis 20 is substantially coincident with a longitudinal axis of the reference surface 14. In some embodiments the means for automatically sealing is characterized by evacuating the bag after stretching and clamping and before sealing. In some embodiments the means for automatically sealing is characterized by centering the open end of the bag on the reference surface 14 with respect to the axis 18 along which the sealing head 16 travels. In some embodiments the means for automatically sealing is characterized by heating a clamped portion of the open end of the bag to thermally form the seal.

In view of that which is contemplated within the scope of the embodiments of the present invention in comparison with the present state of the art, the means for sealing explicitly does not include a device or associated method wherein the bag must be manually grasped for alignment and/or stretching.

FIGS. 1-3 best illustrate the frame 12 defining the reference surface 14 adapted for supporting a bag 22 and a work piece 24, the bag 22 disposed around the work piece 24 and open on a side 26. In some instances, such as illustrated herein, the bag 22 is disposed within a carton 28 used as a protective device during transit and

storage. The carton 28 in FIGS. 2 and 3 has flaps 30 that are closeable around the work piece 24.

The sealing head 16 is supported by the frame 12 so as to be moveable between a retracted position (FIG. 2) and an engaged position (FIG. 3). In the retracted position the sealing head 16 is clearly removed such that the work piece 24 can be moved into or out of a working zone upon the reference surface 14. In the engaged position the sealing head 16 is adjacent the open end 26 of the bag 22.

A conduit 32 is supported by the frame and moveable with the sealing head 16 such that a distal end 34 that is insertable into the open end 26 of the bag 22 in the engaged position of the sealing head 16. A negative pressure source 36 is diagrammatically shown fluidly connected to the conduit 32 to impart a negative pressure to the distal end 34, drawing the present atmosphere out of the bag 22.

In order to impart the negative pressure to the bag 22, however, a substantial seal must be achieved between the outer surface of the conduit 32 and the inner surface of the open end 26 of the bag 22. This part of the methodology is ordinarily resolved by human intervention. However, in the embodiments of the present invention a stretching member 38 is supported by the frame 12 so as to be insertable into the open end 26 of the bag 22. The stretching member 38 is also moveable along axis 40 to stretch the open end 26 of the bag 22 taut, so as to conform to a minimum size opening. In the embodiments illustrated herein a pair of stretching members 38 move oppositely between a retracted position (FIG. 2) and an extended position (FIG. 3) to stretch the open end 26 of the bag 22 taut.

FIG. 4 diagrammatically illustrates the manner in which the stretching members 38 are supported by the frame 12 for two-axis freedom of movement in lateral direction 40 as well as orthogonal direction 41. In one illustrative embodiment the stretching member 38 is moveable in the lateral direction 40 by being mounted to the distal end of a linear actuator 35 such as a rodless fluid cylinder. The linear actuator 35 in turn is moveable in the orthogonal direction 41 by being mounted to the distal end of a linear actuator 37 such as a rodless fluid cylinder. Cooperative

movement of the actuators 35, 37 control both the lateral spread between opposing stretching members 38 and control the depth with which the stretching member is receivingly engaged within the open end 26 of the bag 22. This latter benefit permits a relatively deeper insertion of the stretching member 38 to ensure a quality seal a selected distance away from the open end 26.

The sealing head 16 defines a clamping member 42 for closing and sealing the open end 26 of the bag 22. The clamping member 42 has opposing jaws 44, 46 that are moveable between an open position (FIG. 5) and a closed position (FIG. 6). It will be noted that the clamping member 42 is in the extended position in FIGS. 5 and 6. In FIG. 5 the stretching member 38 is extended into the open end 26 of the bag 22 and spread apart so as to stretch the open end 26 taut. The jaws 44, 46 are clearly open while the bag 22 is stretched. Subsequently the jaws 44, 46 are closed in FIG. 6 to close the open end of the bag 22. In FIG. 7 the stretching member 38 is withdrawn with the jaws 44, 46 remaining in the closed position. A negative pressure can be imparted to the conduit 32 now that a substantial seal has been provided between the open end 26 of the bag 22 and the conduit 32. In FIG. 8 the conduit 32 has been withdrawn after reaching a preselected negative pressure, and the jaws 44, 46 close around the open end 26 of the bag 22 to retain the desired negative pressure. In FIG. 9 the jaws 44, 46 are opened to release the bag 22 after sealing.

The jaws provide a closure member for sealingly joining the open end 26 of the bag 22. For example, the jaws 44, 46 in FIGS. 5 and 6 support heating elements 48, 50 for thermally forming a seal 52 sealing the bag 22.

Preferably, the sealing device 10 is equipped for flexible manufacturing processes whereby different sizes of cartons 28 can be received and processed. Accordingly, a lateral positioning device 60 can be supported by the frame 12, having one or more moveable pushers 62 engageable against the carton 28, or work piece 24, for selectively positioning the same on the reference surface 14. FIGS. 10 and 11 are planar views showing a carton 28 being conveyed into the work zone before (FIG. 10) and after (FIG. 11) the pushers 62 are rotated to position the carton 28 laterally on the

reference surface 14. It will be noted that FIGS. 10 and 11 illustrate opposing pushers 62 that are moveable toward each other to opposingly engage the carton 28, or work piece 24, for selective positioning on the reference surface.

In some instances it may prove desirable to process bags 22 with a longitudinal length greater than the longitudinal length of the sealing head 16. Accordingly, the sealing head 16 can be moveably supported upon the frame 12 for positioning the sealing head 16 at selected positions along the longitudinal axis 20. In FIG. 1, for example, the sealing head 16 is supported on a linear slide 70 and positioned by a linear actuator such as a rodless fluid cylinder (not shown). In this manner, FIG. 12 is a planar view of a carton 28 containing a bag 22 that is partially sealed in a first position 80 of the sealing head 16, then the sealing head 16 is repositioned to a second position 82, shown in broken lines, whereat the bag 22 is then stretched, evacuated and sealed. It will be noted that in the repositioned process at 82 the stretching members 38 can engage the end of the previously sealed position shown at 84 and the distal end of the bag 22 shown at 86 to stretch the second portion of the open end 26.

Preferably, the sealing device is equipped for flexibly processing bags 22 of different heights as well. FIG. 13 diagrammatically illustrates a sensor 90, such as a proximity switch series, indicating the height of the bag 22. A controller 92 is responsive to the sensor 90 and controls, in turn, the position of the reference surface 14 such as by activating an actuator portion 93 of a powered scissor lift 94 supporting the reference surface 14. Alternatively, the sensor 90 can be a bar code scanner placed to read a bar coded label placed on the work piece 24 or the carton 28 and indicative of the size of the bag 22.

Accordingly, the sealing device 10 is adapted for sealing the bag 22 by a process comprising: (1) receiving the work piece 28 in a working zone; (2) inserting the stretching member 38 into the bag 22; (3) inserting the conduit 32 into the bag 22; (4) moving the stretching member 38 to stretch the open end 26 of the bag 22 taut; (5) opening the clamping member 42 and moving the clamping member 42 to receive

engage the open end 26 of the bag 22; (6) closing the clamping member 42 against the open end 26 of the bag 22; (7) withdrawing the stretching member from the bag 22; (8) communicating a negative pressure to the conduit 32 to evacuate the bag 22; (8) withdrawing the conduit 32 from the bag 22 when a preselected negative pressure is achieved at the conduit distal end 34; (9) sealing the bag 22 to retain the negative pressure state in the bag 22; and (10) opening the clamping member 42 and clearly moving the clamping member 42.

The embodiments of the present invention further contemplate a method 100 depicted in FIG. 14 for sealing a barrier bag 22 associated with the sealing device 10 described hereinabove. The method 100 comprises disposing the work piece 24 in the barrier bag 22; positioning the work piece 24 and barrier bag 22 on a reference surface 14 with an open end 26 of the bag 22 facing a preselected direction; inserting the stretching member 38 into the open end 26 of the bag 22 at block 102; and moving the stretching member 38 to stretch the open end 26 of the bag 22 taut in block 104. If the length of the bag 22 is greater than the clamping member then the decision to reposition in block 106 is affirmative so a partial sealing operation is performed in block 108 and then the sealing head is repositioned in block 110. Control then returns to block 102. Alternatively, if no reposition is needed in block 106 then the bag is evacuated in block 112 and sealed in block 114.

Preferably, the method comprises preliminarily sensing the distance of the open end of the bag from the reference surface in block 116 and responsively moving the reference surface 118 to accommodate. Furthermore, preferably the method comprises laterally centering the barrier bag relative to a direction of travel of the clamping member in block 120.

It is to be understood that even though numerous characteristics and advantages of various embodiments of the present invention have been set forth in the foregoing description, together with details of the structure and function of various embodiments of the invention, this disclosure is illustrative only, and changes may be made in detail, especially in matters of structure and arrangement of parts within the

principles of the present invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed. For example, the mechanisms used to move the stretching and sealing members may vary while maintaining substantially the same functionality without departing from the scope and spirit of the present invention. In addition, although the preferred embodiment described herein is directed to use with sealing a bag, it will be appreciated by those skilled in the art that the teachings of the present invention can be applied to other types of work pieces as well without departing from the scope and spirit of the present invention.

What is claimed is:

1. A sealing apparatus for sealing a bag enclosure around a work piece, comprising:
 - a frame defining a reference surface adapted for supporting the bag and work piece, the bag disposed around the work piece and open on a side;
 - a sealing head supported by the frame and moveable between a retracted position and an engaged position, whereat the engaged position the sealing head is adjacent the open portion of the bag;
 - a conduit supported by the frame and comprising a distal end insertable into the open side of the bag;
 - a negative pressure source fluidly connected to the conduit to impart a negative pressure to the distal end, adaptively drawing atmosphere out of the bag;
 - a stretching member supported by the frame and insertable into an open end of the bag and bidirectionally moveable relative to the sealing head to insert into the bag a desired depth and stretch the open end of the bag taut;
 - a clamping member supported by the sealing head and moveable between an open position and a clamped position and adaptively receivingly engaging the open side of the bag in the engaged position of the sealing head;
 - a closure member supported by the clamping member adapted for sealingly joining the open side of the bag to retain the negative pressure therein.
2. The apparatus of claim 1 further comprising a lateral positioning device supported by the frame and having a moveable pusher engageable against the work piece selectively positioning the work piece on the reference surface.
3. The apparatus of claim 2 wherein the lateral positioning device comprises opposing pushers moveable toward each other to opposingly engage the work piece for selectively positioning the work piece on the reference surface.

4. The apparatus of claim 2 wherein the lateral positioning device positions the work piece with the open side of the bag disposed substantially along a longitudinal axis of the reference surface, and wherein the sealing head is moveably supported by the frame for positioning the sealing head at selected positions along the reference surface longitudinal axis.

5. The apparatus of claim 1 further comprising a conveyor supported by the frame and adapted for moving the work piece to the reference surface.

6. The apparatus of claim 1 wherein the closure member comprises a heating element supported by the clamping member and engageable against the bag in the clamped position of the clamping member to thermally seal the bag.

7. The apparatus of claim 1 further comprising a sensor indicating the height of the bag.

8. The apparatus of claim 7 further comprising a controller responsive to the sensor and operatively controlling, in turn, the position of the sealing head.

9. The apparatus of claim 1 furthermore adapted for sealing the bag by a process comprising:

receiving the work piece in a working zone;

opening the clamping member and moving the clamping member to

receivingly engage the open side of the bag;

inserting the stretching member into the bag;

inserting the conduit into the bag;

moving the stretching member to stretch the open side of the bag taut;

clamping the clamping member against the open side of the bag;

withdrawing the stretching member from the bag;
communicating a negative pressure to the conduit to evacuate the bag;
withdrawing the conduit from the bag when a preselected negative pressure is achieved at the conduit distal end;
sealing the bag to retain the negative pressure state in the bag;
opening the clamping member and clearing the clamping member.

10. A method for sealing a barrier bag to enclose a work piece; comprising:
disposing the work piece in the barrier bag;
positioning the work piece and barrier bag on a reference surface with an open end of the bag facing a preselected direction;
inserting a stretching member into the open end of the bag a desired depth;
moving the stretching member to stretch the open end of the bag taut;
closing a clamping member around the open end of the bag;
withdrawing the stretching member from the bag;
evacuating the environment from within the bag;
sealing the open end of the bag closed.

11. The method of claim 10 further comprising sensing the distance of the open end of the bag from the reference surface and responsively moving the clamping member around the open end of the bag.

12. The method of claim 10 further comprising repositioning the clamping member after sealing a first portion of the open end of the bag and then sealing another portion of the open end of the bag.

13. The method of claim 10 wherein the positioning the work piece and barrier bag step comprises centering the barrier bag relative to a direction of travel of the clamping member.

14. The method of claim 10 wherein the sealing step comprises heating the barrier bag to thermally form a seal.

15. A sealing device for a bag, comprising:

a frame receivingly engaging the bag on a reference surface and presenting an open end of the bag; and

means for automatically sealing the bag by detecting the position of the open end of the bag and responsively stretching the bag taut and then sealing the open end of the bag closed without human handling of the bag.

16. The sealing device of claim 15 wherein the means for automatically sealing is characterized by a sealing head supported by the frame and moveable in a first direction to clamp around the open end of the bag.

17. The sealing device of claim 16 wherein the means for automatically sealing is characterized such that the sealing head is moveable in a second direction substantially orthogonal to the first direction for clamping around different portions of the open end of the bag.

18. The sealing device of claim 16 wherein the means for automatically sealing is characterized by evacuating the bag after stretching and clamping and before sealing.

19. The sealing device of claim 16 wherein the means for automatically sealing is characterized by centering the open end of the bag on the reference surface with respect to the path of sealing head travel.

20. The sealing device of claim 16 wherein the means for automatically sealing is characterized by heating a clamped portion of the open end of the bag to thermally form the seal.