Title: CONTINUOUS MOTION SEALING APPARATUS FOR PACKAGING MACHINE

Abstract: A sealing apparatus is especially adapted for a packaging machine which wraps spaced-apart products with a tubular film. The apparatus includes a frame (42) which provides a path (A) along which the products are advanced. A sealing support structure (58) is mounted on the frame for linear reciprocating movement along the path. A crank arm (72) is rotatably mounted on the frame for reciprocating the sealing support structure. Upper and lower sealing dies (81, 82) are mounted on the sealing support structure for linear movement toward and away from each other in a direction which is generally perpendicular to the path.
CONTINUOUS MOTION SEALING APPARATUS FOR PACKAGING MACHINE

Background

This invention relates to a sealing apparatus and, more particularly, to a sealing apparatus which is particularly suitable for a packaging machine in which spaced-apart products are enclosed by a plastic film.

The invention is an improvement over the sealing apparatus which is described in U.S. Patent No. 5,447,012. The '012 patent describes a packaging machine for packaging bundles or groups of products such as rolls of bathroom tissue or paper towels. The rolls are advanced by a conveyor and pull belts, and groups of rolls are collated into bundles. The bundles are wrapped by a plastic film, and the longitudinal edges of the film are lapped and sealed to form an elongated tube.

The film is sealed between each pair of adjacent bundles by a sealing assembly. The sealing assembly simultaneously seals the trailing end of the exiting bundle and the leading edge of the incoming bundle.

U.S. Patent No. 5,753,067 describes a sealer for a bag maker-packaging machine. Thermoplastic bag-making material is formed into a vertical tube, and the tube is sealed by a transverse sealer. The sealer includes a pair of seal jaws which are mounted on rotary arms which rotate on shafts. The shafts are moved toward and away from each other by a turn-buckle mechanism. The seal jaws thereby move along D-shaped trajectories.

U.S. Patent Nos. 5,279,098 and 5,347,795 describe specific mechanisms for moving the shafts of the rotary arms toward and away from each other.

Summary of the Invention

The invention moves upper and lower sealing dies linearly in two directions while the products to be
sealed move continuously to provide good speed with fewer moving components. The continuous motion allows the machine to be run at substantially slower speeds to accomplish the same rate of production as the intermittent motion of the prior art, thereby allowing reduced costs for the same output and improved product control. The design also allows higher production when the machine is kept running at full constant speeds, providing a substantially faster rate of production without increasing cost.

The sealing dies are mounted on mounting bars which are guided for linear vertical movement. The dies are moved toward each other to close against the film for sealing and are moved away from each other to allow the products to pass between the dies. The die mounting bars are mounted on a reciprocating frame which is reciprocated linearly in a direction parallel to the direction in which products move so that the sealing dies move with the film during the sealing step.

The sealing dies are opened and closed by a servo motor so that the length of the sealing region can be varied automatically. This offers a significant advantage when running packages of variable length. The ability to automatically vary the length of the sealing region offers higher rates of operation when running shorter packages and reduces the acceleration and deceleration rates required to return the dies to their initial cycle positions.

The opening gap between the upper and lower dies can also be varied automatically. This offers a significant advantage when running packages of variable height.

The opening and closing rates of the sealing dies can be varied without altering the placement of the dies relative to the product. This offers a significant advantage when extracting air from between the packages while closing the dies. Another advantage of this
feature is that the sealing time can be maximized by quickly opening the dies without altering the horizontal placement of the dies relative to the product.

**Description of the Drawing**

The invention will be explained in conjunction with an illustrative embodiment shown in the accompanying drawing, in which --

Figures 1A and 1B are fragmentary side elevational views of a packaging machine which includes a sealing apparatus in accordance with the invention;

Figure 2 is an enlarged side elevational view of the sealing apparatus;

Figure 3 is a top plan view of the sealing apparatus;

Figures 4-12 are perspective views which illustrate the sequence of steps in a sealing cycle;

Figures 13-21 are side views which correspond to Figures 4-12;

Figure 22 is a transverse view of the sealing section;

Figure 23 is an enlarged fragmentary view of a portion of Figure 22;

Figure 24 is an enlarged fragmentary view of one of the linear guides and bearings;

Figure 25 is a front view of the upper die assembly;

Figure 26 is a sectional view taken along the line 26-26 of Figure 25;

Figure 27 is an enlarged fragmentary view of the right end of the upper die assembly;

Figure 28 is a view similar to Figure 2 of a modified embodiment; and

Figure 29 illustrates one example of the movement of the upper sealing die.

**Description of Specific Embodiment**

Figures 1A and 1B illustrate a packaging machine 25 of the general type which is described in
U.S. Patent No. 5,447,012. The machine is particularly suitable for packaging bundles of rolls of bathroom tissue or paper towels.

The machine 25 includes an infeed choke belt section 26, a product upender section 27, a product collator section 28, a film feed/lap seal/girth former section 29, a pull belt section 30, a sealing section 31, and a discharge section 32. Details of those sections, except for the collator section and the improvements in the sealing section, are described in Patent No. 5,447,012.

Referring to Figures 2 and 3, the packaging machine 25 groups rolls 35 of bathroom tissue or paper towels into bundles 36. In Figure 3, each bundle includes four rolls across the direction in which the rolls are advanced and four rolls in the machine direction. In Figure 4 each bundle includes two rolls across and six rolls in the machine direction. Many other configurations are possible. Rolls can also be stacked on top of each other.

The bundles are advanced in the direction of the arrow A in Figures 2-21 by conveyors and pull belts. Before reaching the sealing section 31, the bundles are enclosed by a plastic film 38 (Figures 2 and 3). As is well known in the art, the longitudinal edges of the plastic film are overlapped and sealed to provide an elongated tube which extends in the direction of the arrow A.

As will be explained hereinafter, the sealing section 31 cuts and seals the plastic tube between each pair of bundles. In Figure 3, the leading end 40 of the bundle 36A has already been sealed. The plastic tube between the handles 36A and 36B is about to be cut and sealed to provide a sealed trailing end for bundle 36A and a sealed leading end for bundle 36B.

Referring to Figures 2 and 3, the sealing section or apparatus 31 includes a stationary frame 42
which includes vertical posts 43-46 and horizontal beams 47-52. Driven pull belts 53 and 54 (Figure 3) for conveying the bundles is mounted on the horizontal beams.

A traversing or reciprocating frame 58 is mounted on the stationary frame 42 for forward and backward linear reciprocating movement in directions which are parallel to the direction of the product movement. The reciprocating frame 58 includes a pair of vertical bars 60 and 61 (Figure 4) and upper and lower cross bars 62 and 63. Laterally extending brackets 65 and 66 (Figure 3) are attached to the vertical bars 60 and 61, and a channel shaped bearing 68 (Figures 2, 22, and 24) is mounted below each of the brackets. The bearings 68 ride on a linear guides or rails 70 which are mounted on the horizontal beams 51 and 52 of the stationary frame.

In the embodiment illustrated in Figures 2 and 3 the frame 58 is reciprocated by a pair of crank arms 72 and 73 which are fixedly mounted on a shaft 74 which is rotatably mounted on the stationary frame 42. The shaft 74 is rotated by a servo motor 76 on the stationary frame. The crank arms 72 and 73 are connected to the brackets 65 and 66 on the reciprocating frame 58 by links 78 and 79. The ends of the links are pivotally connected to the crank arms and the brackets.

Figure 2 illustrates the reciprocating frame 58 in its most upstream or left position with respect to the direction A of product flow. As the shaft 74 rotates 180° from its Figure 2 position, the crank arms 72 and 73 and the links 78 and 79 move the frame linearly to the right in the direction of product flow. The linear movement of the frame is guided by the linear guides 70.

The stroke or length of movement of the reciprocating frame is indicated in Figure 2 by dimension B. The most downstream position or right
position of the frame corresponds to the right end of dimension B.

As the shaft 74 continues to rotate from 180° through 360°, the crank arms and links move the reciprocating frame opposite to the direction of product flow to return the frame to the Figure 2 position.

Referring to Figures 22 and 23, upper and lower sealing die assemblies 81 and 82 are attached to mounting bars 83 and 84 which are attached to upper and lower linear bearings 85 and 86. The linear bearings 85 and 86 are vertically slidable on vertical shafts 87 and 88.

Upper and lower cross members 89 and 90 are clamped to the vertical shafts 87 and 88. Upper and lower pulleys 91 and 92 are mounted on cross shafts 93 and 94 which are attached to the cross members 89 and 90. Right and left drive belts 95 and 96 travel over the upper and lower pulleys 91 and 92.

The upper mounting bar 83 is connected to the rear portions of the drive belts 95 and 96 by clamps 97 (Figure 23). The lower mounting bar 84 is connected to the front portions of the drive belts by clamps 98. The lower cross shaft 94 and the lower pulleys 92 are driven by a servo motor 99.

The mounting bars 83 and 84 for the sealing dies are mounted for vertical reciprocating movement on the vertical shafts 87 and 88. When the servo 99 rotates the lower pulleys 92 counterclockwise, the rear loops of the drive belts 95 and 96 move downward, carrying the upper die 81 downward, while the front loops of the belts 95 and 96 move upward, carrying the lower die 82 upward. The simultaneous movements close the dies. Rotating the servo clockwise then opens the dies.

Referring to Figures 25 and 26, the upper die assembly 81 includes a pair of conventional impulse sealing ribbons 120 and 121 and a serrated cut-off knife
1222 mounted between the sealing ribbons. The sealing ribbon 120 seals the trailing end of the exiting bundle, and the sealing ribbon 121 seals the leading end of the incoming bundle. A layer of Teflon® fabric insulates the ribbons and prevents molten plastic from adhering to the ribbons. A pair of film grippers 123 straddle the sealing ribbons and are resiliently biased by gripper springs 124. As the upper and lower dies close, the film grippers grip the film, the knife 122 cuts the film, and the sealing ribbons seal the film.

In one specific embodiment the servo motor 99 was a 71 in-lb (8Nm) A/C servo motor which included a 20:1 planetary gear box.

The servo motor 99 adjusts the open dimension between dies to accommodate format height changes. The closed location of the dies is adjustable by a hand wheel 100 (Figure 22). The cross members 89 and 90 and the vertical shafts 87 and 88 form a vertically movable assembly which includes the pulleys 91 and 93, drive belts 95 and 96, and mounting bars 82 and 83. The handwheel 100 is threadedly connected to a threaded shaft 101. The threaded shaft passes through upper beam 62 and is rotatably connected to the cross member 89. When the hand wheel is rotated, the threaded shaft 101 moves the vertically movable assembly up or down as indicated by the arrows 102. The vertical shafts 87 and 88 slide within linear guides 103 and 104 on the upper and lower beams 62 and 63 to permit the up and down movement of the vertically movable assembly.

The hand wheel is used to raise or lower the sealing die assembly so that when the dies are closed, they are at half the height of the product to be sealed, or at the center of the package.

The threaded shaft can also be rotated by a servo motor or other mechanical or electrical driving means. Further, the vertically movable assembly could be raised or lowered by mechanisms other than a threaded
shaft, for example, a belt drive.

The reciprocating die frame 58 reciprocates horizontally, propelled by the crank arms 72 and 73 to match the speed of the plastic film while severing and sealing the film tube. The crank arms 72 and 73 advantageously provide two pivot locations 105 and 106 (Figure 2) for the crank arms 72 and 73 to change the amount of horizontal die movement. In one specific embodiment the two pivot locations provided 12 inches and 16 inches of horizontal die movement. The pivot location is set manually depending on the product format.

One alternative method of reciprocating the die frame 58 is illustrated in Figure 28. The reciprocating die frame 58 is attached to a belt drive 107 which travels over pulleys 108 and 109. The pulley 108 is driven by servo motor 76. Rotation of the belt drive in one direction moves the reciprocating die frame to the right, and rotation of the belt drive in the opposite direction moves the die frame to the left.

In one specific embodiment the servo motor 76 for the crank mechanism was a 105 in-lb (12 Nm) A/C servo motor driving the die crank mechanism through a 50:1 gear box. The servo motors and pull belts were controlled by a controller 111 (Figure 2), such as a Giddings & Lewis MMC4PC with a remote I/O.

Figures 4 and 13 illustrate the first step in the sealing cycle. The leading end of the exiting bundle 36A has already been sealed. The upper and lower die mounting bars 83 and 84 are in their open positions to allow the exiting bundle 36A to move past the sealing dies. As described in Patent No. 5,447,012, the movement of the bundles is controlled by pull belts which are entrained over upper and lower rollers 110-115. Side pull belts may also be used. The crank arms 72 and 73 are positioned so that the reciprocating frame 58 is at the beginning of its forward movement in the
direction A of product movement.

Figures 5 and 14 illustrate the sealing dies in the process of closing between bundles 36A and 36B. As the dies move toward each other, the reciprocating frame 58 is moved forwardly by the crank arms 72 and 73. The rate at which the dies are closed can be varied to allow the incoming bundle 36B to collapse the gap with the existing bundle 36A. The rate of die closing is coordinated with the rate of the die traverse for optimal sealing and end gussets. The discharge pull belt assemblies and side discharge pull belt assemblies can be separated in order to release the bundles contained therebetween so that the downward movement of the sealing dies against the plastic film tube can collapse the film tube and move adjacent bundles together. Alternatively, the discharge pull belts could be driven in reverse to accomplish the same results, or the bundle can be allowed to slide across the discharge pull belt on rollers 110 and 111 as the dies close.

As described in Patent No. 5,447,012, gusset plates form gussets in the sides of the plastic tube as the tube is collapsed by the sealing dies, and a vacuum lance evacuates the tube before it is sealed as described in U. S. Patent No. 6,050,056. Mechanical tuckers 117 (Figure 22) can be used to assist the forming of the gussets on large packages.

Figures 6 and 15 illustrate the sealing dies in the closed position at the start of the sealing step. The plastic tube is clamped between the sealing dies so that the sealing ribbons can begin sealing the plastic. The cut-off knife severs the plastic between the spaced-apart sealing ribbons.

Figures 7 and 16 illustrate the end of the sealing step. The sealing dies remain clamped against the plastic film as the crank arms 72 and 73 move the reciprocating frame 58 downstream at the same speed as the speed at which the plastic film is advanced.
horizontal movement of the sealing dies with the plastic film provides sufficient time for the sealing dies to seal the film.

Figures 8 and 17 illustrate the opening of the dies toward the end of the forward movement of the reciprocating frame 58. The sealing dies are opened to permit the reverse movement of the reciprocating frame 58 past the second bundle 36B.

Figures 9 and 18 illustrate the reciprocating frame 58 at the end of its forward stroke. The sealing dies are open, and continued rotation of the crank arms 72 and 73 will begin the backward motion of the reciprocating frame.

Figures 10 and 19 illustrate the reciprocating frame in the process of returning to its original position. The sealing dies remain open.

Figures 11 and 20 illustrate the reciprocating frame 58 near the end of its reverse stroke. The sealing dies are beginning to close as soon as they clear the exiting bundle 36B. Figures 12 and 21 correspond to Figures 4 and 13 and illustrate the reciprocating frame 58 at the end of its reverse stroke and at the beginning of its forward stroke. The sealing dies are in the process of closing.

Figure 29 illustrates one example of the path P of the movement of the upper sealing die which is caused by the combination of the linear horizontal reciprocating movement of the reciprocating frame 58 and the linear vertical reciprocating movement of the mounting bar 83. The same path P is superimposed on Figure 2. The path of movement of the lower sealing die is the mirror image of the path P of Figure 29.

Position 204 on path P corresponds to Figure 4. The sealing dies are open, and the reciprocating frame 58 is in its Figure 2 position.

The curved portion 205 of path P represents the movement of the upper sealing die as the sealing
apparatus moves from its Figure 4 position to its Figure 6 position. The upper and lower sealing dies move toward each other as the reciprocating frame moves to the right.

Position 206 corresponds to Figure 6. The dies are closed against the plastic film and the sealing portion of the cycle begins. Sealing continues until point 207, which corresponds to Figure 7.

Between points 207 and 208, the dies open as the reciprocating frame continues to move to the right. At point 208, corresponding to Figure 8, the dies are fully open.

Between points 208 and 209, the reciprocating frame 58 moves to the left to return the sealing dies toward their starting positions. Between points 209 and 204, the sealing dies begin to close as the reciprocating frame moves to its most upstream position.

In the preferred embodiments, the reciprocating frame 58 is reciprocated by a crank mechanism or by a belt drive. However, other means can be used for moving the frame back and forth along the path on which the products move.

Similarly, the preferred means for opening and closing the sealing dies includes belt drives. However, other means can be used.

While in the foregoing specification a detailed description of a specific embodiment of the invention was set forth, it will be understood that many of the details hereingiven may be varied considerably by those skilled in the art without departing from the spirit and scope of the invention.
I CLAIM:

1. A sealing apparatus for sealing spaced-apart products which are enclosed by a film comprising:
   a frame, the frame providing a path along which spaced-apart products can move,
   a sealing support structure mounted on the frame for movement along said path,
   upper and lower sealing units mounted on the sealing support structure for movement toward and away from each other in a direction which is generally perpendicular to said path,
   means for moving the upper and lower sealing units toward each other to close the sealing units whereby a film between the sealing units can be sealed and for moving the upper and lower sealing units away from each to open the sealing units, and
   means for reciprocating the sealing support along said path between first and second positions.

2. The apparatus of claim 1 in which the sealing support structure is mounted on the frame for linear reciprocating movement along said path.

3. The apparatus of claim 2 in which the upper and lower sealing units are mounted on the sealing support structure for linear movement toward and away from each other.

4. The apparatus of claim 1 in which the upper and lower sealing units are mounted on the sealing support structure for linear movement toward and away from each other.

5. The apparatus of claim 1 in which said means for moving the upper and lower sealing units includes a servo motor.

6. The apparatus of claim 5 in which the means for moving the upper and lower sealing units includes a belt drive which is driven by said servo
motor.

7. The apparatus of claim 1 in which said means for reciprocating the sealing support structure includes a crank arm rotatably mounted on the frame and a link connecting the crank arm and the sealing support structure.

8. The apparatus of claim 7 including a servo motor for rotating the crank arm.

9. The apparatus of claim 7 including a linear bearing between the sealing support structure and the frame for supporting the sealing support structure for linear movement along said path.

10. The apparatus of claim 9 including a linear guide on the sealing support structure, the upper and lower sealing units being mounted on the linear guide for linear movement toward and away from each other.

11. The apparatus of claim 7 including a linear guide on the sealing support structure and linear bearings on the upper and lower sealing units for supporting the sealing units for linear movement along said path.

12. The apparatus of claim 1 including a linear guide on the frame and a linear bearing on the sealing support structure for supporting the sealing support structure for linear movement along said path.

13. The apparatus of claim 1 in which said means for reciprocating the sealing support structure includes a belt drive mounted on the frame and connected to the sealing support structure.

14. The structure of claim 1 including a linear guide on the frame which extends in the direction of said path and a linear bearing on the sealing support structure for supporting the sealing support structure for linear movement along said path.
15. The apparatus of claim 1 including a pair of linear guides on the sealing support structure which extend generally perpendicularly to said path, a pair of bearings on each of the upper and lower sealing units slidably mounted on the linear guides for linear movement toward and away from each other.

16. The apparatus of claim 15 including upper and lower cross members connected to said pair of linear guides, and means for moving said upper and lower cross members and said linear guides in a direction which is generally perpendicular to said path.

17. The apparatus of claim 16 in which said linear guides are slidably mounted in said sealing support structure.

18. The apparatus of claim 18 in which said means for moving includes a threaded shaft connected to one of the upper and lower cross members and extending through said sealing support structure whereby rotation of the threaded shaft moves said upper and lower cross members and said linear guides relative to said sealing support structure.

19. The apparatus of claim 16 including upper pulleys rotatably mounted on the upper cross member and lower pulleys rotatably mounted on the lower cross member, a pair of drive belts extending over the upper and lower pulleys, and means for rotating the upper or lower pulleys to move the drive belts, the upper and lower sealing units being connected to the drive belts for movement with the drive belts.

20. The apparatus of claim 15 including upper pulleys rotatably mounted on the upper cross member and lower pulleys rotatably mounted on the lower cross member, a pair of drive belts extending over the upper and lower pulleys, and means for rotating the upper or lower pulleys to move the drive belts, the upper and
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7  B65B51/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
IPC 7  B65B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)
EPO—Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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