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FORM, FILL AND SEAL PACKAGING METHODS AND APPARATUS

This invention relates to packaging methods and apparatus, and more particularly to a form-fill-seal packaging method and apparatus.

5 The invention is especially concerned with a method of and apparatus for forming, filling and sealing packages in which a web of flexible sheet packaging material is pulled from a supply and fed over means for forming it into tubing, product to be
10 packaged being provided in the tubing, and the tubing being sealed to form packages.

 One type of apparatus in which the invention may be used is a machine of the so-called vertical form-fill-seal class in which a web of flexible packaging material is guided from a supply roll of the material
15 over a forming shoulder, at which it is formed into tubing, the tubing being intermittently fed downward, sealed to form a longitudinal tube seam, and ultimately sealed at package length intervals (and cut
20 into individual packages). Heretofore, there have been four basic subclasses, generally, of this class of vertical form-fill-seal machine in commercial use as follows :

 1. The type having a vertically reciprocating
25 carriage carrying a set of sealer bars for sealing the tubing at package length intervals, the bars closing on the tubing at the upper end of the upstroke of the carriage, pulling a package length increment of the tubing downward on the downstroke of the
30 carriage, and then opening for the upstroke, as sold by Hayssen Manufacturing Company of Sheboygan, Wisconsin, the present applicants, and a number of other companies.

 2. The type having belts engaging the tubing on a
35 mandrel to feed it downward in package length increments, with a dwell between successive feed cycles, a set of sealer bars being operable in a fixed horizontal plane below the lower end of the mandrel during each dwell to form a transverse seal

across the tubing.

3. The type in which the forming shoulder is vertically reciprocable for feeding the tubing downward in package length increments, with a dwell between successive feed cycles, a set of sealer bars being operable in a fixed horizontal plane during each dwell to form a transverse seal across the tubing.

4. The type having vertically reciprocating vacuum grippers (vacuum boxes) engageable with the tubing on a mandrel, or a vertically reciprocating fin seal gripper (the longitudinal seam for the tubing being a fin seal in this case, as distinguished from a lap seal), for feeding the tubing downward in package length increments, with a dwell between successive feed cycles, a set of sealer bars being operable in a fixed horizontal plane below the lower end of the mandrel during each dwell to form a transverse seal across the tubing.

Problems such as the following may at times be encountered in the operation of packaging machines of these types:

(A) The pull on the tubing required to draw the material over the forming shoulder and feed it downward, i.e., either the so-called "breakaway pull", which is the pull required to start the feed of the material and the tubing following a dwell, or the "continuous pull", which is the pull required to keep the material moving, may be so high for certain materials as to tend to degrade the material, by inducing severe stresses particularly at the shoulder area and may further cause stretching of the packaging material in other instances, and to degrade the material from the standpoint of appearance,

(B) The machine may have to be operated at a lower package production rate than desired, and

(C) The material fails to track properly over the forming shoulder, reducing efficiency of operation.

Claims 1 and 5 of the claims of this specification set out two aspects of this invention.

Examples of the invention will now be described with reference to the accompanying drawings in which:

Fig. 1 is a perspective of a vertical form-fill-seal machine of this invention, and illustrating the method of this invention,

Fig. 2 is a front elevation of Fig. 1, showing certain drive mechanism of the machine,

Fig. 3 is a side elevation of the lower part of Fig. 2,

Fig. 4 is an enlarged horizontal section generally on line 4--4 of Fig. 2,

Fig. 5 is an enlarged vertical section generally on line 5--5 of Fig. 2,

Fig. 6 is a section generally on line 6--6 of Fig. 5,

Fig. 7 is a diagram of a control circuit for Fig. 1, and

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring first more particularly to Fig. 1 of the drawings, there is generally indicated at 1 a vertical form-fill-seal apparatus of this invention, in which a web W of flexible packaging material is pulled from

a supply, fed over means 3 for forming the web into tubing T, product to be packaged is provided (in any of various suitable well-known ways) in the tubing, and sealing operations are performed on the tubing as generally indicated at 5 (again in any of various suitable well-known ways) to seal it to form packages. The packaging material may be low density polyethylene film, for example, and the supply may be constituted by a roll R of the film suitably supported as indicated at 7. The forming means 3 may be a forming shoulder generally of a conventional type such as shown, for example, in the coassigned U.S. patents 3 050 916 issued August 28, 1962, 3 449 888 issued June 17, 1969, and 3 664 086 issued May 23, 1972.

As shown in Figs. 1, 2 and 4, the forming shoulder 3 forms the web W of packaging material into the tubing T with the longitudinal margins 9 and 11 of the web W in lapping relationship, and directs the tubing downwardly around a vertically extending, hollow mandrel 13 (also as shown, for example, in the above-mentioned coassigned US patents). As illustrated, margin 9 is on the inside, margin 11 on the outside. At 15 in Fig. 1 is diagrammatically indicated suitable means for sealing the lapping margins 9 and 11 of the web to form a longitudinal seam for the tubing. Product is provided in the tubing T via the hollow mandrel 13 in suitable conventional manner, and the tubing is transversely sealed at package length intervals by the sealing means indicated at 5 below the lower end of the mandrel. The sealing means 5 may, for example, comprise a pair of sealing bars each designated 17 operable in a fixed horizontal plane below the lower end of the mandrel to form a top seal for the package being completed and the bottom seal for the next package to be formed. The seal bars may have cutting means incorporated therein (as is conventional) for cutting transversely between the seals made at 5 to separate

the completed package P from the tubing. In the embodiment of the invention illustrated in Figs. 1-7, the tubing is intermittently fed forward, which is downward, one package length increment, the seal bars 17 being open. The tubing dwells between successive feed cycles, the seal bars being closed on the tubing for the transverse sealing operation during each dwell. Suitable means, which may be wholly conventional and well known in the art, is used for moving the seal bars toward and away from one another.

The web W is intermittently pulled from supply roll R, measured for each sealing operation at 5, and fed forward toward the forming shoulder 3 by means indicated generally at F located between the supply roll and the forming shoulder. This means F is intermittently operable to apply a forward force to the web at a position between the supply roll and the forming shoulder for feeding the web forward one package length increment in a given interval. Thus, it acts as a web feeding and measuring or metering means. As illustrated, it comprises a lower roll 19 and an upper roll 21 with means indicated generally at 23 for intermittently driving these rolls through a predetermined interval corresponding to the desired length for the packages to be formed to feed the web forward one such increment. As shown in Fig. 2, the driving means 23 comprises a continuously operating electric motor/-speed reducer unit 25 driving the input of an electric clutch/brake unit 27 via gearing indicated at 29, the output of the clutch/brake unit being connected to the lower roll 19 as indicated at 31. The rolls 19 and 21 are geared together as indicated at 33. The clutch of unit 27 is adapted intermittently to be engaged and the brake of unit 27 disengaged for driving the rolls 19 and 21 to feed forward the requisite package length increment of web W on each feed cycle by a suitable programmable control 35 which

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is under the control of an encoder 37 (see Fig. 7),
the clutch being disengaged and the brake engaged
to terminate the feed cycle and remaining so for the
5 dwell of the web W and tubing T, the clutch then being
engaged and the brake disengaged for the next feed
cycle.

The web W travels from the measuring and feeding
rolls 19 and 21 under a guide roll 38 and thence up
10 to and around forming shoulder 3. The increment of
the web W fed forward by the measuring and feeding
rolls 19 and 21 is taken up and pulled over the
forming shoulder 3 under tension by tubing feeding
means indicated generally at 39 in Figs. 1 and 2
15 below (downstream from) the forming shoulder. This
tubing feeding means 39 acts to apply a forward (down-
ward) force to the tubing T, separately from the appli-
cation of force to the web W by the rolls 19 and 21,
and externally of the tubing, at a rate such as to pull
20 the web over the forming shoulder 3 under tension to
maintain the web taut. In this regard, the tubing
feeding means tends to draw the tubing down (forward)
on the mandrel 13 a distance greater than the package
length increment in the stated interval of operation
25 of the rolls 19 and 21. The draw-down force on the
tubing is relatively low. While means 39 tends to draw
the tubing T down a greater distance than the package
length increment, the tubing is drawn down only a dis-
tance corresponding to the package length increment
30 (the tension is insufficient to stretch it to any sub-
stantial extent), and the package length increment of
the web W metered out and fed forward by the rolls 19
and 21 is thereby taken up and pulled over the forming
shoulder 3 under tension, with the tension substantial-
35 ly uniform for proper tracking of the material over
the forming shoulder.

The tubing feeding means 39, as illustrated,
comprises a pair of endless belts, and more particu-
larly a pair of vacuum belts each designated 41 at op-

posite sides of the mandrel 13 (for vacuum gripping the tubing to feed it downward). Each belt is a flat belt trained around an upper pulley 43 and a lower pulley 45 and so arranged as to have a downwardly movable inner reach 41a engageable with the tubing T at the respective side of the mandrel 13. The two pulleys for each belt are mounted on a block 47 having a vacuum passage 49 therein (see Figs. 5 and 6) in which a vacuum is drawn in suitable conventional manner via a vacuum hose 51. The belt has holes 53 spaced at suitable intervals throughout its length. The inner reach 41a of the belt travels in sealing engagement with the face 55 of the block 47 toward the mandrel 13, i.e., the inside of the block, in register with one end 57 constituting the inlet end of the vacuum passage 49 in the block. As the belt travels past inlet 57, vacuum is drawn through those holes 53 in the belt which are in communication with the inlet. The tubing on the mandrel 13 is thereby vacuum gripped to the inner reach 41a of the belt for being fed downward by the belt.

The vacuum belts 41 are operated intermittently for feeding the tubing T downward on the mandrel 13 concurrently with each operation of the web feeding rolls 19 and 21. The belts may be started in operation generally at the same time or somewhat before the rolls 19 and 21 start feeding the web W. They are operated at such a rate relative to the rolls 19 and 21 as to tend to feed the tubing downward at a rate faster than that at which rolls 19 and 21 feed the web forward, and may be stopped generally at the same time or shortly after the rolls 19 and 21 stop. Means for operating the belts in this manner is shown to comprise a gear drive 59 from the electric motor/ speed reducer unit 25 to the input of each of a pair of air-operated slip clutches each designated 61, with individual drive trains as indicated at 63 from the outputs of the slip clutches to the upper pulleys 43 for the two

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belts 41. The slip clutches 61 are under control of an air valve 65 (Fig. 7) which is in turn controlled by the programmable control 35. The latter functions to
5 actuate (engage) the slip clutches 61 to start driving the belts either at the same time or somewhat before the electric clutch/brake unit 27 is actuated, and to maintain the slip clutches engaged for driving the belts until the electric clutch/brake unit 27
10 is deactuated or somewhat thereafter, the slip clutches then being deactuated to stop the belts. While engaged, the slip clutches permit slip in the drives from the unit 25 to the belts.

In the operation of the apparatus of Figs. 1-7,
15 the motor /speed reducer unit 25 is operated continuously. The clutch/brake unit 27 is actuated (i.e., its clutch is engaged, its brake disengaged) in timed relation to a function of the apparatus such as a filling function, the encoder 37 being operable to
20 signal the programmable control 35 to actuate the unit 27 to start driving rolls 19 and 21 to unwind the web W from the supply roll R and feed it forward at the appropriate time (e.g., when a scale has weighed out the quantity of product to be delivered
25 for a package, and has dumped the product for delivery down through the mandrel 13 into the tubing T). The unit 27 remains actuated for an interval such as to cause rotation of the rolls 19 and 21 to feed forward a package length increment of the web, and is then
30 deactuated. The interval may be determined and controlled via the programmable controller 35 or by means of an optical scanning system operating in conjunction with registration marks at package length intervals on the web in the case of preprinted web, or
35 by means measuring the rotation of the rolls 19 and 21 in the case of unprinted web, or in other suitable manner well known in the art.

The programmable control 35 operates to actuate the valve 65 for engaging the slip clutches 61 to start

driving the belts 41 either at the same time or somewhat before the rolls 19 and 21 start feeding the web W forward toward the forming shoulder 3.

5 Thus, when the rolls 19 and 21 operate to feed the web forward, the belts are in operation and act to draw down the tubing T formed as the web passes over the forming shoulder 3. The drive for the belts is such that they tend to travel at a rate greater
10 than the rate at which rolls 19 and 21 feed the web forward. For example, they may tend to travel at a rate about 10% greater than the rate at which rolls 19 and 21 feed the web forward (that is, the belts if wholly free of any restraint would travel
15 a distance 10% greater than the amount of web released (i.e., fed forward) by rolls 19 and 21. However, the tubing T cannot advance any faster than the rate at which rolls 19 and 21 feed the web forward without stretching (the web being caught
20 in the nip of rolls 19 and 21) and the pull exerted by the belts on the tubing is relatively light and too low to cause any substantial stretching. Hence, the belts travel generally at a greater rate than the web and, in tending to travel faster than the
25 web, exert a downward pull on the tubing T to tension it and thereby pull the material over the forming shoulder 3 under tension to maintain the web taut. The operation of the belts at a greater rate than the speed of the web feed is governed and
30 controlled by slippage in the slip clutches 61, and by some slippage of the belts past the packaging material.

At the start of the downward feed of the tubing T, the seal bars 17 are open, and remain open
35 throughout the downward feed of the tubing off the lower end of the mandrel 13. The means for moving the seal bars toward and away from one another is operable as in the second type of prior vertical form-fill-seal

machines referred to above, well known in the art.

When the rolls 19 and 21 have measured out and fed forward one package length of web W, and the belts 41 have drawn the tubing T down one package length on the mandrel and fed one package length of the tubing T off the lower end of the mandrel, the clutch/brake unit 27 is deactuated to stop the rolls 19 and 21 and thereby stop the forward feed of the web, for the dwell of the web and the tubing for the sealing operation. The slip clutches 61 are deactuated either at the same time as the rolls 19 and 21 stop, or slightly thereafter. When deactuated, the slip clutches may be wholly disengaged so as to stop drives 63 to the belts 41, or they may remain lightly engaged to exert a light drive via 63 on the belts so that the belts exert a light draw-down force on the tubing to maintain tension in the tubing.

With the tubing T stopped, and with product in the tubing above the transverse seal at the lower end of the tubing (this seal being one package length below the seal bars at 5 and constituting the bottom seal for the package to be completed) the seal bars are closed on the tubing to form the top seal for the package P being completed and the bottom seal for the next package to be formed. The seal bars then open, and rolls 19 and 21 and belts 41 are operated through the next feed cycle.

The apparatus shown in Figs. 1-7 wherein the web W is intermittently metered forward in package length increments by the rolls 19 and 21 and the tubing T is advanced by the belts 41 has been demonstrated dramatically to reduce both the breakaway pull and the continuous pull on the tubing in comparison to prior vertical form-fill-seal machines of the first type mentioned above, and more particularly in comparison to the standard Hayssen Manufacturing Company vertical form-fill-seal machine. The following chart shows the results of comparative tests on

different packaging films of the breakaway and continuous pull for different packaging films on a standard Hayssen machine and a prototype of the apparatus shown in Figs. 1-7:

TEST RESULTS

	Standard Vertical			Apparatus of		
	Material Type	Trademark	Thickness mm	Form-Fill-Seal Machine		Figs. 1-7 Breakaway and Continuous Pull
				Breakaway	Continuous	
				Pull-grams	grams	
1	Low Density PE	None	0,0381	1814	1814	56
2	Low Density PE	None	0,0381	1530	1587	56
3	Low Density PE	CURLON	0,0508	907	907	56
4	Low Density PE	VISQUEEN	0,0635	907	1474	56
5	Low Density Cast PE	REYNOLON	0,1016	1587	2041	226
6	Oriented PP	BICOR	0,0254	963	1020	113
7	PP/PE/K-Cellophane	CURPOLENE	0,1092	2948	3175	56
8	K-Cellophane	None	0,0508	1587	1814	793
9	K-Cellophane	None	0,0508	1360	1587	737
10	HDPE/EVA	COEX	0,0635	1587	1700	283
11	Paper-PE	None	0,0952	6123	6350	1871

PP = Polypropylene

PE = Polyethylene

K = Saran Coated (Cellophane and Saran are Registered Trade Marks)

HDPE = High Density Polyethylene

EVA = Ethyl Vinyl Acetate

In the tests on the standard Hayssen machine and the prototype of this invention, the same forming shoulder was used on both machines, being moved from one machine to the other for carrying out the tests, this forming shoulder being a chrome plated cast bronze shoulder dimensioned to form tubing with an internal diameter of about 76 mm , and with a lap seam of normal overlap. In each instance, the width of the film was 26,67 cm (providing a lap seam about 2,54 cm wide). For each film tested, the film was drawn from a supply roll mounted in the machine and formed into tubing over the shoulder. A small clamp was attached to the lower end of the tubing, and weights were added to the clamp to determine the amount of weight (the pull) required (1) to start the film moving, which was the "breakaway" pull, and (2) to keep the film moving, which was the "continuous" pull. In the case of the standard machine, the carriage (carrying the seal bars) was maintained out of operation at the lower end of its stroke, the weight (force) applied to the lower end of the tubing taking the place of the carriage and seal bars for pulling the tubing down. In the case of the prototype of this invention, belts 41 were deactuated so that they did not exert any pull on the tubing, the breakaway and continuous pull being determined by means of the weights with the rolls 19 and 21 in operation to feed the film forward from the supply roll R to the forming shoulder.

As is apparent from the chart, the amount of pull required to form the flat web of film (for each film) into tubing, i.e. , the amount of pull required to pull the film over the forming shoulder 3, was much less in the new machine than in the old. For example, where a 2948g breakaway pull and a 3175g continuous pull was required in the old machine for item 7, only a 56 g breakaway pull and a 56 g continuous pull was required in the new machine.

The filling of the packages may be carried out in conventional manner, well-known in the art, either on an intermittent fill basis, or, in the case of a

liquid product through which the transverse seals may be made, by maintaining liquid product in the tubing above the level at which the transverse seals are made.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions and methods without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.



CLAIMS:-

1. The method of forming, filling and sealing packages comprising intermittently measuring successive packaging length increments of a flexible web and pulling them from a supply and feeding them forwardly
5 to means for forming them into tubing, the pulling being effected by applying a forwarding force to the web between the supply and the forming means, feeding the tubing downwardly on a downwardly extending tubular mandrel and off the lower end of the mandrel
10 as each length is measured and fed forward by applying a separate forwarding force to the tubing such as to pull the web over the forming means and maintain it taut, sealing the tubing below the lower end of the mandrel by sealing means adapted to
15 be opened for intervals for said pulling of the web from its supply and feeding each package length of the tubing downwardly off the lower end of the mandrel and closed on the tubing during each dwell of the tubing between successive feed cycles to form a
20 transverse seal across the tubing, and delivering the product to be packaged downwardly through the mandrel and out of its lower end into the lower end of the tubing.
2. A method as claimed in claim 1 comprising
25 intermittently pulling the web from the supply and feeding it forward to the forming means at a predetermined rate, and pulling the tubing down on the mandrel in such manner as to tend to pull it down at a higher rate, but with slippage, into
30 order to create the tension in the feeding step.
3. A method as claimed in claim 2 wherein the pulling of the tubing down on the mandrel is carried out intermittently and concurrently with the intermittent pulling and measuring of the web.

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4. A method as claimed in claim 3 wherein the pulling of the tubing starts before the pulling and measuring of the web and stops after the pulling and measuring of the web.

5 5. Apparatus for forming, filling and sealing packages comprising a downwardly extending tubular mandrel for delivery downwardly therethrough and out of its lower end product to be packaged, intermittently operable web feeding and measuring means
10 for pulling successive package length increments of a web of flexible packaging material from a supply, measuring said increments and feeding them forward, forming means for forming the fed web into tubing, said feeding and measuring means acting to apply a
15 forwarding force to the web between the supply and the forming means for feeding said increments forward to said forming means, means for applying a separate forwarding force to the tubing operable as the web material is measured and fed forward to the
20 forming means to pull the tubing down on the mandrel under tension to maintain it taut and thereby pull the web material over the forming means and to feed each package length increment of the tubing down off the lower end of the mandrel, and sealing means for
25 forming a transverse seal across the tubing below the lower end of the mandrel adapted to be opened for feeding each package length increment of the tubing downwardly off the lower end of the mandrel and closed on the tubing during each dwell between
30 successive feed cycles of the tubing to form a transverse seal across the tubing.

6. Apparatus as claimed in claim 5 wherein the web feeding and measuring means is operable to feed the web forward at a predetermined rate, and the
35 means for pulling the tubing down on the mandrel is operable to tend to draw the tubing down on the



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mandrel at a higher rate, but with slippage, in order to maintain said tension.

7. Apparatus as claimed in claim 6 wherein the means for pulling the tubing down on the mandrel is operable intermittently concurrently with each intermittent operation of the web feeding and measuring means.

8. Apparatus as claimed in claim 7 having means for starting the means for pulling the tubing down on the mandrel before the web feeding and measuring means starts and stopping it after the web feeding and measuring means stops.

9. Apparatus as claimed in any one of claims 5 to 8 wherein the means for pulling the tubing down on the mandrel comprises vacuum belt means.

10. A method of forming, filling and sealing packages substantially as hereinbefore described with reference to the accompanying drawings.

11. Apparatus for forming, filling and sealing packages substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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