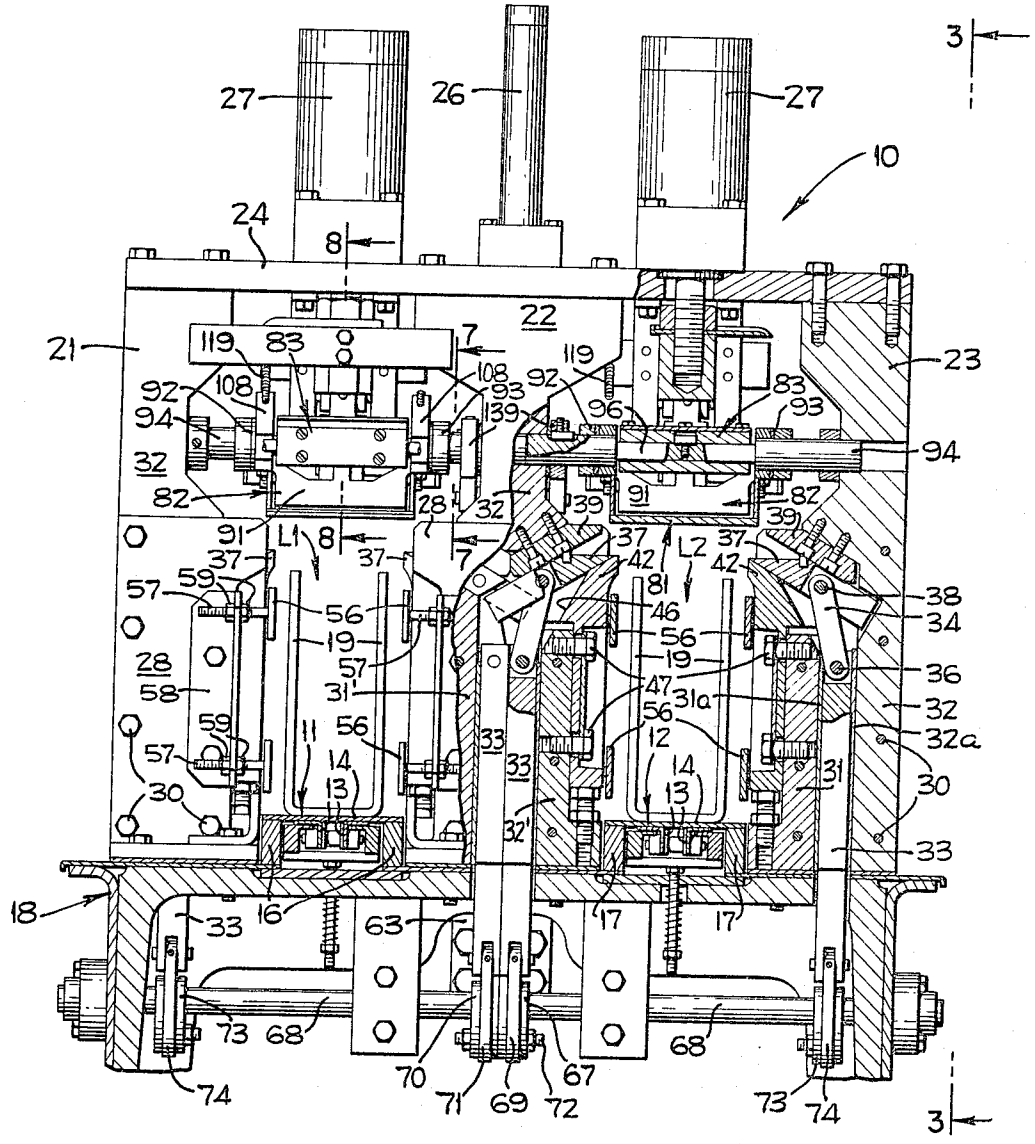
Oct. 25, 1966 J. L. REIMERS ET AL 3,280,535

APPARATUS FOR SEALING THE TOPS OF CARTONS

Filed July 8, 1963

6 Sheets-Sheet 1

FIG_1



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APPARATUS FOR SEALING THE TOPS OF CARTONS

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FIG_2

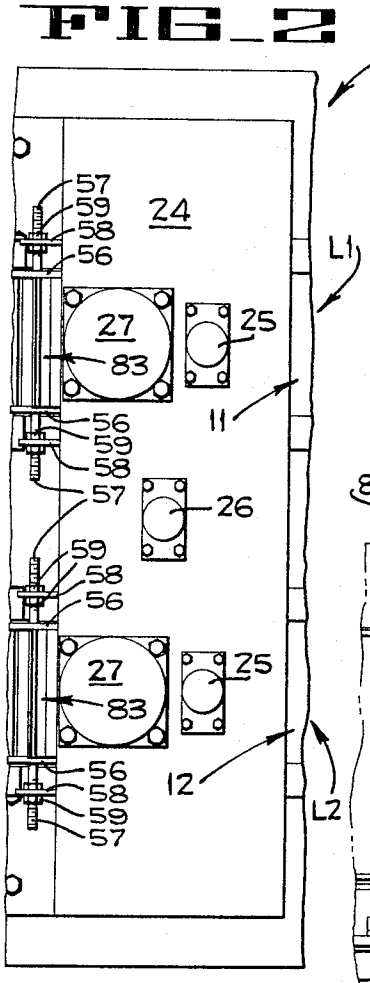


FIG_3

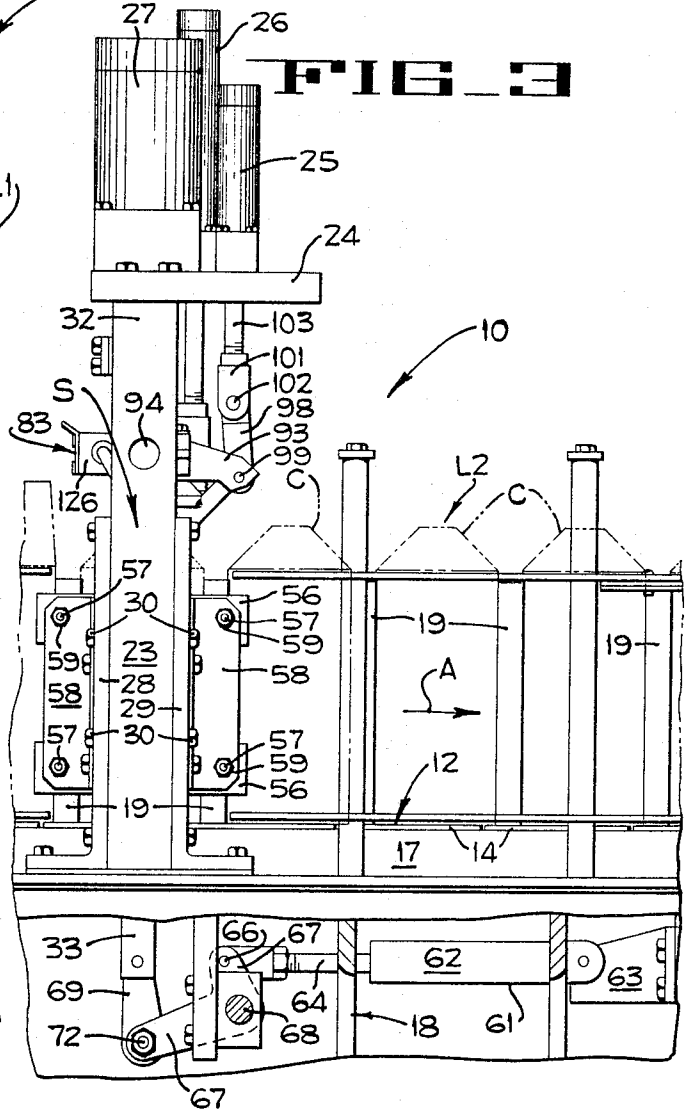
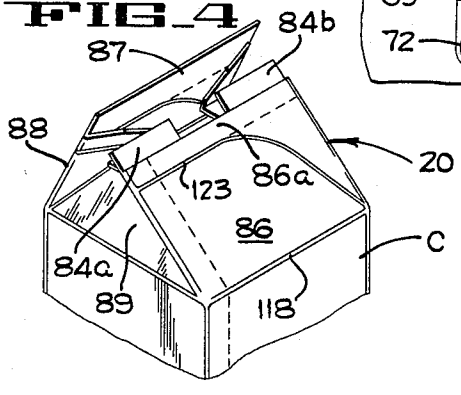


FIG_4



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APPARATUS FOR SEALING THE TOPS OF CARTONS

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FIG_5

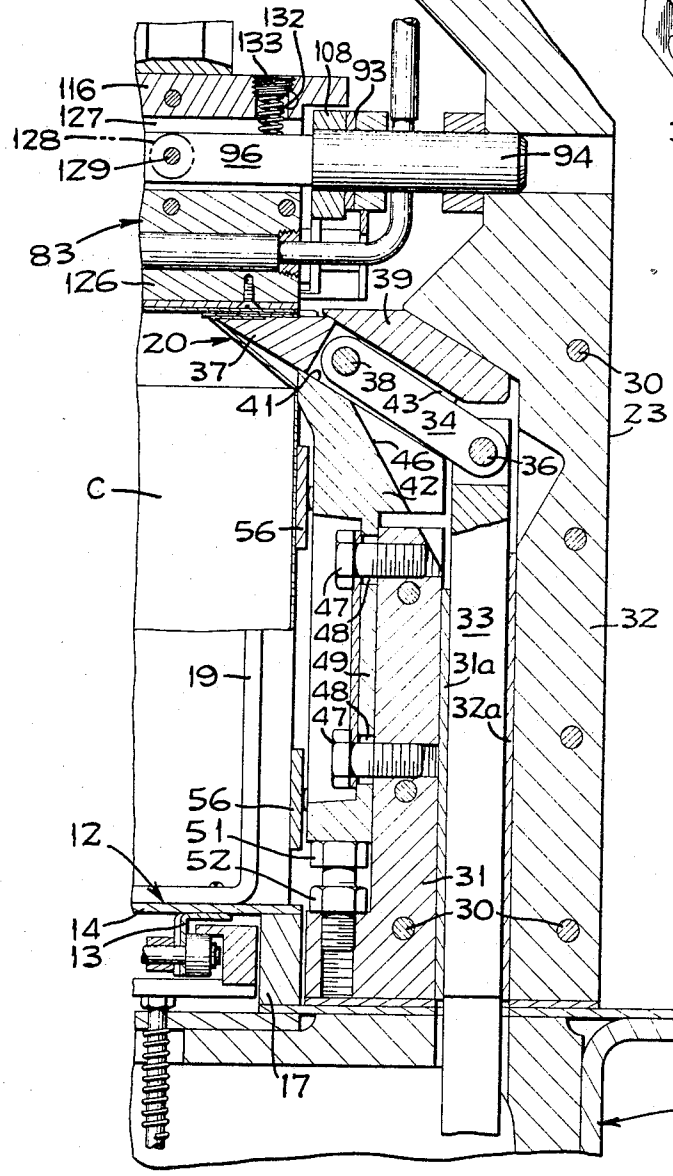
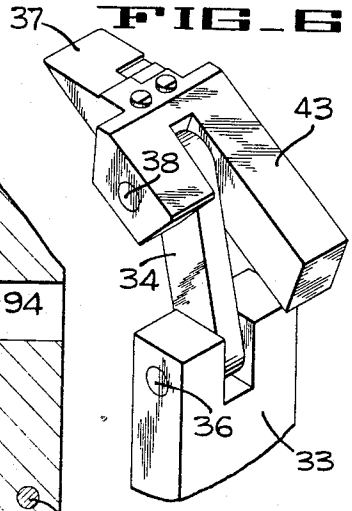


FIG_6



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APPARATUS FOR SEALING THE TOPS OF CARTONS

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FIG_8

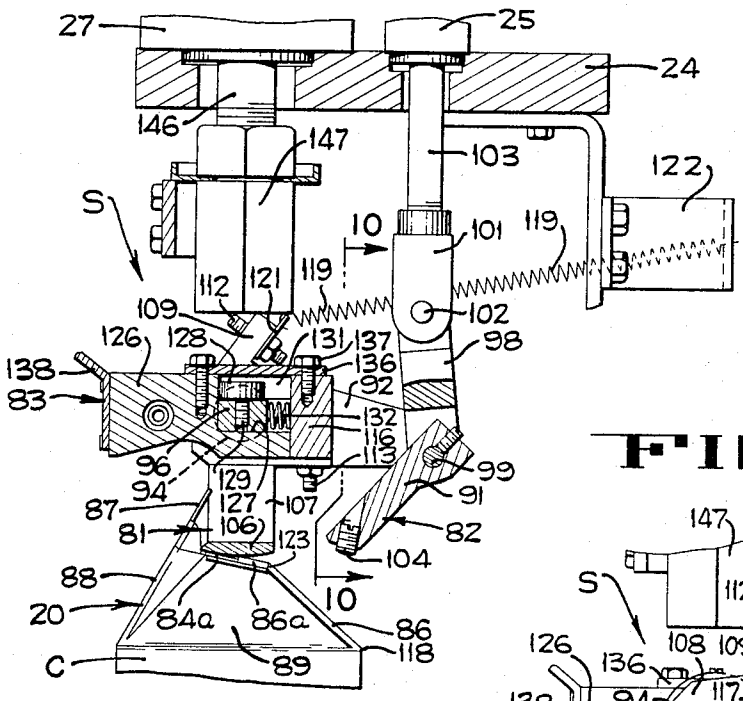


FIG_7

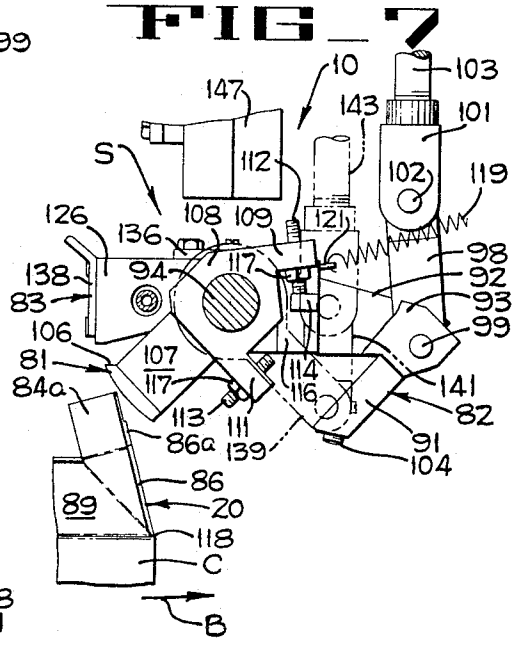
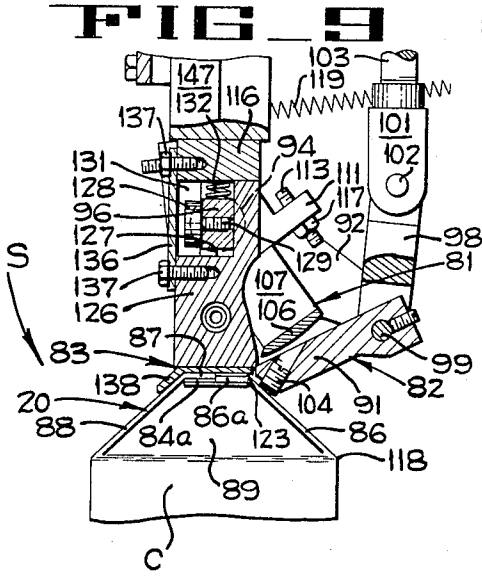


FIG_9



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APPARATUS FOR SEALING THE TOPS OF CARTONS

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FIG_10

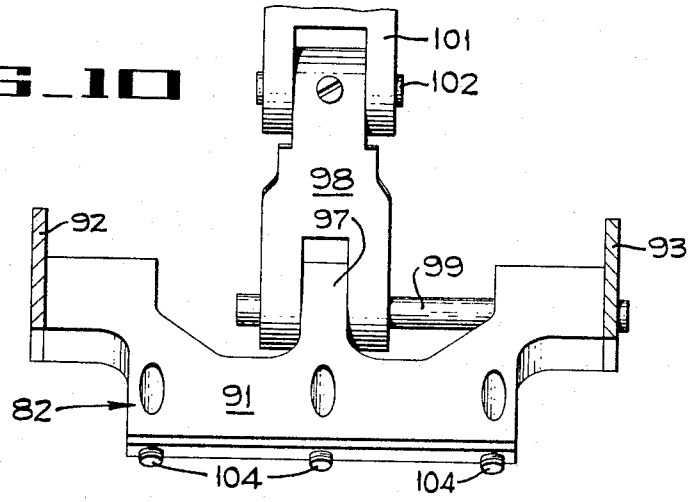


FIG_11

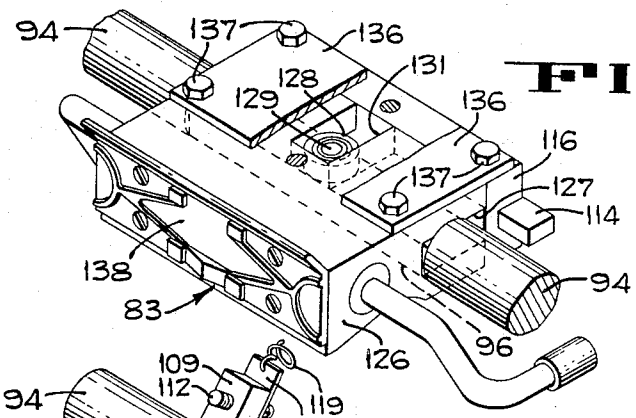
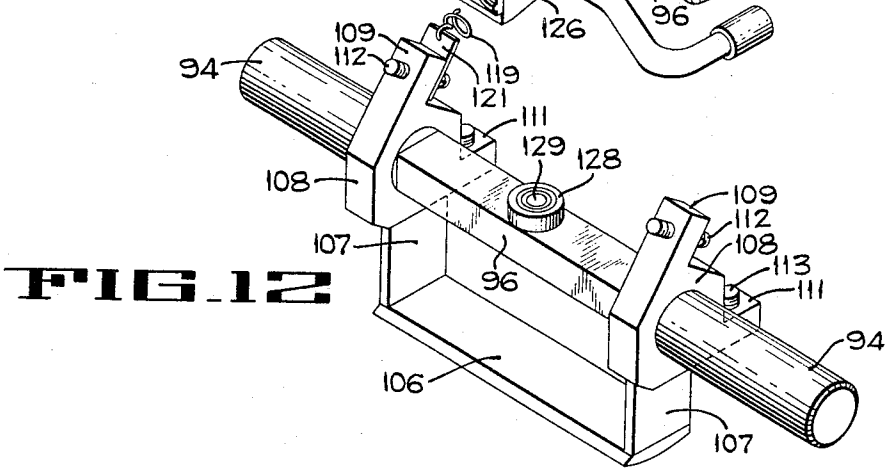


FIG_12



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APPARATUS FOR SEALING THE TOPS OF CARTONS

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FIG_13

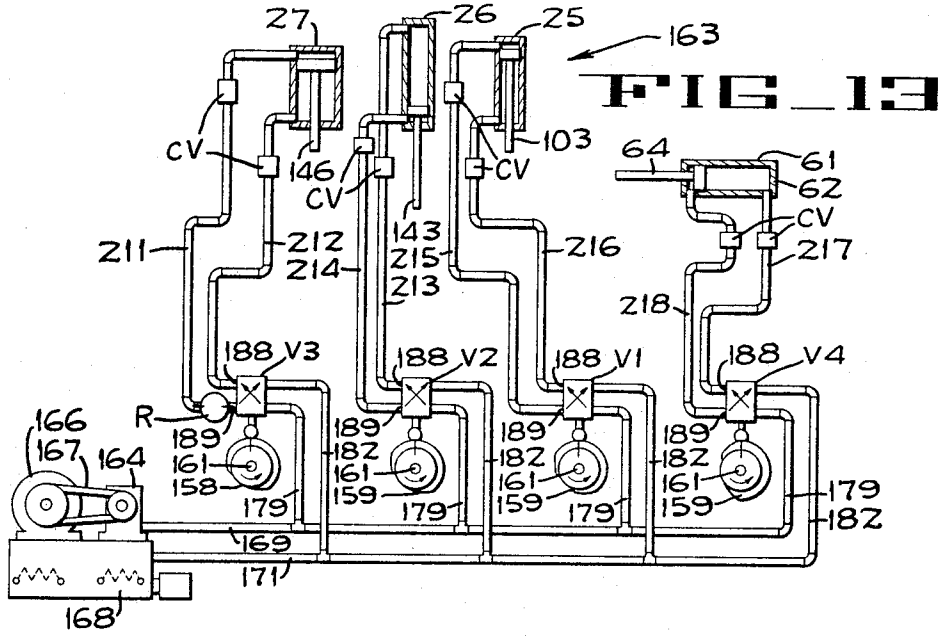


FIG_14

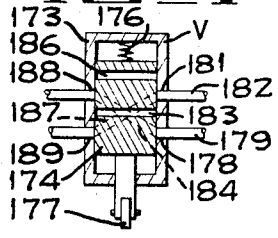


FIG_15

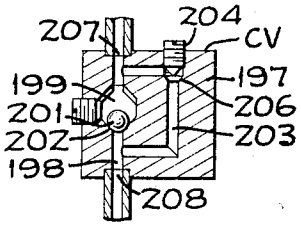
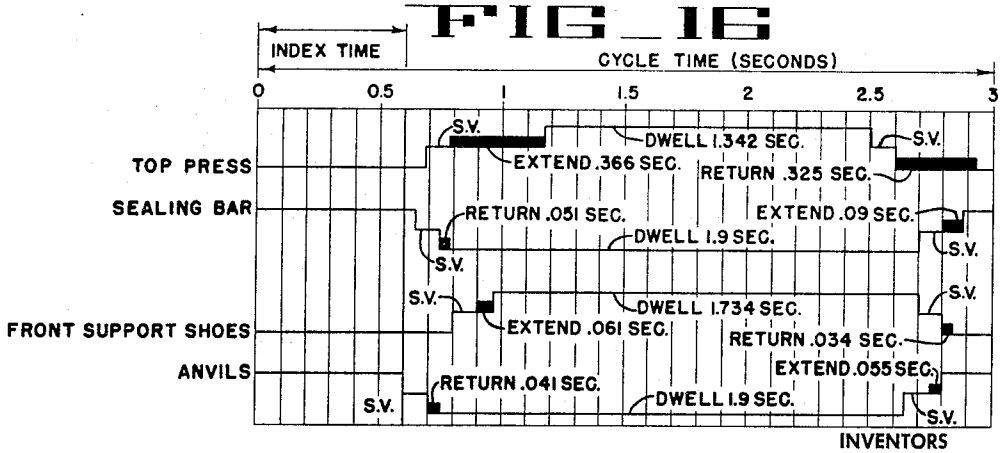


FIG_16



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United States Patent Office 3,280,535 Patented Oct. 25, 1966

3,280,535
APPARATUS FOR SEALING THE TOPS OF CARTONS

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Filed July 8, 1963, Ser. No. 293,350
7 Claims. (Cl. 53—379)

The present invention pertains to packaging equipment and more particularly relates to an apparatus for sealing the tops of cartons such as milk cartons.

In carton forming and filling machines of the type disclosed in the application for patent of Heffelfinger et al., Serial No. 216,248 filed August 10, 1962, now Patent No. 3,248,841, and assigned to the assignee of the present invention, cartons made of a thermoplastic laminate are used for packaging milk. Each carton includes a laminated carboard inner base layer with a polyethylene coating on both the outside and the inside of the base layer. During operation of the above-mentioned carton forming and filling machine, the cartons are erected and filled with milk, the surfaces of the top closure which forms the seal are then heated to a bonding temperature, and the several flaps, tabs and lips of the top closure are subsequently folded and held together under considerable pressure until the contacting layers of the heated polyethylene are bonded together to provide a fluid tight seal.

It has been discovered that if milk is spilled on the heated surface of the carton flaps which are subsequently sealed together, an ineffective seal may be obtained. It has also been determined that if relative movement occurs between the bonding surfaces while the sealing force is being applied, an imperfect seal may result.

It is therefore, one object of the present invention to provide an improved apparatus for sealing cartons.

Another object is to provide a top sealing apparatus having improved means for gently folding the several taps, lips and flaps of the top closure of the carton together to prevent spilling of the milk onto the surfaces to be sealed.

Another object is to provide an improved adjustable side shoe bearing support for preventing relative movement of the sealing surfaces during the sealing operation.

These and other objects and advantages of the present invention will become apparent from the following description and the accompanying drawings, in which

FIGURE 1 is a transverse section taken through a carton forming and filling apparatus showing the top sealing apparatus of the present invention, certain parts being cut away and other parts being shown in section.

FIGURE 2 is a fragmentary plan of the top sealing apparatus of FIGURE 1.

FIGURE 3 is a side elevation of the top sealing apparatus, the view being taken looking in the direction of arrows 3—3 of FIG. 1.

FIGURE 4 is a perspective of the top closure of a carton of the type to be sealed with the apparatus of the present invention, certain parts being shown in the positions they assume shortly after being contacted by the folding shoe of the top sealing apparatus.

FIGURE 5 is an enlarged vertical section similar to a portion of FIG. 1 and showing one of the side shoes or anvils of the sealing apparatus in its extended position and showing one of the adjustable side shoe supports.

FIGURE 6 is a perspective of one of the side shoes and a portion of its actuating structure.

FIGURE 7 is an enlarged vertical section taken along lines 7—7 of FIGURE 1 showing certain parts of the top sealing apparatus in positions they assume as the carton is approaching the sealing station, certain other parts being shown in phantom.

FIGURE 8 is an enlarged vertical section taken along lines 8—8 of FIGURE 1 showing the several parts of the top sealing apparatus in positions they assume immediately after the carton has been indexed into the sealing station.

FIGURE 9 is a section similar to FIGURE 8 but showing the parts in different operative positions.

FIGURE 10 is a vertical section taken on line 10—10 of FIG. 8 to particularly show the construction of a support shoe.

FIGURE 11 is a perspective showing the sealing bar of the present invention.

FIGURE 12 is a perspective of a folding shoe of the present invention.

FIGURE 13 is a diagram illustrating the hydraulic system for the top sealing apparatus of the present invention.

FIGURE 14 is an enlarged central section through one of several four-way hydraulic valves employed in the hydraulic system of FIG. 13.

FIGURE 15 is an enlarged central section through one of several speed control valves in the hydraulic system of FIG. 13.

FIGURE 16 is a chart illustrating the timing of the several hydraulic power units used in the top sealing apparatus.

The top sealing apparatus **10** (FIGS. 1, 2 and 3) of the present invention is intended for use in a carton forming and filling machine of the type disclosed in the previous referred to Heffelfinger et al. application in place of the sealing apparatus disclosed therein. In the Heffelfinger machine, two rows of cartons formed from a thermoplastic laminate are intermittently advanced past several stations where they are erected, filled with milk or similar products to be packaged, and heated so that the temperature of the thermoplastic material on the mating surfaces of the top closure are raised to a predetermined bonding temperature prior to their arrival at the closing station. When at the closing station, the different flaps and tabs of the top closure are deflected into a closed position and are held in this position under considerable force until the surfaces are bonded together thereby forming a fluid tight closure. Reference may be had to said Heffelfinger et al. application for a detailed description of any part of the carton forming and filling machine that is not described in detail herein.

As illustrated in FIGURES 1, 2 and 3, the top sealing apparatus **10** of the present invention is adapted to handle two lines **L1** and **L2** of containers C which are intermittently advanced into the carton closing station S by endless conveyors **11** and **12**, respectively. The conveyors **11** and **12** are intermittently driven in the direction of the arrow A in FIGURE 3 so as to index each carton, in turn, in lines **L1** and **L2** into the top sealing station.

Each conveyor includes a plurality of links **13** (FIG. 1) having flat horizontal carton supporting plates **14** thereon which are guided along rails **16** and **17**. The rails **16** and **17** are secured to the frame **18** of the machine at a predetermined elevation so as to determine the exact elevation of the bottom of the cartons. Spaced upstanding U-shaped pusher bars **19** are secured to the plates **14** and serve to accurately position the cartons in spaced relation longitudinally of the conveyors. The conveyors are intermittently indexed at 3.0 second intervals, by means fully disclosed in the aforementioned application, in such a way that the cartons require 0.6 seconds to move between adjacent stations and are held stationary at the top sealing station S for approximately 2.4 seconds.

Since the portion of the top sealing apparatus **10** associated with lines L1 and L2 are identical, the parts in each line will be assigned the same numbers, and the description of the parts operating on one carton in one of the lines will serve to disclose the construction and operation of the apparatus of the other line also. It will be understood, of course, that the top sealing apparatus **10** of the present invention operates on two cartons at the same time, one carton in each line, to first gently fold the several heated flaps, tabs and lips of each of the top closures **20** (FIG. 4) together, as shown in FIGURES 5 and 9, and thereafter applies pressure to these folded parts so as to seal them in liquid tight engagement.

The apparatus **10** (FIGS. 1, 2 and 3) comprises vertically extending pedestals **21**, **22** and **23** which are disposed in a common plane extending transversely of the conveyors **11** and **12** and are bolted to the frame **18**. The conveyor **11** moves cartons to be sealed between the pedestals **21** and **22**, and the conveyor **12** moves cartons to be sealed between pedestals **22** and **23**. A transversely extending bridge plate **24** is bolted to the upper ends of the pedestals and supports two flap-folding hydrauilc power units **25** (FIGS. 2 and 3), a centrally disposed lip-folding hydraulic power unit **26**, and two carton sealing hydraulic power units **27**.

Each pedestal is of composite construction comprising a forward angle support **28** (FIG. 3) and a rear angle support **29**. A pair of spaced vertically extending bearing members **31** and **32** (FIG. 5) are disposed between each pair of supports **28** and **29** and are secured thereto by bolts **30**. Bearing plates **31***a* and **32***a* are secured to the opposed faces of members **31** and **32** to slidably receive a vertically extending push rod **33**. It will be noted that the central pedesal **22** (FIG. 1) is extra wide and is arranged to receive two vertical push rods **33** and that this central pedestal includes a left and a right hand bearing member **31'** and **32'** respectively which correspond in function to the bearing members **31** and **32**.

The upper end of each push rod **33** (FIG. 6) is bifurcated and is pivotally connected to one end of a link **34** by a pin **36**. The other end of the link **34** is pivotally connected to a bifurcated portion of a side flap-supporting shoe or anvil **37** (FIGS. 5 and 6) by a pin **38**. Each anvil **37** is moved along an inclined path toward and away from the carton to be sealed due to vertical reciprocation of the associated push rod **33** said anvil being guided by an upper bearing block **39** (FIG. 5) which is bolted to the associated bearing member **32**, and by an inclined bearing surface **41** of a lower bearing block **42**.

As is shown in FIGURE 5, the upper portion of each anvil **37** is inserted below certain tabs and lips of the top closure **20** of the carton C prior to the sealing operation for the purpose of resisting the substantial sealing force applied downwardly to these lips and tabs by a structure soon to be described. Because of this substantial force, one leg **43** (FIG. 6) of the bifurcated end portion of the anvil **37** is elongated to provide relatively long upper and lower bearing surfaces, thereby extending the life and requisite accuracy of the anvil **37**. Each of the lower bearing blocks **42** has its bearing surface **41** centrally notched as indicated at **46** so as to receive the associated link **34** when the associated anvil **37** is in its retracted position as shown in FIGURE 1.

Also, the lower bearing block **42** (FIG. 5) is vertically adjustable to compensate for any wear occurring between the anvil **37** and the upper and lower bearing blocks during long usage of the machine. In order to compensate for this wear, the lower block **42** may be adjusted vertically by first loosening cap screws **47**, which are screwed into the bearing member **31** and extend through slots **48** in a vertical wall **49** of the lower bearing shoe. The lower block **42** is then raised or lowered by adjusting a cap screw **51** which is screwed into a lower flanged portion of the bearing member **31** and abuts the lower end of the lower bearing block **42**. After the adjustments are made, the cap screws **47** are tightened and the adjusting cap screw **51** is locked in adjusted position by a lock nut **52**.

It will be appreciated that the cartons must be accurately aligned transversely of the associated conveyors **11** and **12** in order to properly seal the top closures **20** of the cartons. Accordingly, guide rails **56** (FIG. 1) are provided which have studs **57** welded thereto that extend through holes in angle brackets **58** (FIGS. 1 and 3) that are bolted to the angle supports **28** or **29**. The guide rails **56** are locked in adjusted position by lock nuts **59** screwed on the studs **57**.

The push rods **33** are vertically reciprocated in timed relation with the movement of the conveyors **11** and **12** by a hydraulic power unit **61** (FIG. 3). The cylinder **62** of the power unit **61** is pivotally connected to a bracket **63** which is bolted to the frame **18**. The power unit **61** is disposed centrally of the sealing unit **10** (FIG. 1) and the free end of the piston rod **64** of the hydraulic power unit **61** is pivotally connected by a pin **66** (FIG. 3) to one end of a bifurcated bell crank **67** which is keyed to a transversely extending shaft **68** journalled in the frame **18** of the machine. A link **69** is pivotally connected by a pin **72** between the other end of the bifurcated bell crank **67** and one of the two center push rods **33** which are slidably received within the central pedestal **23**. The piston rod **64** is also pivotally connected to a bellcrank **70** (FIG. 1) that is keyed to shaft **68** and connected to the other center push rod **33** through a link **71**. Each of the push rods **33** at the left and right side of the unit are actuated, when the power unit is activated, through a lever **73** that is keyed to the shaft **68** and pivotally connected to a link **74** which is pivoted to the push rod.

The timing of the actuation of the power unit **61** relative to the movement of the conveyors **11** and **12** is such that the power unit moves the four anvils **37** from the retracted position shown in FIGURE 1 to the extended position shown in FIGURE 5 immediately after the conveyors **11** and **12** have moved a pair of cartons into the top sealing station S. The anvils **37** are returned to the retracted position imediately before the conveyors **11** and **12** begin their next intermittent motion.

A more detailed description of the timing and control of the hydraulic power unit **61** relative to the other parts of the top sealing apparatus **10** will subsequently be described.

Two of the above-described anvils **37** cooperate with a folding shoe **81** (FIGS. 7, 8, and 9), a front support shoe **82**, and a sealing bar **83** to first fold the several heated flaps and tabs of the top closure **20** of the carton into sealing position and thereafter to squeeze the flaps and tabs together to provide a fluid tight bond therebetween. When a carton approaches the top sealing apparatus **10** in the direction of arrow B (FIG. 7), its top closure is shaped substantially as shown in FIGURE 7, the carton has already been filled with milk, and the several flaps, lips and tabs to be sealed together have been heated to a bonding temperature. As the carton is being moved into the top sealing station S, the front support shoe **82** is elevated as shown in FIGURE 7, and the folding shoe **81** is elevated and resiliently held in a downwardly and rearwardly inclined position so as to initially engage the forward corners of the tabs **84***a* and **84***b* and the upper edge of a narrow lip **86***a* on the forward flap **86** of the carton C. Continued movement of the carton causes the folding shoe **81** to gently deflect this flap **86** of the carton downwardly and rearwardly until forward tabs **84***a* and **84***b* (FIG. 4) are contacting the inner surface of the flap **86** and the carton assumes the position shown in FIGURE 8 as the conveyor terminates its movement.

Shortly thereafter, the sealing bar **83** and the front support shoe **82** are moved downwardly to the position shown in FIGURE 9 to thereby fold a wide lip **87** (FIGS.

4 and 8) of the rear flap **88** into sealing position over the narrow lip **86***a* at the top of flap **86** and over tabs **84***a* and **84***b*, as shown in FIGURE 9. Pressure is subsequently applied to the sealing bars **83**, and this pressure is resisted by the associated anvils **37** so as to squeeze the wide lip **87** against the narrow lip **86***a* and against the tabs **84***a* and **84***b* and to hold this pressure until the bond is complete. When bonded together, the inside surfaces of the flaps **86** and **88** bear against opposite edges of side flaps **89** (one only being shown) which are shaped in the form of isosceles trapezoids and add rigidity to the top closure.

Each front support shoe **82** (FIGS. 1, 7, 8, 9 and 10) comprises a solid, transversely extending plate **91** that includes arms **92** and **93** (FIGS. 7 and 10) journalled on a shaft **94** which has a rectangular central portion **96** (FIG. 1). The front support shoes **82** associated with lines L1 and L2 are mounted on separate shafts **94**, which shafts are in axial alignment and are journalled in the pedestals **21**, **22** and **23**. A centrally disposed tongue **97** (FIG. 10) is pivotally connected to one end of a yoke **98** by a pin **99**. The other end of the yoke **98** is pivotally connected to a second yoke **101** by a pin **102**, and the second yoke **101** is screwed onto the piston rod **103** of the associated hydraulic power unit **25**. Major adjustments of the front supoprt shoes **82** are accomplished by screwing the second yoke **101** greater or less distances onto the piston rod **103**, and minor adjustments are made by screwing three carton engaging, self-locking setscrews **104** into or out of the plate **91**.

The main function of each front support shoe **82** is to firmly engage and maintain the forward flap **86** of the top closure of the carton in proper position against certain edges of the side flaps when the folding shoe is moved from the position shown in FIGURE 8 to the position shown in FIGURE 9, thereby allowing the sealing bar **83** to move into the FIGURE 9 sealing position and complete the folding operation.

As has already been mentioned, it is of considerable importance that the milk within the carton is not spilled onto any of the heated surfaces which are to be subsequently sealed together since such spillage results in poor seals. Accordingly, all flap folding operations must be performed as gently as possible.

In order to provide a more gentle folding operation, the folding shoe **81** is spring urged to a position wherein it will engage the upper edge of the narrow lip **86***a* as the carton is moved into the top sealing station. The spring tension is such that the folding shoe **81** will gently force the narrow lip **86***a* first to the position shown in FIGURE 4 and thereafter to the position shown in FIGURE 8 as the carton completes its movement into the top sealing station. It has been determined that this gentle folding action of the forward flap **86** caused by the movement of the carton itself, results in very little, if any spilling of the milk onto the heating surface, and accordingly results in much better seals than have heretofore been possible.

Each folding shoe **81** (FIGS. 7 and 12) is of generally U-shaped construction comprising a carton engaging blade **106** secured to two arms **107** having hubs **108** (FIG. 12) journalled on the associated shaft **94**. Each hub **108** (FIG. 12) includes a pair of outwardly projecting fingers **109** and **111** that receive abutment screws **112** and **113**, respectively. The free end of each screw **112** and **113** is positioned to engage a tab **114** projecting outwardly from a head **116** that is connected to the sealing bar **83** as clearly shown in FIGURE 12. The screws **112** and **113** on each hub **108** are locked in desired position by lock nuts **117** and cooperate with the tabs **114** to determine the limits of pivotal movement of the folding shoe **81** relative to the sealing bar **83**.

An important feature of the invention is that the folding shoe **81** is pivotally urged into a position wherein the abutment screw **112** engages the tab **114** when a carton is approaching the top sealing station. This will assure that the relatively fast moving carton will be engaged by the folding shoe **81** at the farthest possible point from a score line **118** which provides a horizontal pivot axis between the forward flap **86** and the body of the carton. Contact at this point, which is at the very upper edge of the narrow lip **86***a*, provides for a much more gentle flap-folding operation than has heretofore been possible. The folding shoe **81** is resiliently urged to the above described position by a relatively light spring **119** which is connected at one end to a tab **121** bolted to the finger **109** of the folding shoe **81**, and is connected at the other end to a bracket **122** which is bolted to the fixed bridge plate **24**.

After the folding shoe **81** makes initial contact with the upper edge of the narrow lip **86***a*, the continued forward movement of the carton will cause the folding shoe **81** to pivot about the axis of the shaft **94** thereby overcoming the resilience of the spring **119** and permitting the carton to move the folding shoe **81** to the position shown in FIGURE 8 thereby gently causing the narrow lip **86***a* to fold about a score line **123** in in the flap **86** and, at the same time, causing the front flap **86** to pivot about its axis **118**. It will be appreciated that the engagement of the abutment screw **113** with the tab **114** in response to the movement of the carton into the top sealing station, will limit the amount of movement of the folding shoe **81** so that it assumes a vertical position as shown in FIGURE 8 until such time as the sealing bar **83** is moved out of its retracted position shown in FIGURE 8. After the sealing bar **83** swings downwardly approximately 45° form the position shown in FIGURE 8 toward the position shown in FIGURE 9, the tab **114** engages the screw **112**. During continued counterclockwise movement of the sealing bar **83**, the folding shoe **81** is moved to the retracted position shown in FIGURE 9 thereby permitting the sealing bar **83** to move to the sealing position wherein it is in engagement with a portion of the rear flap **88** and with the wide lip **87**.

Each of the sealing bars **83** (FIGS. 1 and 11) associated with lines L1 and L2 includes a body **126** which is provided with a transversely extending slot **127** that slidably receives the previously mentioned rectangular central portion **96** of the shaft **94**. The slot **127** permits vertical movement of the sealing bar **83** relative to the shaft **94** when the sealing bar is in the position shown in FIGURE 9. A cam follower **128** is journalled on a cap screw **129** secured to the rectangular portion **96** of the shaft **94** and is received in a vertical slot **131** in the body **126**. As shown in FIGURE 5, the sealing bar **83** is resiliently urged toward its upper position relative to the shaft **94** by two springs **132** (only one being shown in FIGURE 5), each of which is disposed between the shaft and a plug **133** screwed into the head **116** that is bolted to the body **126**. A face plate **136** is rigidly connected to the body **126** and to the head **116** by capscrews **137**. An angle flap squaring and sealing shoe **138** is bolted to the lower end of the body **126** and cooperates with the associated front support shoe and with the associated anvils **37** to accurately fold the several flaps, lips and tabs of the top closure **20** into sealing position and to maintain these flaps and tabs in desired position during the squeezing, or bonding operation.

In order to rotate the shafts **94** and, accordingly, the sealing bars **83**, between the positions shown in FIGURES 8 and 9, two arms **139** (FIGS. 1 and 7), are keyed to the axially aligned shafts **94** and are pivotally connected by a link **141** (FIG. 7) to the lower end of the piston rod **143** of the hydraulic power unit **26**.

After the top closure has been folded and squared as indicated in FIGURES 5 and 9, the sealing bar **83** is forced downwardly with a force of approximately 200 p.s.i., thereby squeezing the heated tabs and lips of the top closure between the anvils **37** and the sealing bar

83 to seal the top closure. The sealing pressure is applied to the sealing bar 83 by the associated hydraulic power unit 27 which urges the piston rod 146 downwardly, causing an enlarged head 147 screwed thereon to engage and force the sealing bar 83 downwardly with sufficient force to provide the necessary fluid tight seal. The sealing force is applied to the head for approximately 1.8 seconds.

The actuation of each hydraulic power unit 25, 26, 27 and 61 (FIG. 13) is controlled in timed relation with the movement of the conveyors 11 and 12 by means of four-way timing control valves V1, V2, V3, and V4, respectively, which are operated by cams 156, 157, 158 and 159 keyed to a cam shaft 161 which is shown schematically in FIGURE 13 and is driven one revolution for each intermittent movement of the conveyors 11 and 12. The drive for the conveyors 11 and 12, and for the cam shaft 161 is fully disclosed in the aforementioned Heffelfinger et al. application, and refernce may be had to said application if a detailed description of these drive parts is desired.

The valves V1, V2, V3 and V4, and the hydraulic power units 25, 26, 27 and 61 are included in a hydrauic power system 163 (FIG. 13) which includes a hydraulic pump 164 driven by a motor 166 through a belt drive 167. The pump 164 draws hydraulic fluid from a sump 168 and delivers it at high pressure through a distribution manifold 169. After passing through the power units 25, 26, 27 and 61 the hydraulic fluid is returned to the sump 168 through a return manifold 171.

As has already been mentioned, the direction of flow of the hydraulic fluid into the power units 25, 26, 27 and 61 is controlled by the four-way hydraulic valves V1, V2, V3 and V4 respectively. The rate of movement of the piston rods of each power unit is controlled during both extensions and retraction by two speed control valves CV, one valve being placed in each conduit connecting the associated power unit to the manifolds 169 and 171 so as to permit free entry of hydraulic fluid into the associated power units and to restrict to a predetermined rate the discharge of fluid therefrom.

The four-way valves V1, V2, V3 and V4 are identical therefore the description of one will suffice for all. The valve V is shown diagrammatically in FIGURE 14 and includes a housing 173 having a shiftable core 174 therein. A spring 176 disposed between the core and the housing normally urges a cam follower 177, journalled on one end of the core, against one of the associated timing cams 156–159. A high pressure coduit 179 is connected between a port 178 and the high pressure distribution manifold 169, and a port 181 of each valve is connected by a low pressure conduit 182 to the return manifold 171. The port 178 communicates either with a straight line passage 183 extending centrally through the core 174, or with a slanted or cross passage 184 which extends along the periphery of the cylindrical core Similarly, the port 181 communicates either with the straight passage 186 or with a slanted passage 187 that is formed in the periphery of the core 174 on the opposite side of the core from the peripheral passage 184. With this arrangement, hydraulic fluid can be selectively directed through the discharge ports 188 and 189 in the housing 173. It will be understood that each of the passages 183, 184, 186 and 187 are independent passages and do not communicate with each other.

The several speed control valves CV (FIGS. 13 and 15) are identical in construction and accordingly the description of one will suffice for all. Each speed control valve CV (FIG. 15) comprises a housing 197 having a straight line passage 198 therethrough. An enlarged portion 199 of the passage 198 has a ball check valve 201 therein which rests against a seat 202 to prevent flow of fluid downwardly (FIG. 15) through the passage 198, but permits unrestricted flow upwardly (FIG. 15) through the passage 198. A U-shaped control passage 203 in the housing 197 by-passes the ball valve 201 and communicates with opposite ends of the straight line passage 198. An adjustable needle 204 cooperates with a frusto-conical seat 206 in the control passage to resist the downward (FIG. 15) flow of fluid therethrough, to thereby control the rate of travel of the piston of the associated hydraulic power unit. It will be understood that the needle valve 204 of each speed control valve CV will be adjusted so as to achieve the desired rate of travel of the piston of the associated hydraulic power unit. It will also be understood that the speed control valves CV are all positioned so that upper ports 207, rather than lower ports 208, are connected to the associated hydraulic power unit.

As shown in FIGURE 13, a conduit 211 having a speed control valve CV and a relief valve R therein is connected between the upper end of the power unit 27 and the port 189 in the valve V3, and a conduit 212 having a speed control valve CV therein is connected between the lower end of the power unit 27 and the port 188 in the valve V3. A conduit 213 having a speed control valve CV therein is connected between the upper end of the power unit 26 and the port 188 in the valve V2, while a conduit 214 having a speed control valve CV therein is connected between the bottom of the power unit 26 and the port 189 of the valve V2. Conduits 215 and 216 having speed control valves CV therein are connected between the upper end of the hydraulic unit 25 and the port 189 of valve V1, and the lower end of the hydraulic power unit 25 and the port 188 of the valve V1, respectively. Similarly, conduits 217 and 218, having speed control valves CV therein, are connected between the closed end of the power unit 61 and the port 188 of the valve V4, and between the other end of the power unit 61 and the port 189 of the valve V4, respectively.

In regard to the chart shown in FIGURE 16, it will be understood that the darkened areas indicate the time required for the piston rods of the associated power unit to move from the extended to the retracted positions or from the retracted to the extended positions, and that pressure will be applied to the same side of the piston in a dwell period after movement is completed and until the associated cam adjusts the associated valve to its other position. The lines marked S.V. correspond to the sloping portions of the associated cams which shift the valves V1 to V4 between the cross-passage position and the straight-passage position. The time required for the valves to shift from one position to the other will not be included in the description to follow, but as shown in FIGURE 16, each shifting of the valve requires approximately 0.1 second. In the description to follow, it will be understood that the term "cross-passage position" indicates the position at which the passages 184 and 187 register with the conduits 179 and 182, and the term "straight-passage position" indicates the position at which the passages 183 and 186 register with the conduits 179 and 182.

As indicated at the top of FIGURE 16, the conveyor indexing operation takes place during the first 0.6 second of a three second operating cycle, and the remaining portion of the cycle is utilized for performing the different operations on the carton.

Since the several operations performed by the top sealing apparatus 10 on each top closure 20 are identical for each carton, the description of the top sealing operation performed on one carton will suffice for all. The operation will be described with particular reference to FIGURES 13 and 16, and it will be understood that, although only one power unit 25 and one power unit 27 are shown in FIGURE 13, separate units are provided for lines L1 and L2 and these units are connected in parallel.

At the start of the cycle, indicated by a zero on the diagram shown in FIGURE 16, the piston rod 146 of the top press power unit 27 is in the retracted position there-

by holding the head 147 (FIG. 8) in the elevated position; the piston rod 143 of the hydraulic power unit 26, which controls the actuation of the sealing bar 83, is in the extended position holding the sealing bar out of the path of movement of the approaching carton; the piston rod 103 of the hydraulic power unit 25 holds the front support shoe 82 in its uppermost position; and the piston rod 64 of the hydraulic power unit 61 holds the anvils 37 in their retracted positions. Thus, as the carton to be sealed approaches the sealing station, the folding shoe 81, front support shoe 82 and sealing bar 83 are in the positions shown in FIGURE 7, and the anvils 37 are in the retracted position shown in FIGURE 1.

The upper edge of the narrow lip 86*a* (FIG. 7) of the top closure of the carton then engages the spring-loaded folding shoe 81 which folds the lip 86*a* downwardly as indicated in FIGURE 8 upon being indexed into the top closing station. After the conveyor 11 or 12 has indexed the carton into the top sealing station, the cam 159 (FIG. 13) shifts the valve V4 to the straight-passage position thereby directing hydraulic fluid at high pressure from the conduit 179, through the valve V4, through the conduit 218, and into the power unit 61 to thereby retract the piston rod 64. The hydraulic fluid in the power unit 61 is discharged therefrom through the conduit 217, the speed control valve CV, the valve V4, the conduit 182, and returns to the sump 168 through the conduit 171. The speed control valve CV in line 217 controls the rate of flow out of the power unit 161 so that the piston rod 64 is moved to the retracted position and the anvils 37 are moved to the extended position in approximately 0.041 second. As indicated in FIGURE 13, the piston rod 64 remains in this position for an additional 1.9 seconds.

As each of the anvils 37 completes its movement into the flap supporting position shown in FIGURE 5, the piston rod 143 of the power unit 26 is retracted to rotate shaft 94 and move the sealing bar 83 and folding shoe 81 to the position shown in FIGURE 9. In order to retract the piston 143, the cam 157 shifts the valve V2 from hte cross-passage position to the straight-passage position thereby causing high-pressure hydraulic fluid to flow from the conduit 179, through the valve V2, through the conduit 214, and into the lower end of the hydraulic unit 26. The fluid in the upper end of the hydraulic unit 26 flows through the conduit 213, the flow control valve CV, the valve V2, the conduit 182, and is returned to the sump 168 through the conduit 171. The flow control valve CV in the conduit 213 controls the rate of movement of the piston rod 143 so that it is retracted in approximately 0.051 second and is held in the retracted position for 1.9 seconds.

After the sealing bar 83 and folding shoe 81 have moved to the position shown in FIGURE 9, the cam 156 shifts the valve V1 to the straight-passage position causing the piston rod 103 to move down to the extended position thereby moving the front support shoe 82 from the FIGURE 8 position to the FIGURE 9 position. Upon shifting the valve V1 to the straight-passage position, high pressure fluid flows from the conduit 179, through the valve V1, through the conduit 215, through the speed control valve CV and into the upper end of the hydraulic power unit 25. Fluid is discharged from the power unit 25 through the speed control valve CV, through the conduit 216, through the valve V1, through the conduit 182, and through the return manifold 171 into the sump 168. The speed control valve CV in the conduit 216 permits the piston 103 to move to the extended position in approximately 0.061 second and to dwell in this position for an additional 1.734 seconds.

With the sealing bar 83 and the front support shoe 82 in the FIGURE 9 position and in cooperative relationship with the anvils 37 which are in the FIGURE 5 position, it will be appreciated that the several heated flaps, tabs, and lips of the top closure will be disposed in the sealing position between the sealing bar 83 and the anvils 37. Sealing pressure is then applied to the heated flaps, tabs, and lips to cause them to bond together.

In order to provide this pressure, shortly after sealing bar 83 has been moved to the position shown in FIGURE 9, the cam 158 shifts the valve V3 from the cross-passage position to the parallel-passage position causing high-pressure fluid to flow from the conduit 179, through the valve V3, through the relief valve R, through the conduit 211, through the speed control valve CV and into the upper end of the hydraulic power unit 27. Fluid in the lower end of the power unit 27 is discharged through the speed control valve CV, through the conduit 212, through the valve V3, through the conduit 182, and through the return manifold 171 to the sump 168. The speed control valve CV in the condiit 212 controls the rate of movement of the piston rod 146 so that it requires approximately 0.366 seconds to move from the retracted to the extended position. The piston rod 146 remains in the extended position for an additional 1.342 seconds, which is sufficient to cause the heated surfaces of the top closure to seal together.

An important feature of the present invention is use of the relief valve R in the conduit 211 (FIG. 13). The relief valve R is set at approximately 200 p.s.i. so as to reduce the pressure entering the hydraulic power unit 27 to a pressure below that which will overpower the hydraulic power unit 61 which operates the anvils 37. Since the anvils 37 must resist the pressure applied to the closure by the sealing bar 83, it will be appreciated that, if the pressure of the power unit 27 is great enough to overpower the unit 61 and move each anvil 37 (FIG. 5) down its inclined path of movement, relative movement will exist between the flaps, tabs, and lips of the top closure causing a defective seal. Accordingly, the relief valve provides means for accurately controlling the pressure of the hydraulic fluid entering the upper end of the power unit 27 to a predetermined value which, in turn, accurately controls the amount of pressure acting on the top closure to provide consistenly good seals on the top closure of all cartons passing through the sealing apparatus 10, without danger of overpowering the hydraulic power unit 61.

After approximately 2.5 seconds of the cycle time has elapsed, the cam 158 shifts the valve V3 to its original cross-passage position causing the high-pressure fluid to enter the power unit 27. The fluid in the power unit 27 is forced out of the upper end of the unit and passes through the speed control valve CV in conduit 211 as it returns to the sump 168. This speed control valve CV restricts the movement of the piston rod 146 so that it requires approximately 0.325 second to return to the retracted position. The piston rod 146 remains in the retracted position until the three second cycle is completed.

After the piston rod 146 has retracted sufficiently to release the sealing pressure on the sealing bar 83, the cam 159 shifts the valve V4 into the cross-passage position thereby directing high-pressure fluid into the power unit 61 causing the piston rod 64 to move toward its extended position, and causing the anvils 37 to move toward their retracted positions. As the piston rod 64 moves toward its extended position, the fluid discharged therefrom passes through the speed control valve CV in conduit 218, which valve is set so as to permit the extension to occur in 0.055 second. The piston rod 64 remains in its extended position until completion of the cycle of operation.

With the sealing pressure released and the anvils 37 retracted, the front support shoe 82, the folding shoe 81, and the sealing bar 83 are returned to the starting position shown in FIGURE 7 upon simultaneous shifting of the valves V1 and V2 to the cross-passage position by the cams 156 and 157, respectively.

Shifting of the valve V1 to the cross-passage position causes high-pressure fluid to enter the lower end of the power unit **25**, and causes the fluid to be discharged from the upper end of the power unit **25**. The discharged fluid flows through the speed control valve CV in conduit **215** which valve is set to cause the piston rod to return to its retracted position in 0.034 second. The piston rod **103** remains in the retracted position until the end of the cycle.

Shifting of the valve V2 to the cross-passage position causes high-pressure fluid to enter the upper end of the power unit **26** forcing the piston rod downwardly and forcing fluid out of the lower end of the power unit **26** through the speed control valve CV in conduit **214**. The speed control valve in conduit **214** is set so as to cause the piston rod **143** to return to its extended position in 0.09 second. The piston rod remains in its extended position until the end of the cycle of operation. It will be appreciated that extension of the piston rod **143** will move the sealing bar **83** to the position shown in FIGURE 7 and that the spring **119** will return the folding shoe **81** to the position shown in FIGURE 7.

It will be apparent from the foregoing description that the top-sealing apparatus **10** of the present invention includes a spring-loaded folding shoe which is arranged to engage the uppermost end of the top closure to gently fold the forward flap **86** of the carton downwardly and to minimize the possibility of the splashing of milk onto the surfaces of the carton which are subsequently sealed together. Better seals are also provided since the apparatus includes means for accurately controlling the pressure of fluid entering the power unit that applies the sealing pressure to the flaps, tabs, and lips of the top closure. The effective life of the top sealing apparatus is also greatly increased by providing an adjustable bearing block for each anvil which bearing block resists the sealing force.

While one embodiment of the present invention has been shown and described, it will be understood that various changes and modifications may be made without departing from the spirit of the invention or the scope of the appended claims.

The invention having thus been described, what is believed to be new and desired to be protected by Letters Patent is:

1. Apparatus for sealing the top closure of a thermoplastic carton having flaps, tabs and lips separated by score lines comprising a support structure, means on said structure for folding the flaps of the top closure together with the tabs projecting outwardly from the upper edges of certain of said flaps, means inserted below said tabs for supporting the tabs, first pressure means for holding said support means in supporting position, a means for adjusting the position of said support means relative to said support structure to assure accurate positioning of said support means, means for applying a sealing force to a portion of said top closure against the resistance of said support means, and means for controlling the pressure of said sealing force to a predetermined pressure that is less than that of said first pressure means.

2. The apparatus for sealing the top closure of a thermoplastic carton having flaps, tabs and lips separated by score lines comprising a support structure, means on said structure for folding the flaps of the top closure together with the tabs projecting outwardly from the upper edges of certain of said flaps, means inserted below said tabs for supporting the tabs, first pressure means for holding said support means in supporting position, means for adjusting the position of said support means relative to said support structure to assure accurate positioning of said support means relative to the tabs, means for applying a sealing force to a portion of said top closure against the resistance of said support means, means for localizing the sealing force at areas of the top closure where leakage is apt to occur to disrupt natural flow lines in the top closure, and means for restricting the pressure of said sealing force to a predetermined pressure less than that of said first pressure means to prevent the overpowering of said support means and to prevent squeezing of the top closure to such an extent that the top closure surfaces are injured.

3. Apparatus for sealing the heated top closure of a thermoplastic carton having a front and a rear flap with a narrow lip extending from said front flap and a wide lip extending from said rear flap, said top closure also including inwardly bent side flaps with tabs projecting outwardly therefrom, comprising a conveyor for intermittently advancing the carton along a predetermined path into a top sealing station, a pivotally mounted folding shoe at said top sealing station, resilient means connected to said shoe for holding said shoe in a position inclined downwardly and toward the forwardly-advancing carton is it approaches the sealing station for engaging the uppermost edge of said narrow lip and gently folding said lip downwardly and rearwardly as the carton is moved into the top sealing station, said folding shoe being pivoted into a vertical position against the urging of said resilient means as the carton moves into the sealing station, support means movable under said tabs and lips immediately after the carton has been moved into the top sealing station for supporting said tabs, a sealing bar for folding the rear flap toward said front flap and for folding said wide lip over said narrow lip and said tabs, and for moving said folding shoe out of contact with said top closure, and means for moving said sealing bar downwardly upon said lip against the resistance of said supporting means to seal said top closure.

4. Apparatus for sealing the heated top closure of a thermoplastic carton having a front and a rear flap with a narrow lip extending from said front flap and a wide lip extending from said rear flap, said top closure also including inwardly bent trapezoidal side flaps with tabs projecting outwardly therefrom, comprising a conveyor for intermittently advancing the carton along a predetermined path into a top sealing station, a pivotally mounted folding shoe at said top sealing station, resilient means conected to said shoe for holding said shoe in a position inclined downwardly and toward the carton approaching the sealing station for engaging the uppermost edge of said narrow lip and gently folding said lip downwardly and rearwardly as the carton is moved forwardly into the top sealing station, said folding shoe being pivoted into a vertical position against the urging of said resilient means as the carton moves into the sealing station, support means movable under said tabs and lips immediately after the carton has been moved into the top sealing station for supporting said tabs, a sealing bar for folding the rear flap against edges of said trapezoidal side flaps which lie in a common plane and for folding said wide lip over said narrow lip and tabs and for moving said folding shoe out of contact with said top closure, means for moving said front flap into firm engagement with other edges of said trapezoidal side flaps which lie in another common plane, and means for moving said sealing bar downwardly upon said lip against the resistance of said supporting means to seal said top closure.

5. In an apparatus for sealing the heated top closure of a thermoplastic carton having flaps, tabs and lips separated by score lines, the combination of means for folding the flaps of the top closure together with the tabs projecting outwardly from the upper edges of certain of said flaps, an anvil movable into position below one of said tabs to support said one tab, an upper bearing block mounted in fixed position, a lower bearing block cooperating with said upper bearing block to guide said anvil along an inclined path toward and away from said one tab, means mounting said lower bearing block for adjustment relative to said upper bearing block to compensate for wear between said bearing blocks and said

anvil, actuating means conected to said anvil for moving said anvil between a retracted position away from said one tab to an extended position in supporting engagement with said one tab, and means for applying sealing force to a portion of said top closure against the resistance of of said anvil to seal said one tab to said portion of said top closure.

6. In an apparatus for sealing the heated top closure of a thermoplastic carton having flaps, tabs an dlips separated by score lines, the combination of means for folding the flaps of the top closure together with the tabs projecting outwardly from the upper edges of certain of said flaps, an anvil for insertion below one of said tabs to support said tab, an inclined upper bearing block mounted in fixed position, an inclined lower bearing block cooperating with said upper bearing block to guide said anvil along an inclined path toward and away from said tab, means mounting said lower bearing block for vertical adjustment relative to said upper bearing block to compensate for wear between said bearing block and said anvil, actuating means connected to said anvil for moving said anvil between a retracted position away from said tab to an extended position in supporting enaggement with said tab, first pressure means connected to said anvil for holding said anvil in said supporting position under a first pressure, means for applying a sealing force to a portion of said top closure against the resistance of said anvil, and means for controlling the pressure of said sealing force to a predetermined pressure which is lower than that of said first pressure to prevent movement of said anvil when sealing pressure is being applied.

7. In an apparatus for sealing the heated top closure of a liquid filled thermoplastic carton having a front and a rear flap with a narrow lip extending from said front flap and a wide lip extending from said rear flap, said top closure also including inwardly bent side flaps with tabs projecting outwardly therefrom, the combination of a conveyor for intermittently advancing the carton along a predetermined path into a top sealing station, a rotatable shaft extending transversely of said conveyor above the path of movement of the carton, a folding shoe pivotally mounted on said shaft and having a transversely extending lip contacting member, a sealing bar mounted on said shaft for rotation therewith, power means connected to said sealing bar for moving said sealing bar from a substantially horizontal position above the predetermined path to a vertical position, means rigidly secured to said sealing bar and operatively connected to said folding shoe for permitting a predetermined amount of rotation of said sealing bar relative to said folding shoe, and resilient means connected to said folding shoe for holding said shoe at one end of its predetermined range and for holding said lip contacting member in position to engage the upper edge of said narrow lip when said sealing bar is in its horizontal position and when said carton is being moved into said top sealing station, continued movement of the carton into the top sealing station causing movement of said folding shoe through said predetermined amount into a vertical position and causing said lip contacting member to fold said front flap into sealing position with said narrow lip being held in a substantially horizontal plane by said lip contacting member, said power means then being arranged to swing said sealing bar from its horizontal position to its vertical position thereby pivoting said folding shoe out of said predetermined path and folding said rear flap into sealing position with the wide lip being held in a horizontal plane contacting the upper surface of the narrow lip.

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