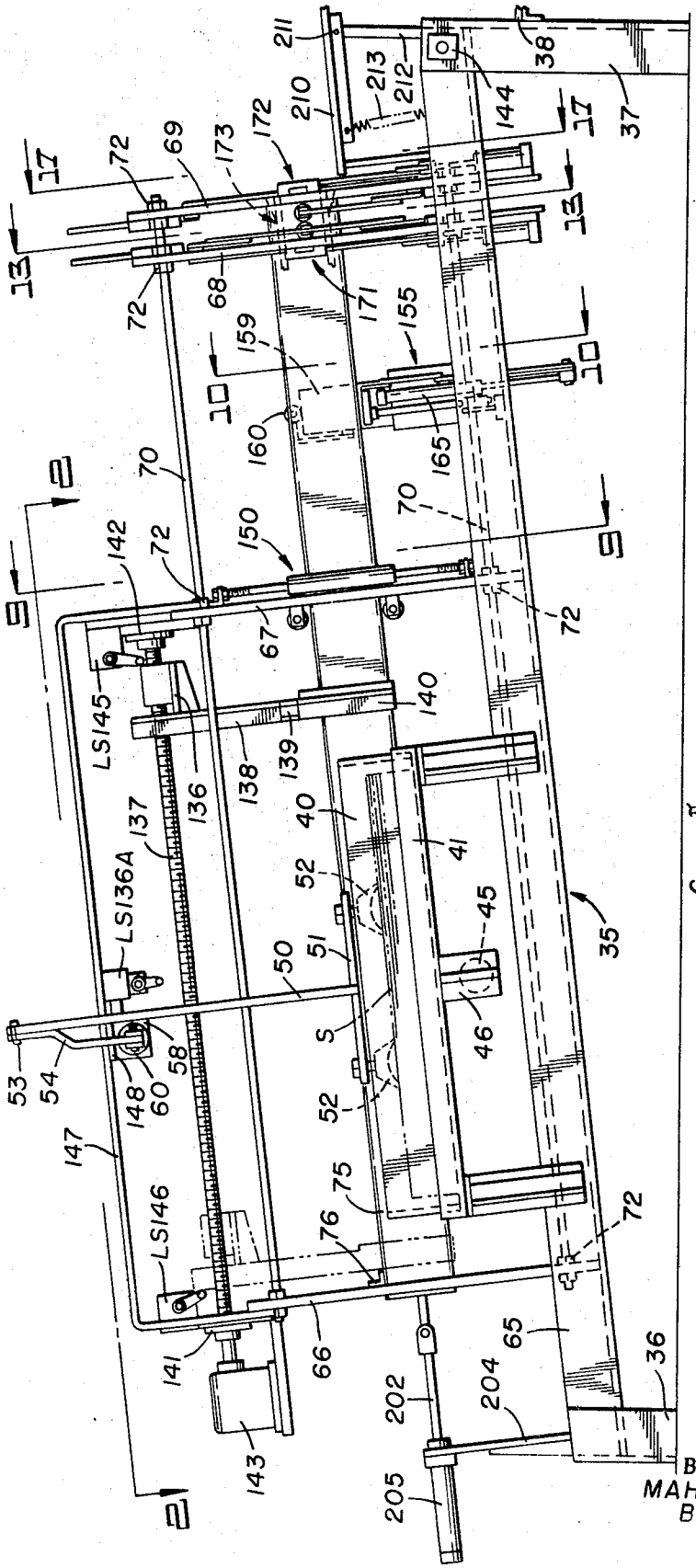
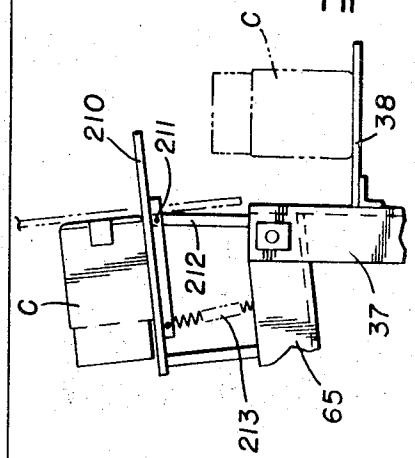
Dec. 8, 1970 F. J. LAWLER 3,545,167

PACKAGING SYSTEM FOR MERCHANDISE RECEIVING CONTAINERS OF VARIOUS VOLUMES

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PACKAGING SYSTEM FOR MERCHANDISE RECEIVING CONTAINERS OF VARIOUS VOLUMES

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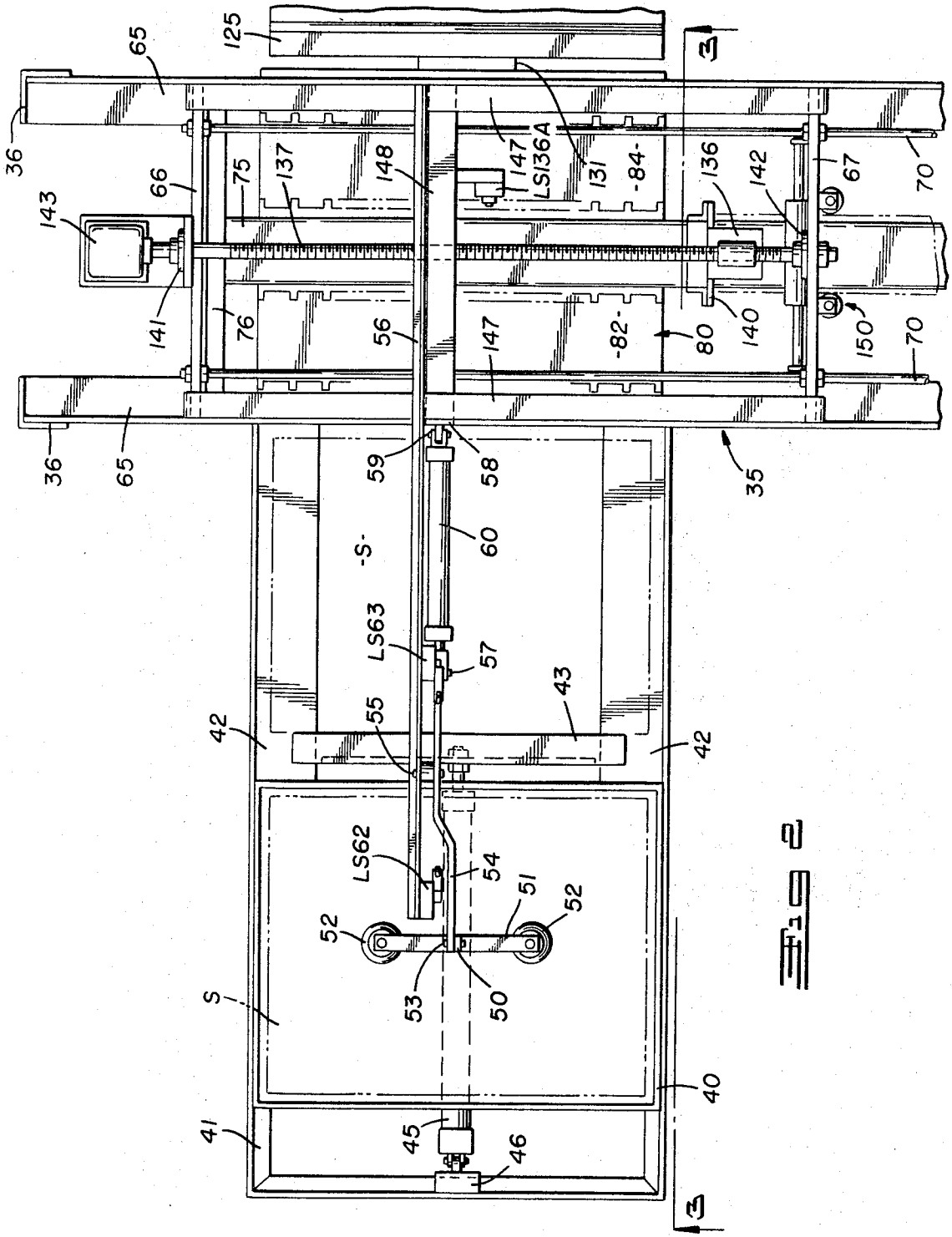


FIG. 2

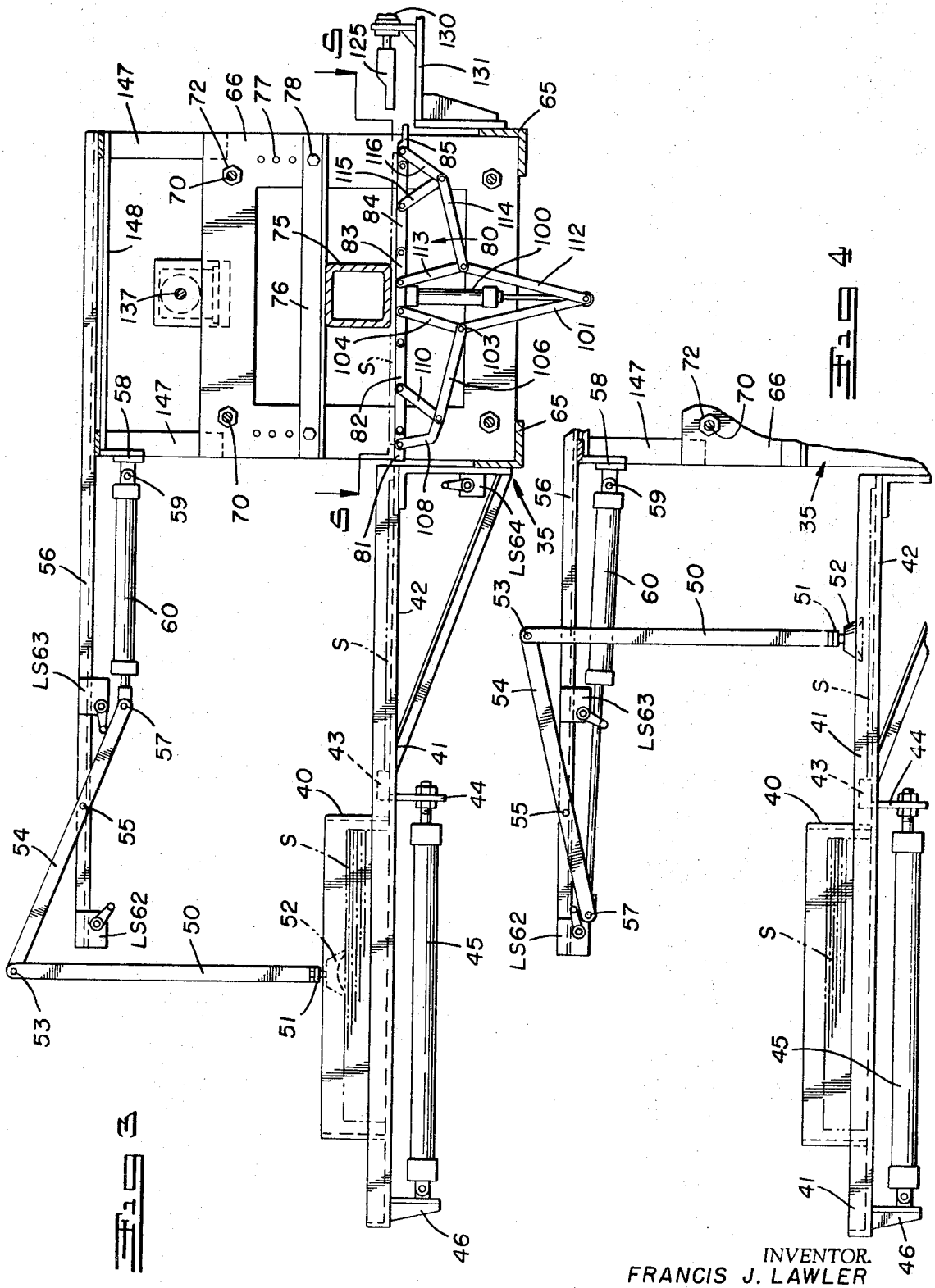
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PACKAGING SYSTEM FOR MERCHANDISE RECEIVING CONTAINERS OF VARIOUS VOLUMES

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PACKAGING SYSTEM FOR MERCHANDISE RECEIVING CONTAINERS OF VARIOUS VOLUMES

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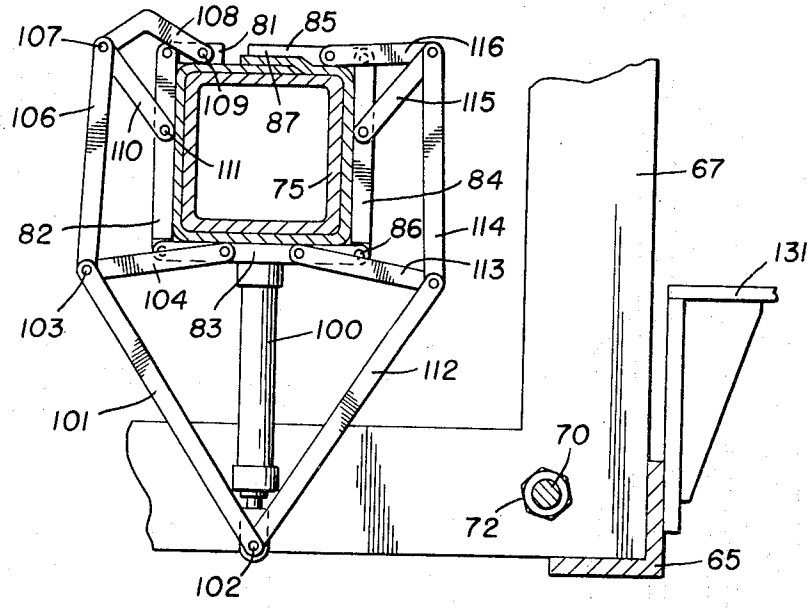


FIG 4

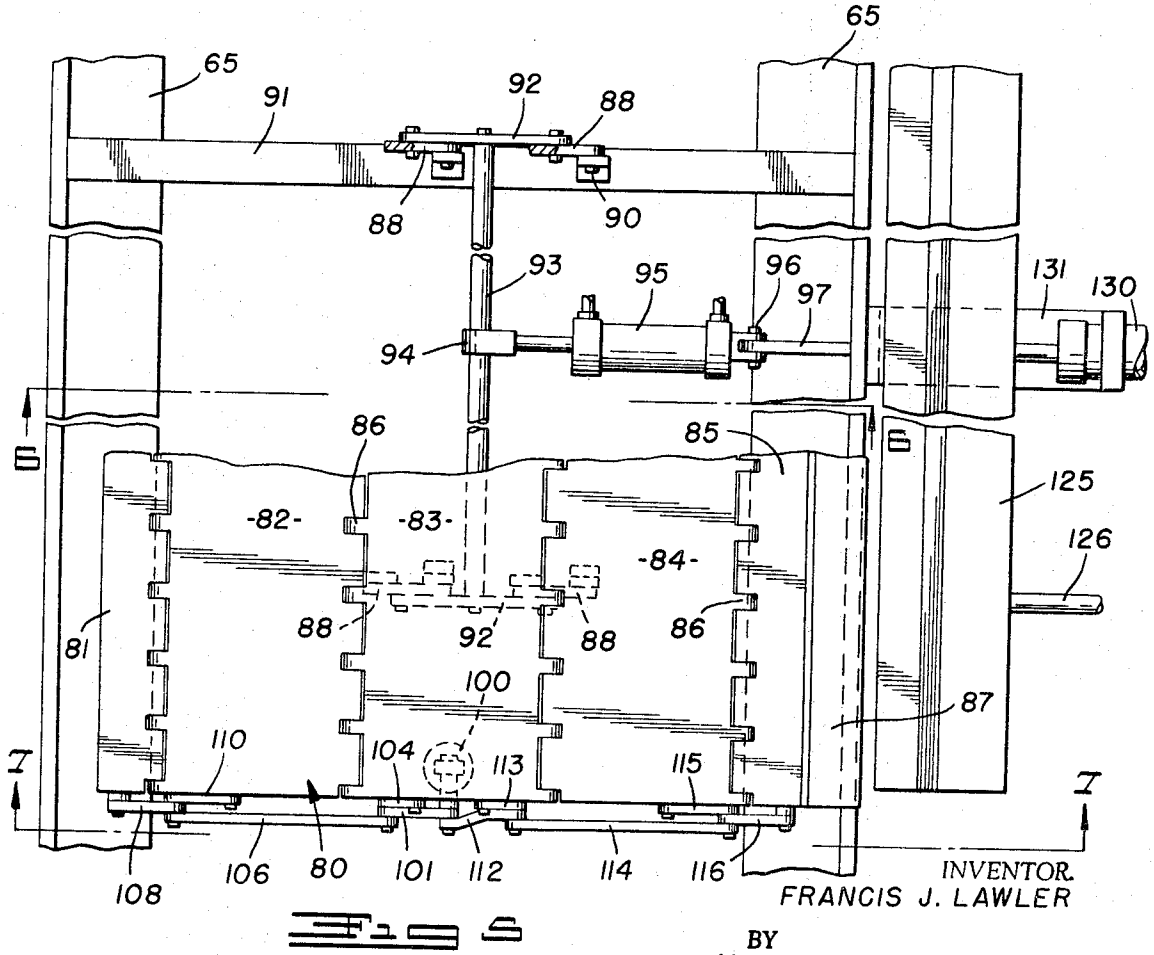


FIG 5

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PACKAGING SYSTEM FOR MERCHANDISE RECEIVING CONTAINERS OF VARIOUS VOLUMES

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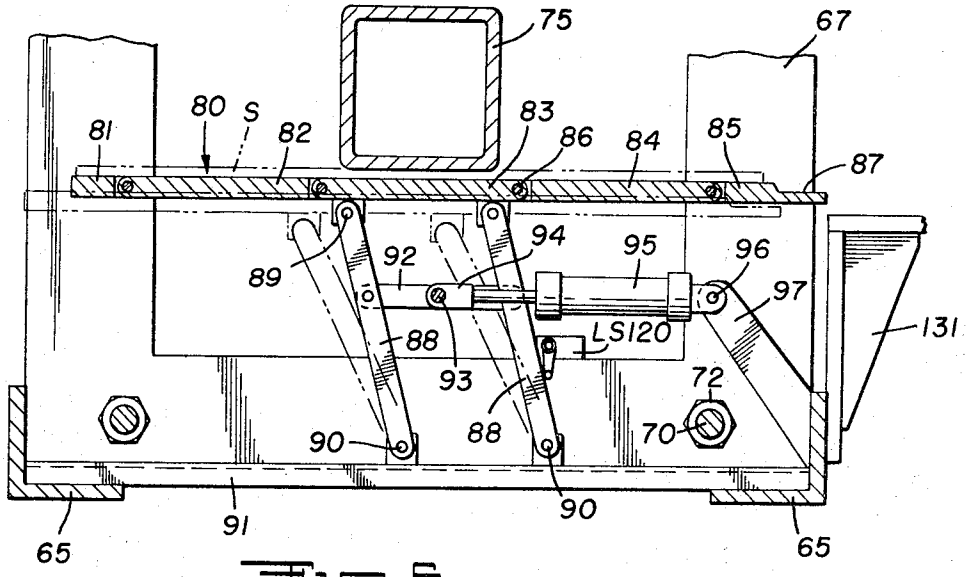


Fig 6

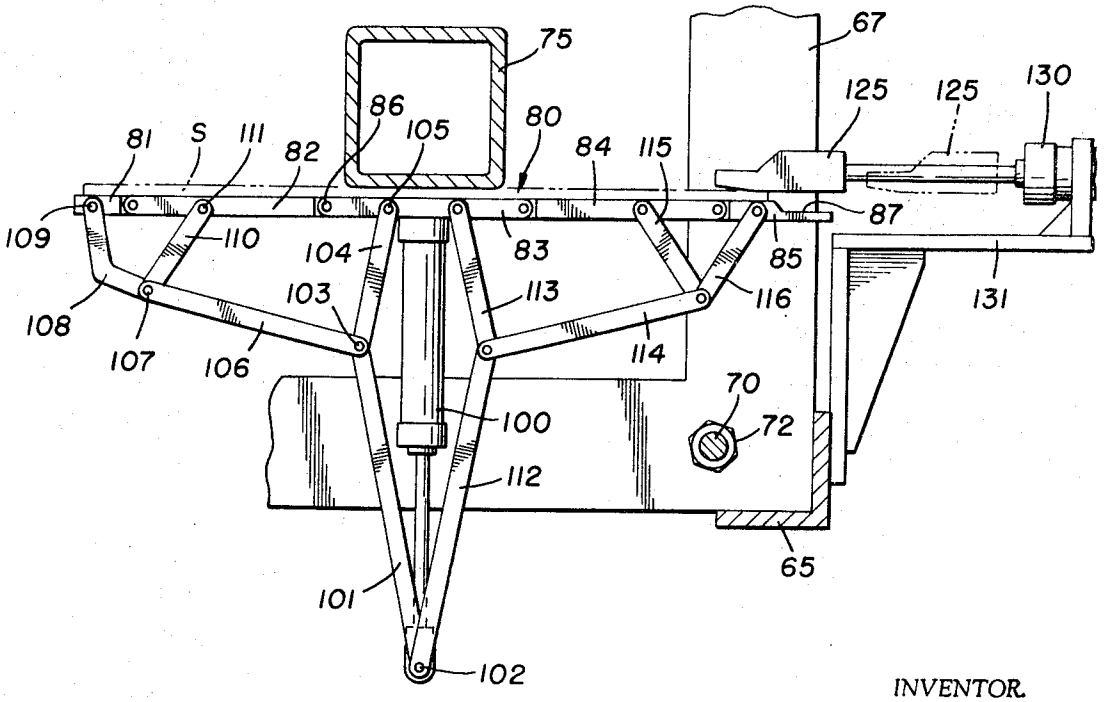


Fig 7

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PACKAGING SYSTEM FOR MERCHANDISE RECEIVING CONTAINERS OF VARIOUS VOLUMES

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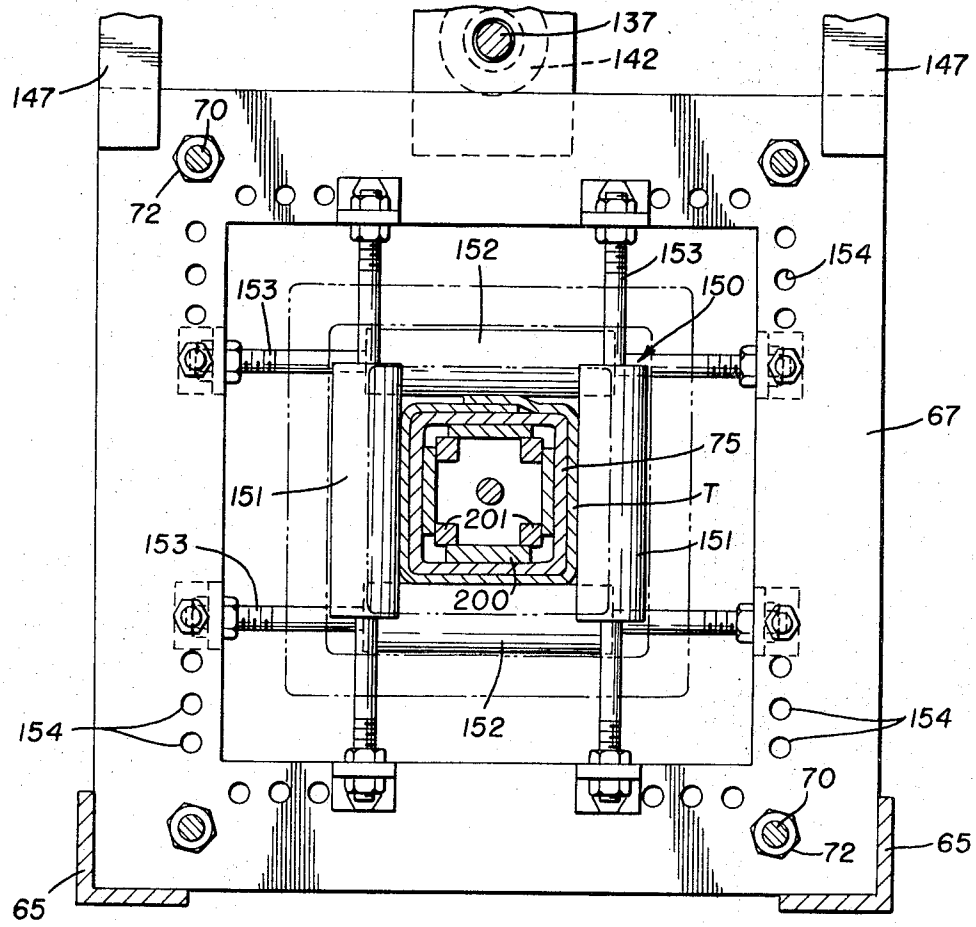


Fig 9

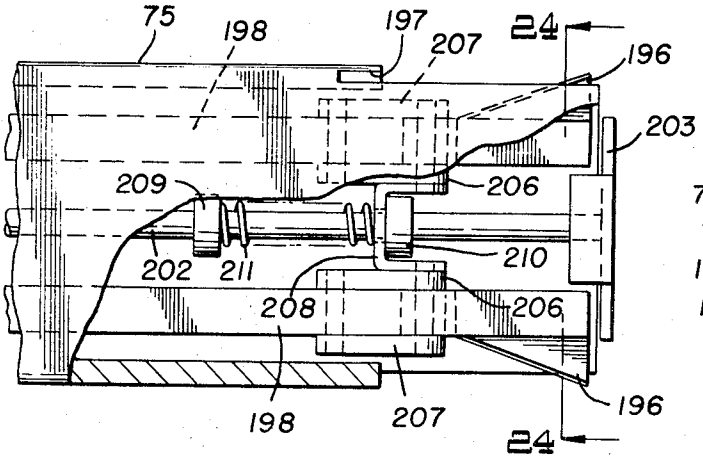


Fig 23

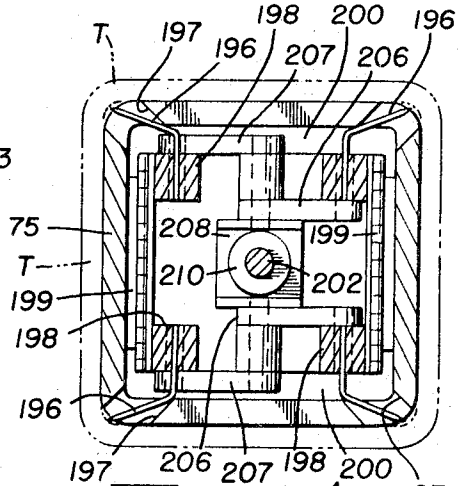


Fig 24

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PACKAGING SYSTEM FOR MERCHANDISE RECEIVING CONTAINERS OF VARIOUS VOLUMES

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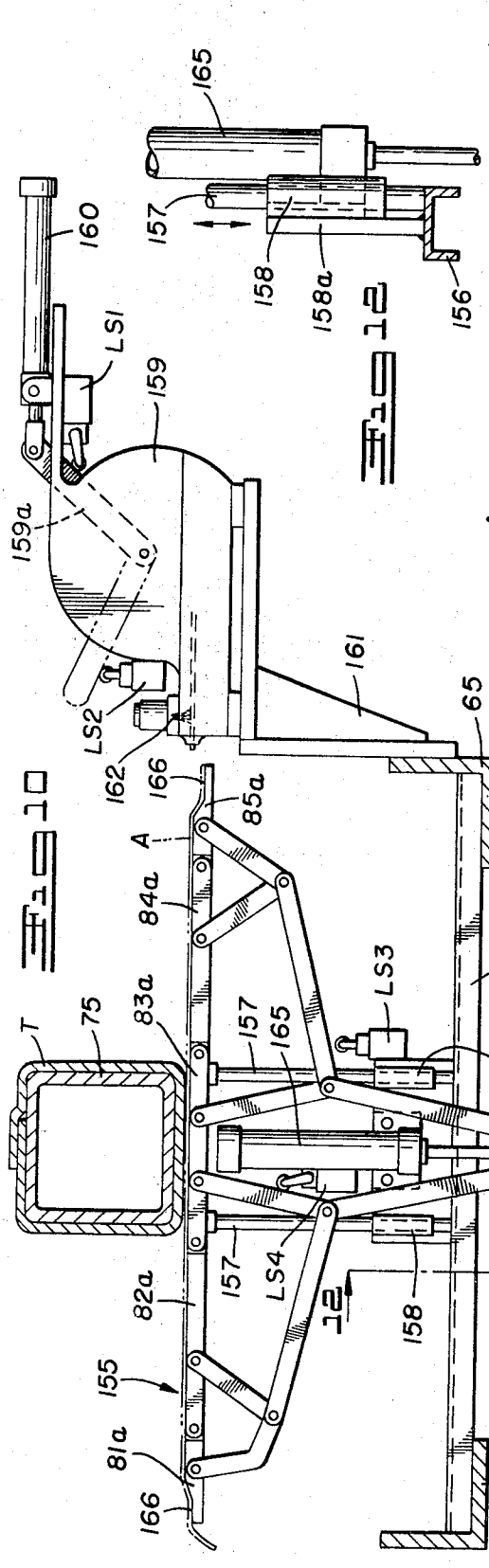


Fig. 12

Fig. 10

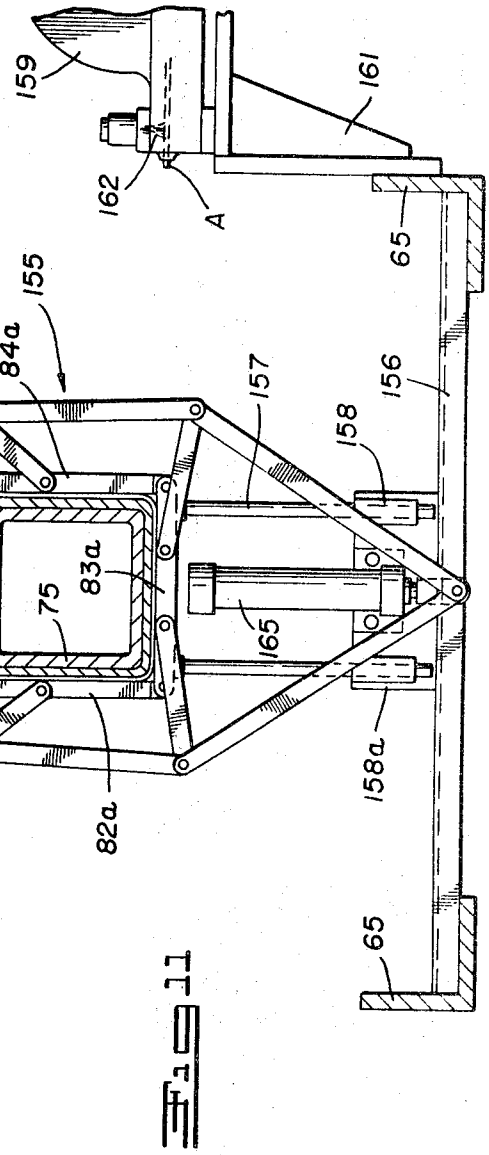


Fig. 11

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PACKAGING SYSTEM FOR MERCHANDISE RECEIVING CONTAINERS OF VARIOUS VOLUMES

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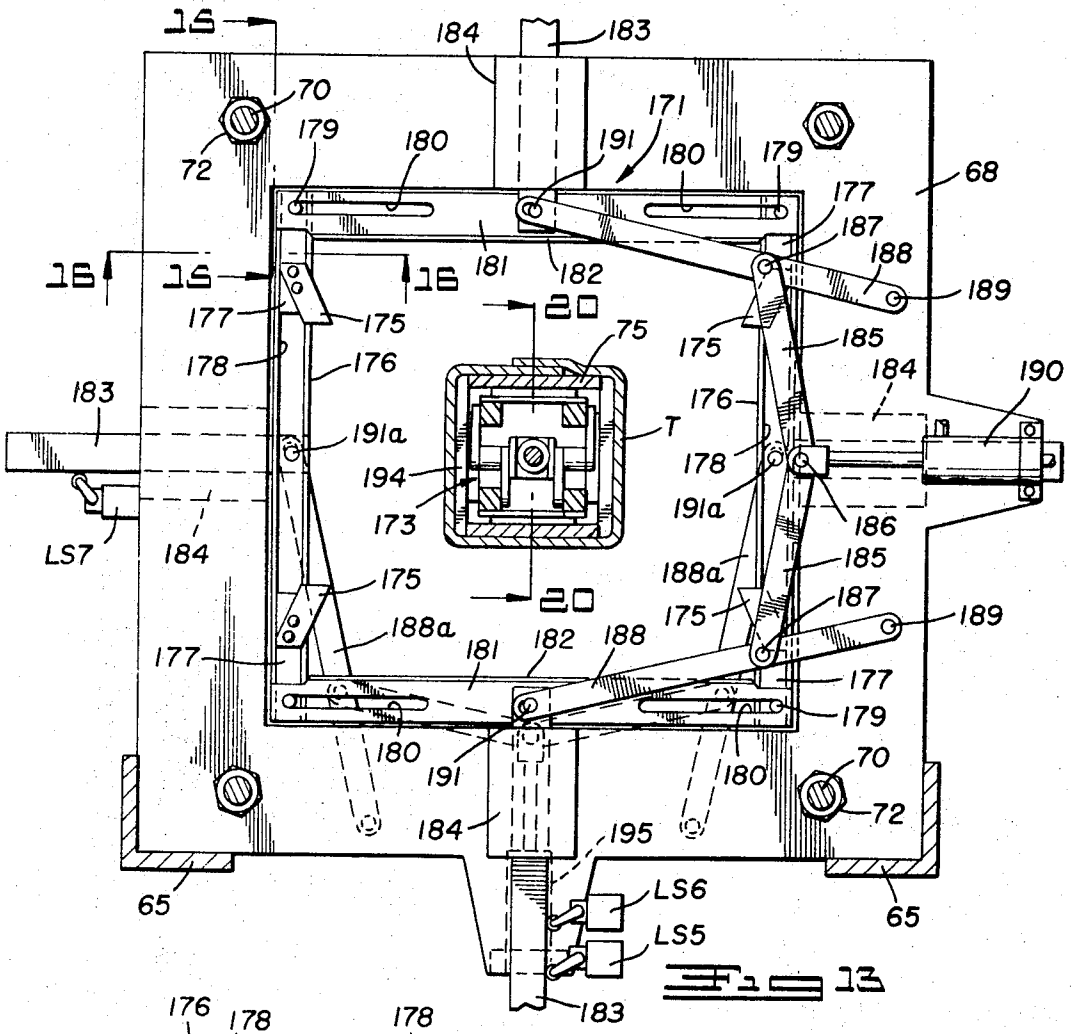


Fig. 13

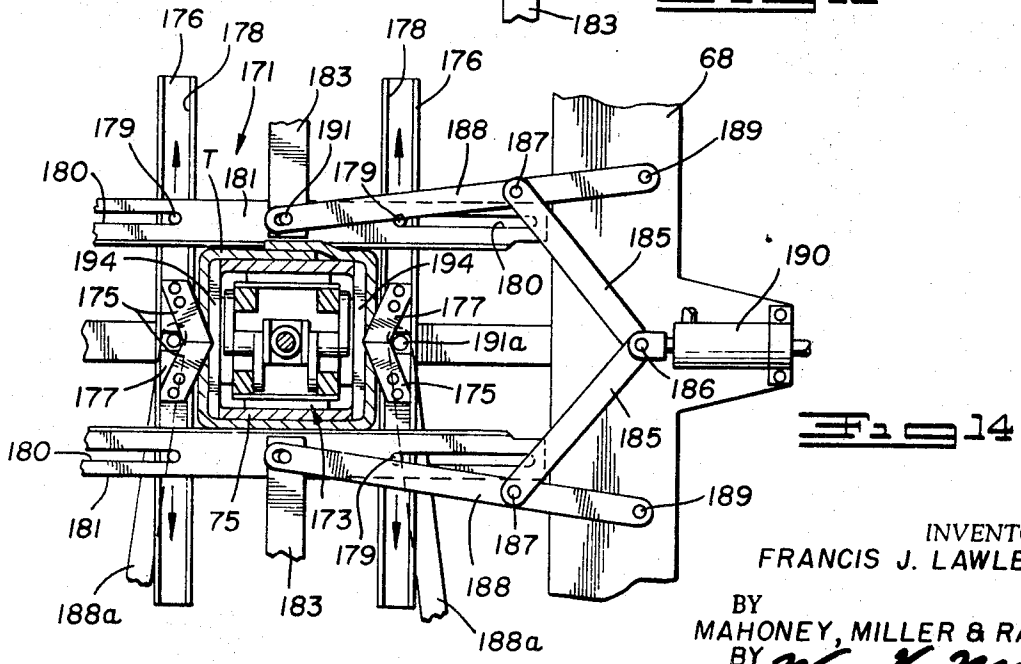


Fig. 14

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PACKAGING SYSTEM FOR MERCHANDISE RECEIVING CONTAINERS OF VARIOUS VOLUMES

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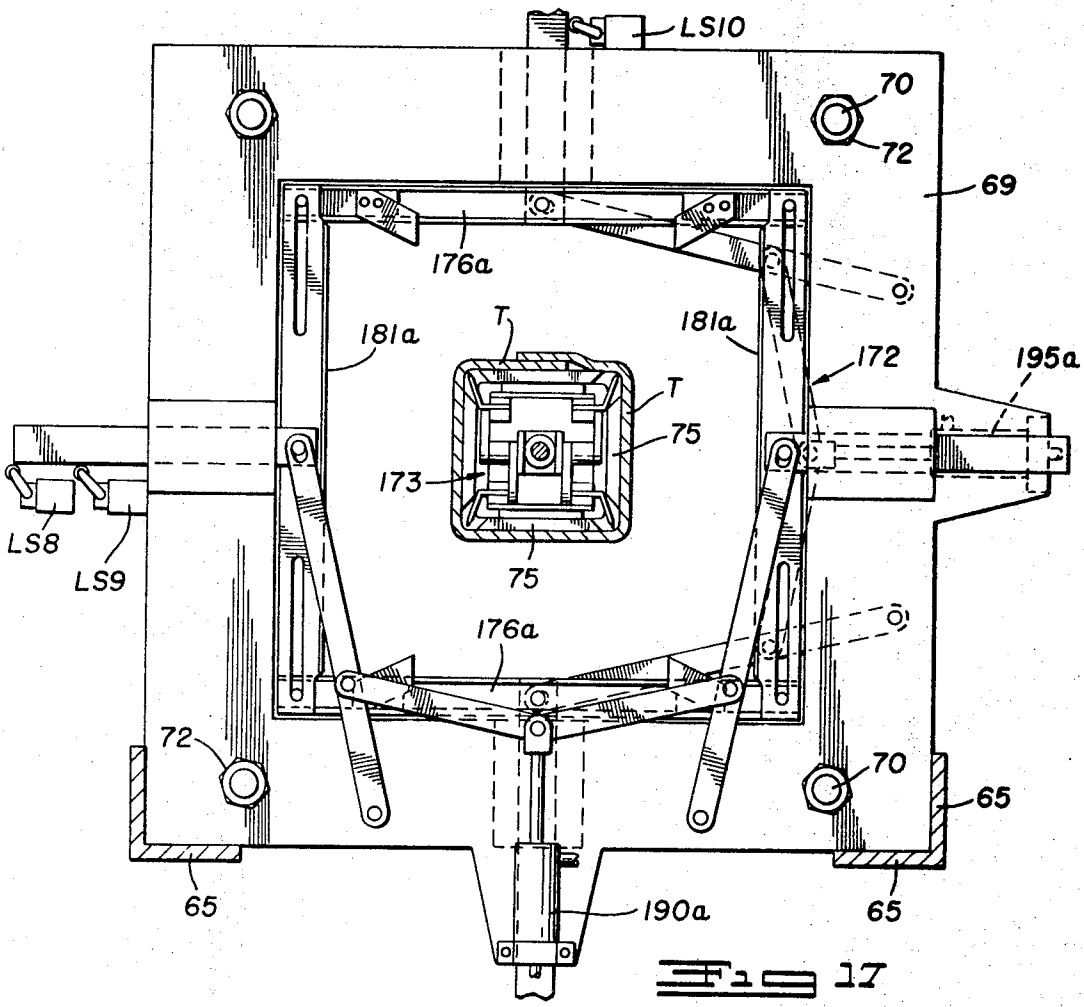


Fig 17

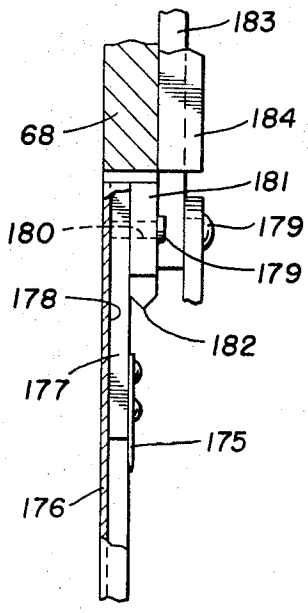


Fig 15

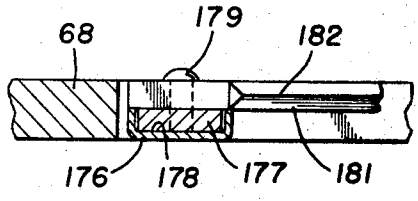


Fig 16

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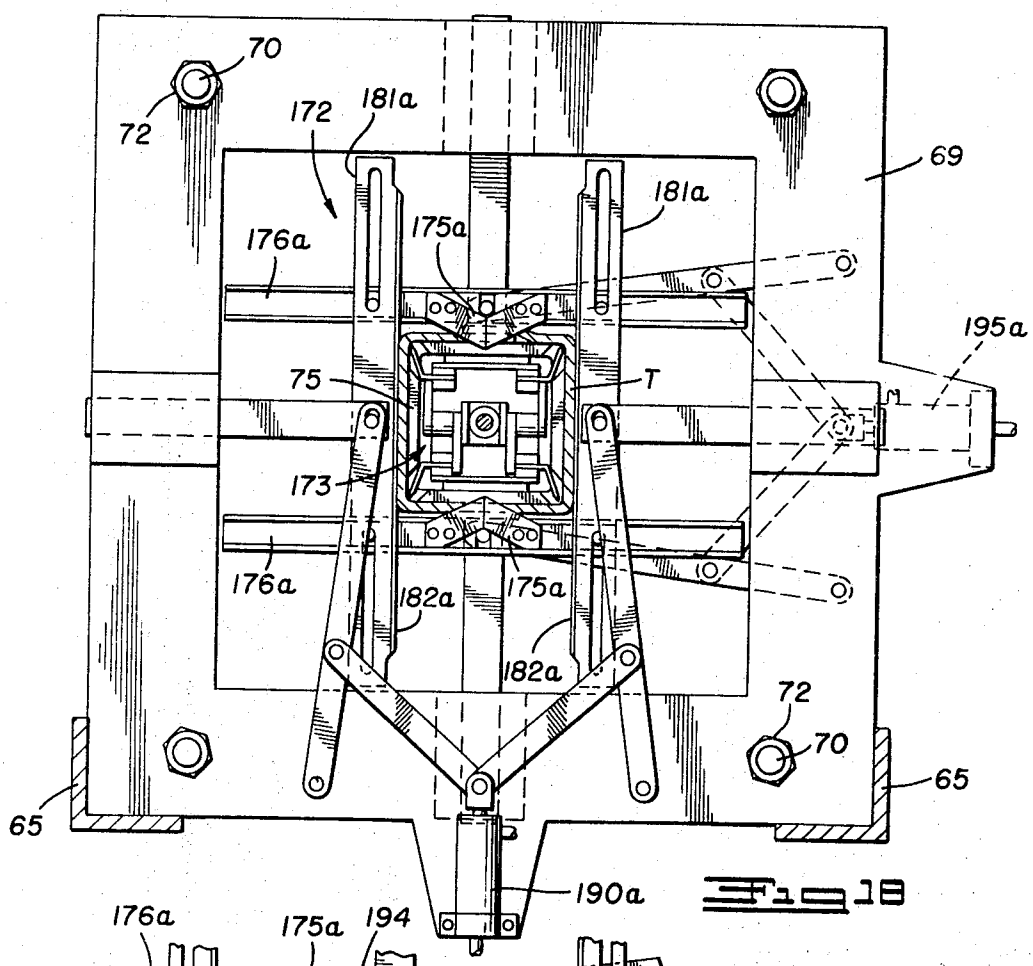


Fig 18

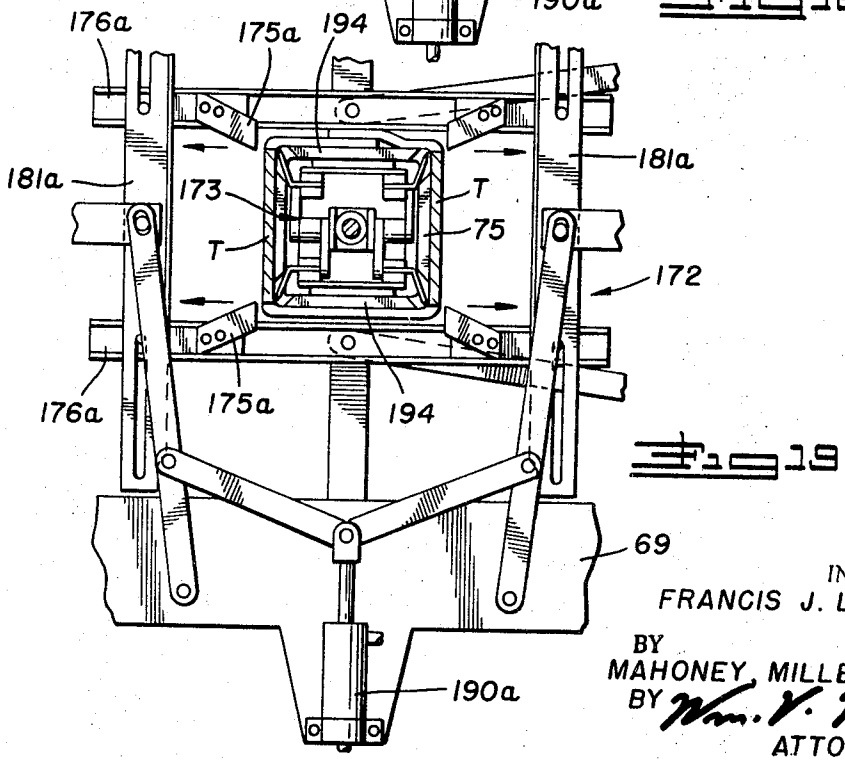


Fig 19

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PACKAGING SYSTEM FOR MERCHANDISE RECEIVING CONTAINERS OF VARIOUS VOLUMES

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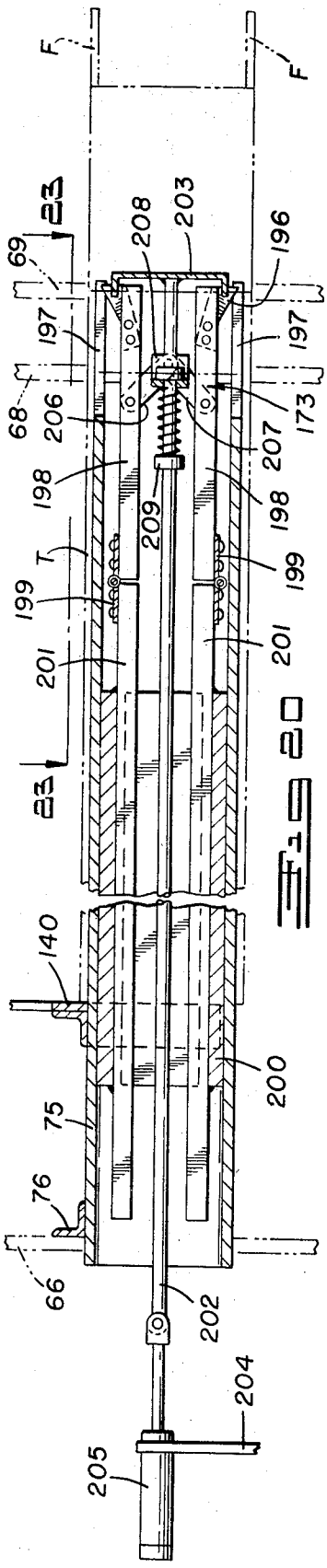


Fig 20

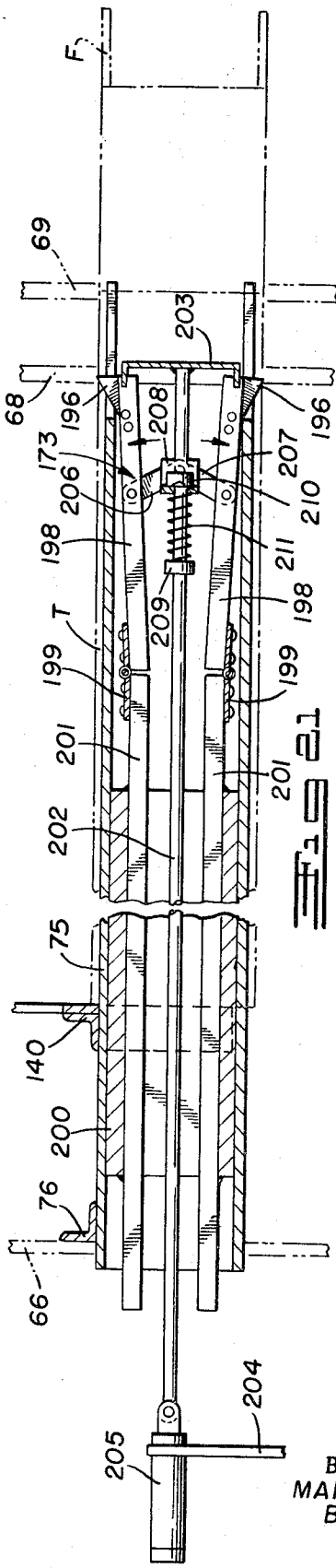


Fig 21

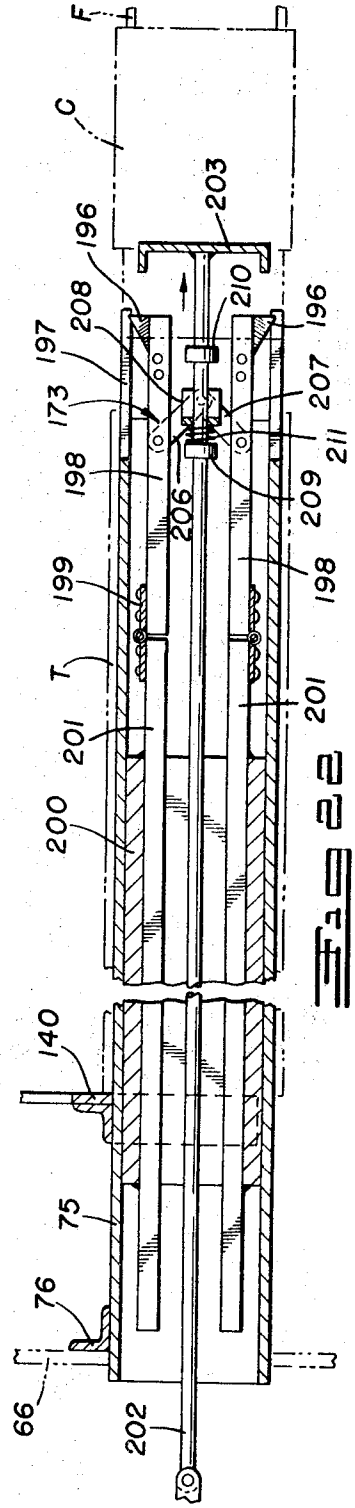


Fig 22

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PACKAGING SYSTEM FOR MERCHANDISE RECEIVING CONTAINERS OF VARIOUS VOLUMES

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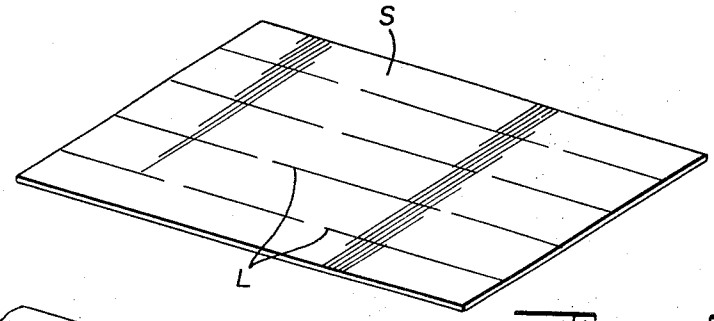


Fig 25

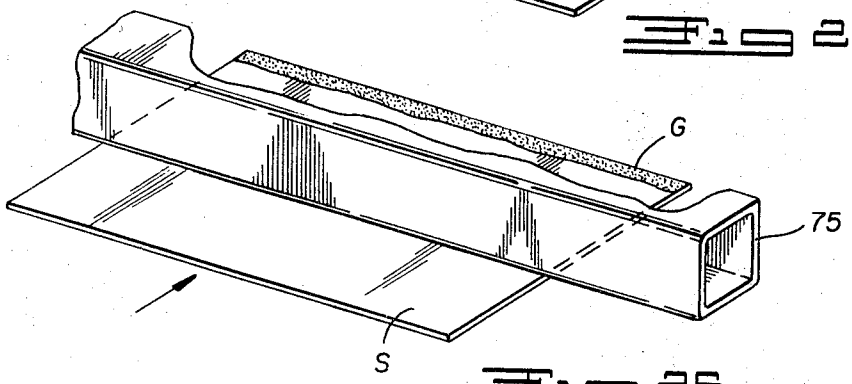


Fig 26

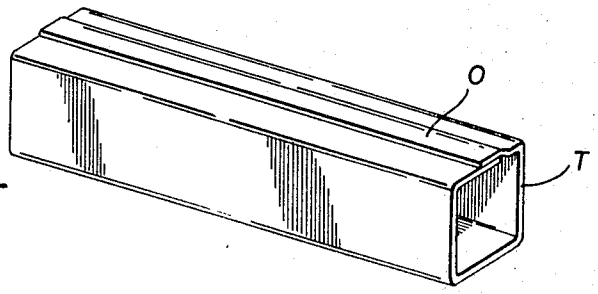


Fig 27

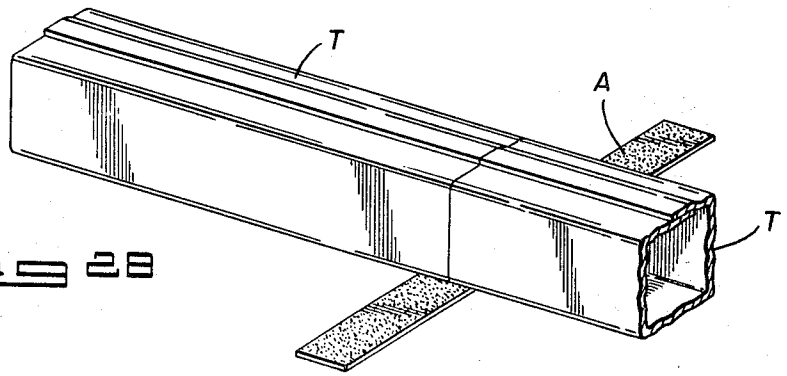


Fig 28

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PACKAGING SYSTEM FOR MERCHANDISE RECEIVING CONTAINERS OF VARIOUS VOLUMES

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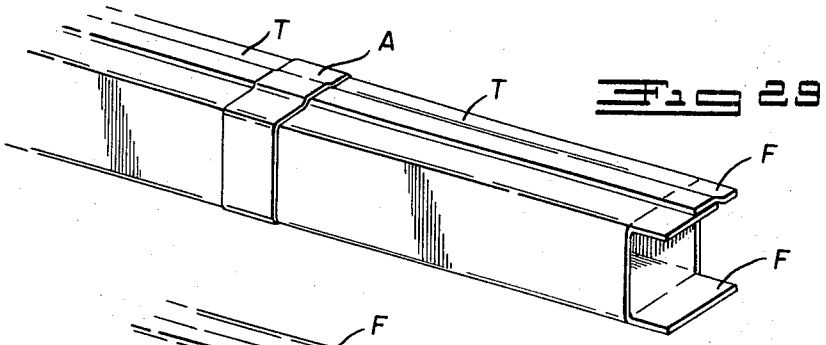


Fig 29

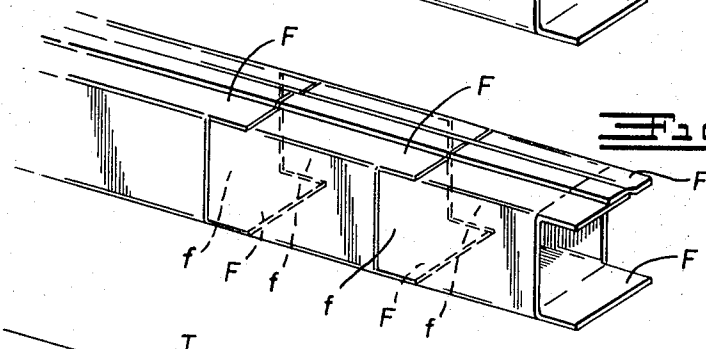


Fig 30

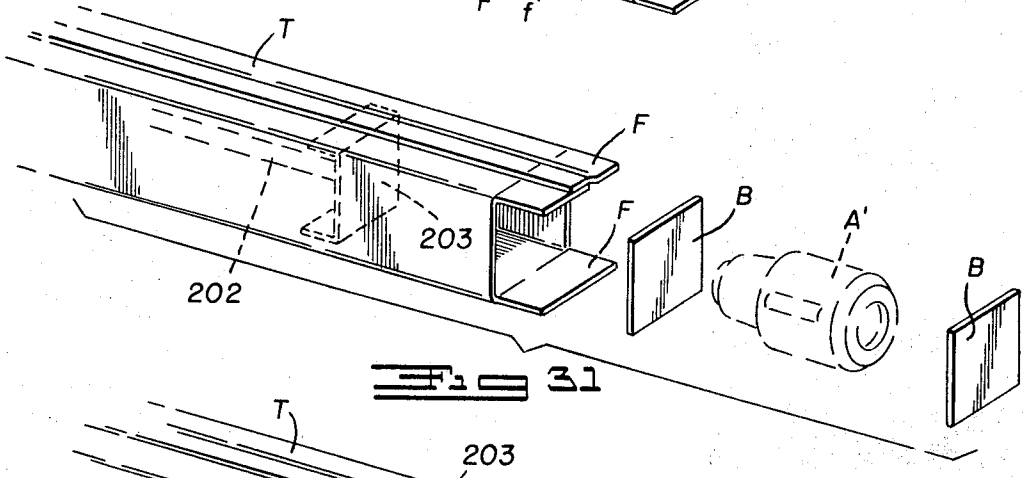


Fig 31

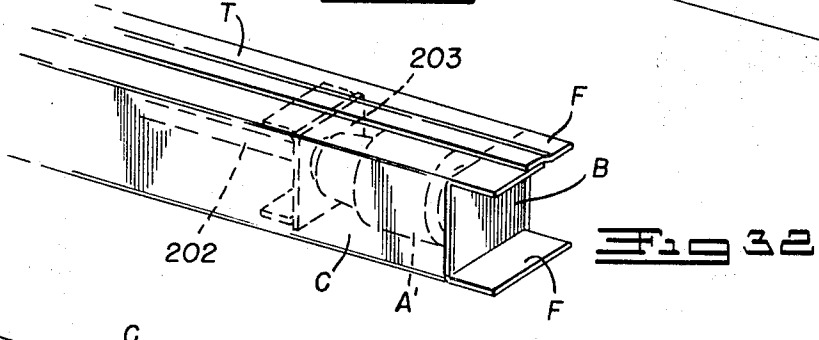


Fig 32

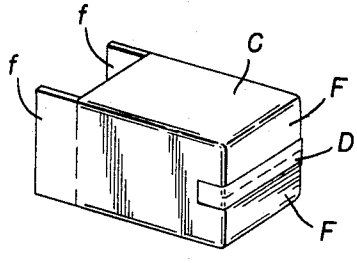


Fig 33

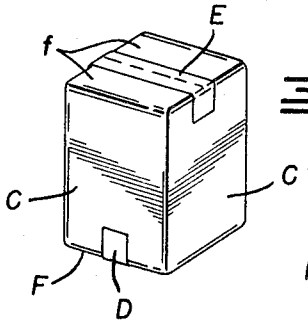
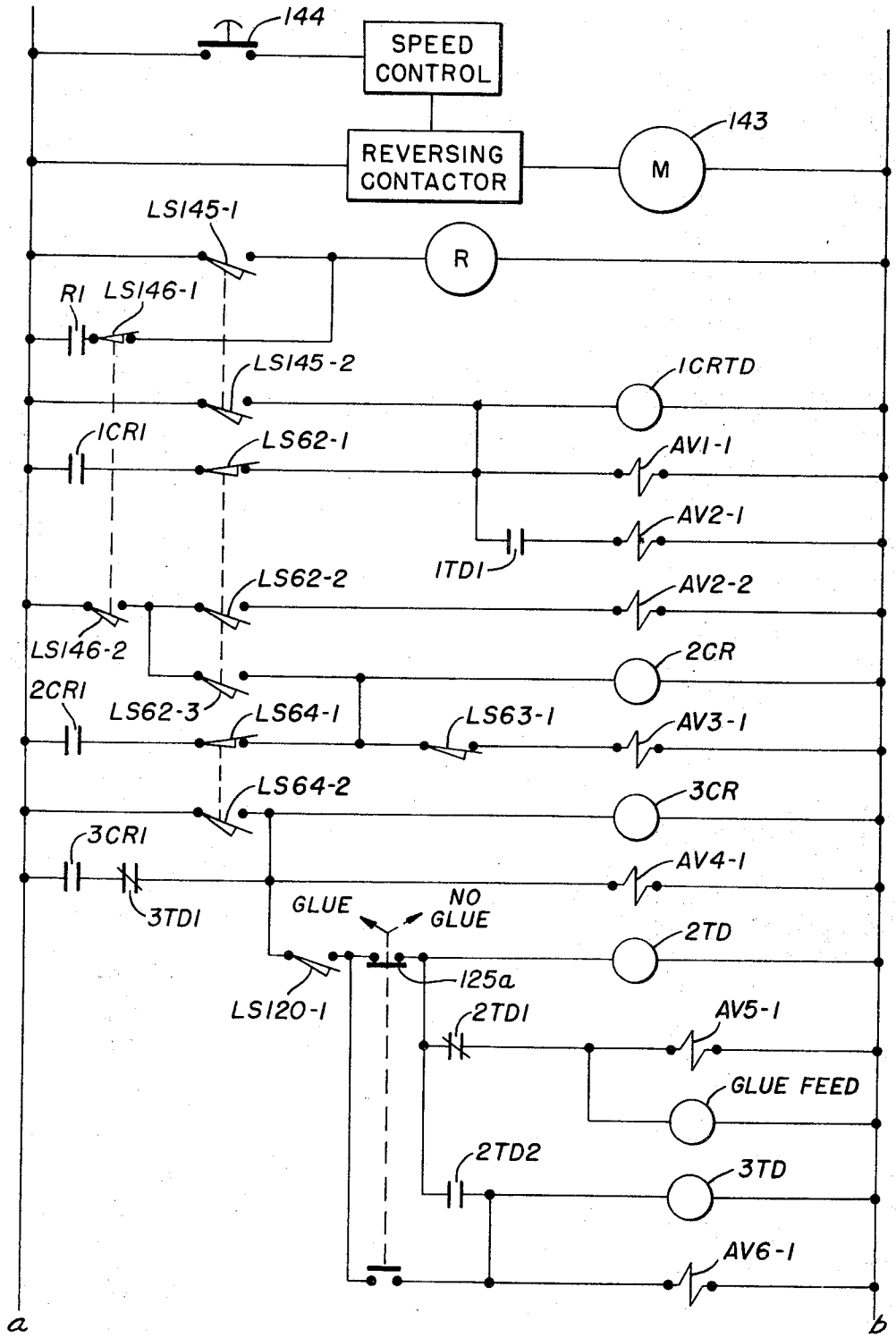


Fig 34

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FRANCIS J. LAWLER

Fig 35

BY
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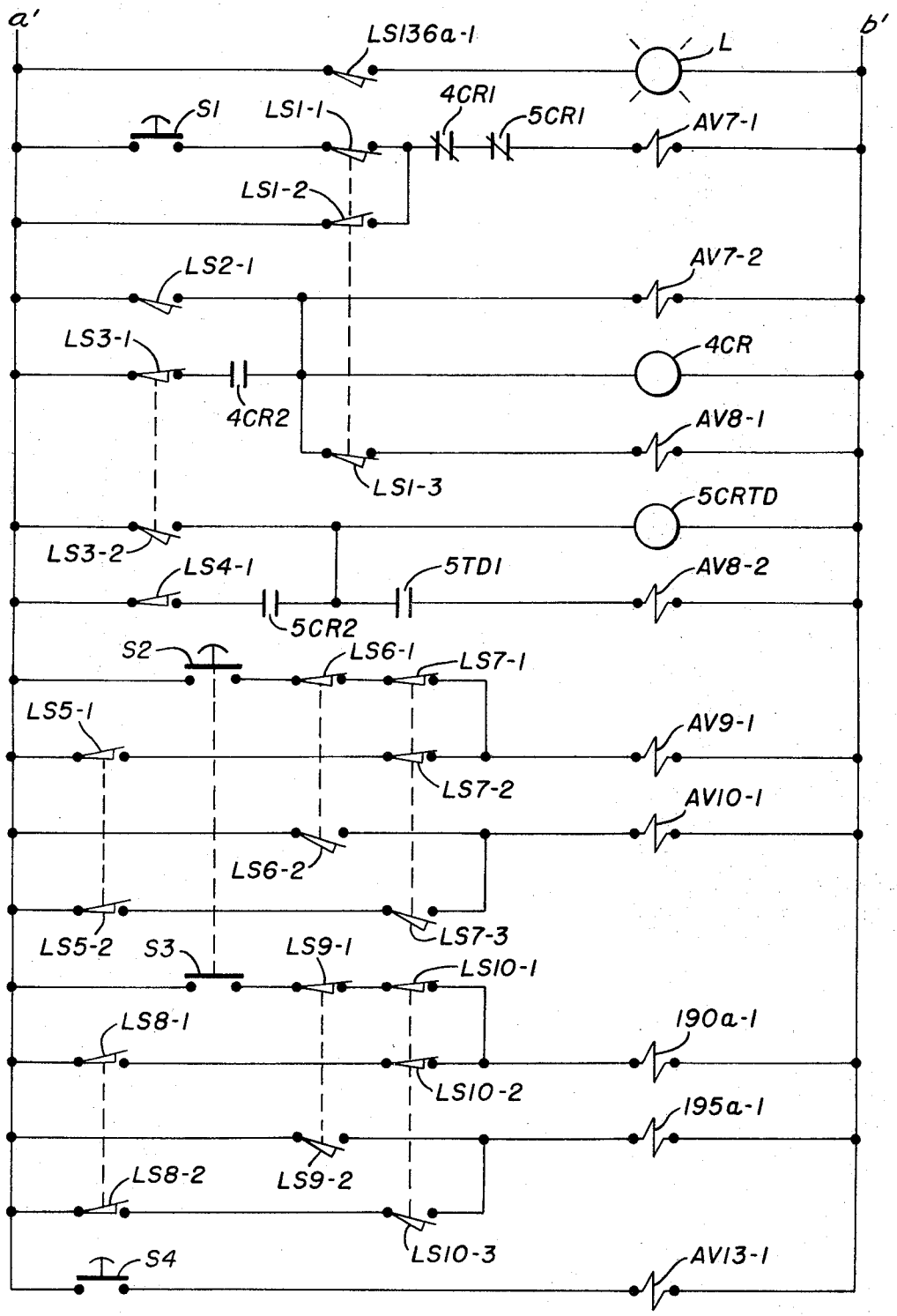


Fig 35a

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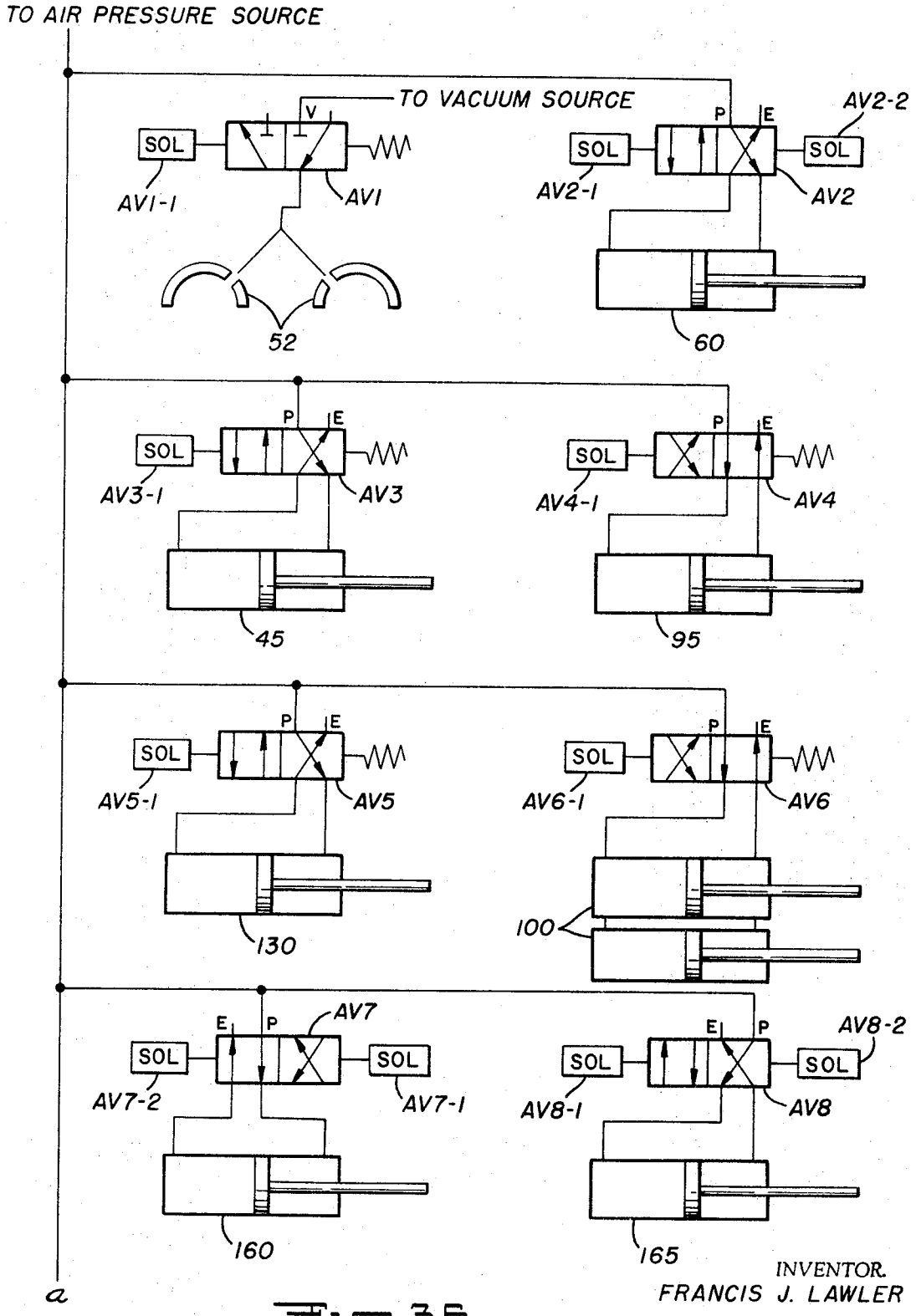


Fig 3B

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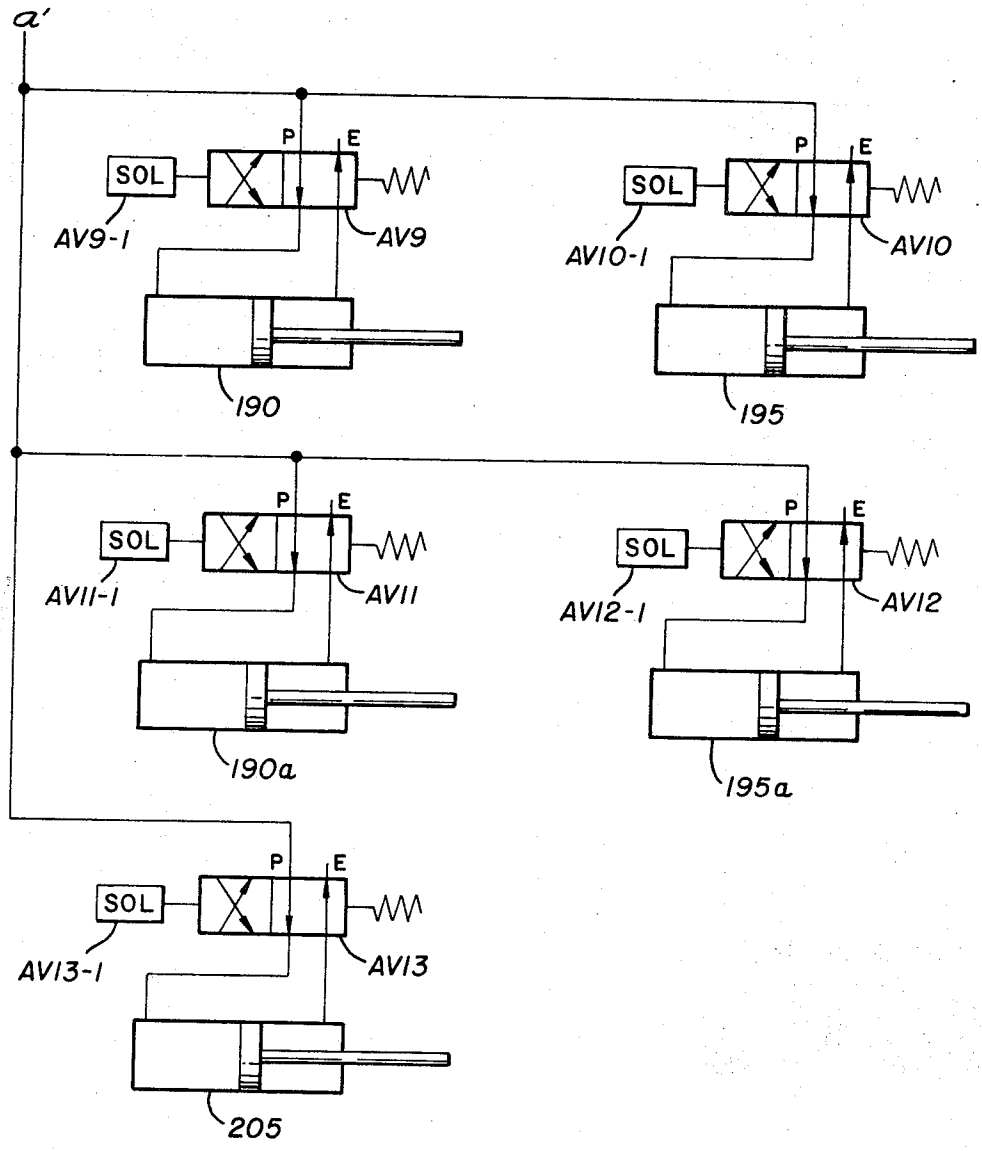


Fig 3a

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United States Patent Office 3,545,167
Patented Dec. 8, 1970

3,545,167

PACKAGING SYSTEM FOR MERCHANDISE RECEIVING CONTAINERS OF VARIOUS VOLUMES

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Columbus, Ohio 43224

Filed June 4, 1968, Ser. No. 734,311
Int. Cl. B65b 47/06
U.S. Cl. 53—29 27 Claims

ABSTRACT OF THE DISCLOSURE

A system for use in packaging articles or groups of articles of merchandise or material requiring differences in volumetric space for packaging. The system is embodied in a machine which receives a sheet of fiberboard or other formable material, forms it into an elongated tube of square or rectangular cross section and predetermined girth, and joins its leading end to the trailing end of a previously formed tube; and while the tube is still in the machine permits the operator to pack in the leading end of the continuously joined tube sections material or merchandise of assorted size, shape or quantity, after which the machine adjusts to the exact length required, cuts and scores the tube so that it is of the required length and volume with closure flaps formed on each end so that the operator can complete the closure by folding and sealing the flaps.

BACKGROUND OF THE INVENTION

This invention provides successive enclosures or containers of fiberboard, preferably corrugated board, for units of merchandise or material which vary in size or quantity so as to require successive containers of varying lengths, although they may be of a preselected uniform girth. It eliminates the need to cut down a manufactured carton of a standard size to fit the material or merchandise placed therein when the carton is not of the required size. Or in lieu of cutting down the oversize carton, to fill it with excess packaging material. At present, for merchandisers to pack merchandise for shipment to a customer, orders of which no two are the same size in quantity or shape, it is necessary to have available many different sizes of manufactured cartons of various standard sizes and shapes. In packing orders of merchandise of undetermined or varying sizes, seventy percent of the cost of packing such orders is the result of time consumed in searching for a carton of the correct size for packing an order, repacking the order because the first carton chosen was not large enough or was too large, the time and material costs in cutting a carton down to size when it is found to be too large, or in lieu of cutting a carton to size, the time and material cost of filling the excess carton space with packing material. Added to the above-indicated costs should be the cost of wasted floor space required to stack the many sizes of standard manufactured cartons, each size of which must be purchased in large quantities to obtain the best possible price.

In the accompanying drawings, I have illustrated a preferred form of machine in which my packaging system is embodied and the successive steps in packaging the merchandise, but it is to be understood that specific variations may be made without departing from basic principles of my invention.

In these drawings:

FIG. 1 is a side elevational view of the main structure of the machine.

FIG. 1*a* is a side elevational view of the extended discharge end of the machine which is cut off in FIG. 1.

FIG. 2 is a horizontal sectional view taken along line 2—2 of FIG. 1.

FIG. 3 is a transverse vertical sectional view taken along line 3—3 of FIG. 2.

FIG. 4 is an elevational view showing a portion of the apparatus of FIG. 3 in a different operative position.

FIG. 5 is an enlarged horizontal sectional view taken along line 5—5 of FIG. 3 but partly cut away.

FIG. 6 is a vertical sectional view taken along line 6—6 of FIG. 5.

FIG. 7 is a vertical sectional view taken along line 7—7 of FIG. 5.

FIG. 8 is a view similar to FIG. 7 but showing a different operative position of the same mechanism.

FIG. 9 is an enlarged transverse vertical sectional view taken along line 9—9 of FIG. 1.

FIG. 10 is an enlarged transverse vertical sectional view taken along line 10—10 of FIG. 1.

FIG. 11 is a view similar to FIG. 10 but showing a different operative position of the same mechanism.

FIG. 12 is an enlarged vertical sectional view taken along line 12—12 of FIG. 10.

FIG. 13 is an enlarged transverse vertical sectional view taken along line 13—13 of FIG. 1.

FIG. 14 is a view similar to FIG. 13 but showing a different operative position of the same mechanism.

FIG. 15 is an enlarged vertical sectional view taken along line 15—15 of FIG. 13.

FIG. 16 is an enlarged horizontal sectional view taken along line 16—16 of FIG. 13.

FIG. 17 is an enlarged transverse vertical sectional view taken along line 17—17 of FIG. 1.

FIG. 18 is a view similar to FIG. 17 but showing the same mechanism in a different operative position.

FIG. 19 is another similar view but showing the same mechanism in still another operative position.

FIG. 20 is a longitudinal vertical sectional view taken along line 20—20 of FIG. 13.

FIG. 21 is a similar view but showing a different operative position of the same mechanism.

FIG. 22 is a similar view but showing still another operative position of the same mechanism.

FIG. 23 is a horizontal plan view taken from the position indicated at line 23—23 of FIG. 20 but partly cut away.

FIG. 24 is a transverse vertical sectional view taken along line 24—24 of FIG. 23.

FIG. 25 is a perspective view of a sheet of material which can be used in forming a container tube.

FIG. 26 is a schematic perspective view illustrating how the sheet is fed beneath the mandrel of the machine.

FIG. 27 is a perspective view of the formed container tube.

FIG. 28 is a schematic perspective view illustrating how the trailing end of a leading container tube formed on the machine is spliced by tape to the leading end of a following container tube formed in the machine.

FIG. 29 is a schematic perspective view showing the spliced container tube with flaps formed on its leading end.

FIG. 30 is a similar view, illustrating diagrammatically the cutting and slitting of the formed container tube to produce a container of desired length and capacity.

FIG. 31 is a similar view illustrating schematically the positioning of an article relative to the open leading end of the formed tube adapted to receive the article.

FIG. 32 is a similar view showing the article positioned in the leading end of the tube.

FIG. 33 is a perspective view of the container on its side severed from the tube and loaded with the article with

the flaps at the one or bottom end folded in and taped in closed position but with the flaps at the other or top end in open extended position.

FIG. 34 is a perspective view of the upright packed container with the flaps at the top end folded inwardly and taped in closed position.

FIG. 35 is a schematic diagram of a portion of the electrical system of the machine.

FIG. 35*a* is a similar view of the remainder of the electrical system.

FIG. 36 is a schematic diagram of a portion of the fluid system of the machine.

FIG. 36*a* is a similar view of the remainder of the fluid system.

With reference to the drawings, I have illustrated in FIGS. 1 and 1*a* the general arrangement of a machine embodying my invention. The machine was designed to: Operate to feed or load a sheet of stock of predetermined size, such as a sheet of longitudinally scored corrugated board; bend it transversely around an elongated forming mandrel into a hollow container tube of angular cross section, preferably quadrangular, for example, square or rectangular, having an adhesively secured overlapping seam; permit the formed container tube to be advanced along the mandrel through a distance selected by the operator; forming a succeeding container tube around the mandrel behind the first-formed container tube and joining its leading end in abutting relationship with the trailing end of the first-formed container tube by means of an adhesive tape band; and as the combined container tube is advanced by the operator at will along the forming mandrel, the machine will form, by suitable scoring and cutting operations, a container or box of selected length, as it is packed with material or merchandise by the operator, the container having cover flaps at both ends, those at the leading end being closed by the operator before the container or box is completely severed from the main part of the tube to form the container bottom and those at the other end being closed by the operator after severing to form the container top.

The machine shown in the drawings is designed for forming tubes of square cross section to produce boxes of cubical form but it is not necessarily limited to this form. The structure of the machine is illustrated specifically in the drawings as comprising a main base or frame **35** which is tilted upwardly from its stock-loading or infeed end to its box-removing end, where the box is filled, being supported on a pair of legs **36** and a pair of forward longer legs **37**. Extending outwardly from the forward or discharge end of the frame **35** is a final box-receiving and supporting table or shelf **38** which is rigidly carried by the legs **37** intermediate their height.

The machine is designed to receive the sheets of flat stock S, which may be of the type indicated in FIG. 25 and which preferably have the preformed longitudinally extending score lines L at proper laterally spaced parallel positions. The stock for the machine is piled in an open-top tray or container **40** disposed at one side of the frame **35** at the stock-loading end thereof, as indicated best in FIGS. 2 to 4. This tray is supported by a braced frame extension **41** which extends laterally from the main frame **35** and is rigidly connected thereto and is tilted in the same direction and to the same extent as the main frame **35**. Between the tray **40** and the main frame **35** on the extension **41** is a stock feed table in the form of parallel flat plates **42** which are adapted to receive and slidably support a sheet of stock placed thereon in bridging relationship to the plates **42**. A sheet pusher is provided for engaging the trailing edge of a sheet S supported on the feed table plates **42** and comprises a pusher bar **43** which has its opposed ends overlapping and slidable on the plates **42**. This bar **43** is moved back and forth along the plates **42** preferably by means of a double-acting, fluid-actuated cylinder and piston unit **45**, the piston rod of which is shown connected to a depending bracket **44**, rigidly connected to the bar, and the cylinder of which is shown pivotally connected, for vertical swinging movement, to the rigid fixed arm **46** depending from the frame extension **41** at its outer end.

Sheet-lifting means is provided for lifting successive sheets from the tray **40** and depositing them on the feed table plates **42** and comprises a depending suction-cup carrying arm **50**. This vertical support arm **50** carries rigidly at its lower end a transversely extending horizontal arm **51** which has the suction cups **52** supported on its opposed outer ends. An electromagnetic valve-controlled vacuum source of the usual type (not shown) will be connected to the downwardly opening cups **52**. The support arm **50** has its upper end pivotally connected by a transverse pivot **53** to the outer end of a rocker arm **54**. This rocker arm **54** is pivoted intermediate its length for swinging in a vertical plane about a transverse pivot **55** which is carried near the outer end of a rigid support arm **56** that extends horizontally over the frame extension **41** in elevated, parallel relationship thereto. This arm **54** is rocked about the pivot **55** by means of a double-acting fluid-actuated cylinder and piston unit **60** which has its piston rod pivotally connected thereto at **57** and its cylinder pivoted for vertical swinging movement to a fixed support **58** at the pivot **59**.

The extreme outer end of the support arm **56** carries a limit switch LS**62** and a second limit switch LS**63** is carried by the support arm at a predetermined location inwardly along the arm. The switch LS**62** is adapted to be engaged and actuated by the rocker arm **54** when it is swung into the position shown in FIG. 4, by extension of the cylinder and piston unit **60**, to position the suction cups **52**, and the sheet of stock carried thereby, over the feed table plates **42**. The switch LS**63** is adapted to be engaged and actuated by the rocker arm **54** when it is swung into the position shown in FIG. 3, by retraction of the cylinder and piston unit **60**, to position the suction cups **52** over a sheet of stock in the tray **40**. It will be noted from FIG. 2 that the outer end of the rocker arm **54**, that is, its end pivoted to the arm **50**, is laterally offset relative to its other or inner end so that it will not engage the switches LS**62** or LS**63** during its vertical swinging. However, the other or inner end of the rocker arm **54** will engage the respective switches LS**62** and LS**63** in each of the indicated positions of the rocker arm at opposite sides of the pivot **55**. The limit switch LS**63** may be connected to and activates an electromagnetic valve to control application of suction to the cups **52**. The switch LS**63** may also be connected to and control an electromagnetic fluid control valve to control supply of fluid to the cylinder and piston unit **60** so as to extend it and move the cups **52** with the sheet carried thereby over the feed table plates as shown in FIG. 4. The limit switch LS**62** is connected to and actuates the vacuum valve to control release of vacuum from the cups **52**. Also, the switch LS**62** may be connected to and control an electromagnetic control valve to control supply of fluid for the cylinder and piston unit **45** to extend it so as to provide feeding movement of the sheet pusher bar **43**. A limit switch LS**64** is carried by the frame **35** in position to be engaged by the bracket **44** of the sheet pusher and is connected to the electromagnetic control valve for the cylinder and piston unit **45** to retract the unit and reverse movement of the pusher bar **43**.

Thus, movement of the pusher bar **43** laterally will feed the sheet over the main frame **35** and it will be noted (FIGS. 1 to 3) that this main frame includes the two longitudinally extending, inwardly and upwardly facing angles **65** which extend the full length of the machine in laterally spaced relationship. Supported at predetermined, fixed longitudinal intervals along the angles **65**, as shown in FIG. 1, are the series of upright transverse support plate-like frames **66**, **67**, **68**, and **69** which are preferably of square outline and which may merely rest on the angles. These support frames are rigidly held in spaced relationship by means of four

rods **70** located adjacent the respective corners and extending longitudinally of the machine through the support frames. The rods are threaded to receive clamping nuts **72** which are disposed on opposite sides of the plate frames.

An elongated forming mandrel **75** is provided on the machine and extends substantially the full length of the machine centrally through the aligning plate frames **66, 67, 68** and **69**, with its axis in a tilted position in a plane parallel with the plane of the main frame angles **65**. The mandrel is preferably of hollow form, shown as being of square transverse cross-section, so that a container tube of similar cross-section can be formed thereon by bending a sheet S therearound. The formed tube will have a girth corresponding to that of the mandrel. The mandrel is supported in cantilever position at its inner or rear end in a fixed position substantially centrally of the respective plate frames by means of a transverse angle bar **76** (FIG. 3) which is welded to the top side of the mandrel adjacent its rear end and which has its opposed ends extending outwardly over the vertical portions of the plate frame **66**. These portions of the frame are provided with a series of vertically spaced bolt holes **77** for receiving bolts **78** so that the mandrel can be supported at selected levels depending on the thickness of the sheet stocks to be formed thereon.

For receiving the flat sheet stock pushed laterally by the pusher bar **43** and supporting it beneath the rear portion of the mandrel **75**, a stock clamp and bending unit **80** is provided. This unit is shown in FIGS. 1 to 3 and 5 to 8. It consists of a series of elongated and longitudinally disposed forming plates which are designated **81, 82, 83, 84**, and **85** (FIG. 5) which are hinged together for relative swinging by means of the piano-type hinges **86** disposed between adjacent edges. When the flat stock sheet S is received by the clamp **80**, its plate sections are disposed in a common horizontal plane (FIG. 6) so that their upper surfaces form a support table which is level with the upper surfaces of the feed table plates **42** and is tilted in the same direction and to the same extent as the feed table and the overlying mandrel **75**. It will be noted that the clamp plates **82, 83**, and **84** are of uniform widths which will be sufficient to form three side walls of the square tube to be formed by bending the sheet around the mandrel **75**. The plate **83** is directly below the mandrel and will subsequently engage the stock sheet S to hold it against the bottom side of the mandrel. The sections **82** and **84** will swing upwardly around the opposed sides of the mandrel and the sections **81** and **85** will swing inwardly and overlap the top surface of the mandrel to form the top surface of the tube T, the final position of the clamp being shown in FIG. 8. Because at this time the plate **85** overlaps a seam formed on the top surface of the formed tube T, it is provided with a recessed surface **87** (FIGS. 5 and 6) at its outer extremity.

The central or bottom plate **83** is supported for limited vertical movement toward and from the lower side of the mandrel **75** as shown in FIGS. 5 and 6. It is carried by two pairs of laterally swingable supporting links **88** so that a link is located adjacent each corner of the plate. The upper end of each link is pivoted at **89** to the lower side of the plate **83** and the lower end of each link is pivoted at **90** to a transverse support bar **91** which extends between and is supported by the main frame angles **65**. Each forward and rearward pair of links is provided with a connecting link **92** spaced below the upper ends of the links, which support a longitudinally extending connecting bar **93** therebetween. Intermediate its ends this bar is connected by the pivot connection **94** to the outer end of the piston rod of the fluid-actuated double-acting cylinder and piston unit **95**. The cylinder of this unit **95** is pivoted at **96** to the upper and inner end of a bracket **97** which is rigidly supported on the outer frame angle **65**.

In stock-receiving position, as indicated by broken lines in FIG. 6, the links **88** are swung laterally to the left so that the clamp plates are at a level spaced below the mandrel **75** sufficiently to permit the stock sheet S to move therebetween. This is the condition when the cylinder and piston unit **95** is extended. However, when the unit **95** is retracted, the links **88** will swing laterally to the right lifting the clamp plates and causing the plate **83** to clamp the sheet stock against the bottom of the mandrel. This movement will also center the clamp and especially the plate **83** laterally relative to the mandrel **75**.

For folding the clamp plates **81, 82, 83, 84**, and **85** around the mandrel **75** after the plate **83** has been moved upwardly to clamp the stock sheet thereto, a suitable linkage arrangement is illustrated in FIGS. 3, 7 and 8. The linkage is located at each end of the set of clamp plates and will first be described in the unfolded condition of the plates, as shown in FIGS. 5 and 7. The linkage at each end comprises two sets of slightly different links on opposite sides of a centrally located fluid-actuated cylinder and piston unit **100**, the cylinder of which is rigidly supported on the lower surface of the central clamp plate **83** in depending relationship thereto. The set of links to the left comprises a toggle link pair with a longer link **101** pivotally connected at its one end at **102** to the outer or lower end of the piston rod of the unit **100** and with its other end pivoted at **103** to the outer or lower end of the shorter toggle link **104** which, in turn, is pivoted at **105** at its inner or upper end to the plate **83** at the left side of the cylinder. Connected to the toggle linkage at the common pivot **103** is a link **106** which has its outer or lower end pivoted at **107** to the bell crank link **108**. The link **108** is pivoted at its other end at **109** to the clamp plate **81**. A connector link **110** is pivoted at its lower end at the comon pivot **107** and at its upper end at **111** to the intermediate clamp plate **82**. The set of links to the right of the cylinder and piston unit **100** is similar to the set described in that it has the similarly arranged toggle links **112** and **113**, a long link **114** like the link **106**, a connector link **115** like the link **110** and connected to the other intermediate clamp plate **84**, and a link **116** connected to the outer clamp plate **85**. However, it will be noted that the link **116** is a straight link as compared to the angled or bell crank link **108** connected to the opposite outermost clamp plate **81**. Actuation of the linkage will cause the plates **82** and **84** to fold upwardly against the sides of the mandrel, and due to the difference in linkage at the two sides, will cause the plate **81** to first swing inwardly and then, after a short interval, the plate **85** to swing inwardly to the positions shown in FIG. 8.

The cylinder and piston units **100** at opposite ends of the clamp will be controlled simultaneously by a single electromagnetic valve and when the units are extended, the clamp plates are unfolded as indicated in FIGS. 3, 5 and 7. However, when the cylinders **100** are retracted, the clamp plates are folded upwardly around the mandrel as shown in FIG. 8. The two cylinder and piston units **100** are activated to retract and fold the clamp plates upwardly and inwardly by means of a limit switch LS**120** which may be engaged by one of the links **88** when the stock clamp is moved upwardly to clamp the stock sheet against the mandrel as shown in full lines in FIG. 6.

Outwardly of the unfolded stock clamp plates and carried along that side of the main frame **35** for lateral reciprocation is an elongated glue-applying head **125**. This head may be used to apply glue, such as hot glue supplied through a line **126** (FIG. 5), to the outermost edge of the sheet stock longitudinally along an area adjacent the edge which is to overlap the opposite edge of the sheet when it is folded around the mandrel to the position shown in FIG. 8. This head will function if pressure-sensitive adhesive is not used on the stock sheet and has not been previously applied thereto. This head **125** will be supported for movement from a position outside the frame **35** (FIG. 3) to a position within the frame and over the edge of the sheet clamped to the mandrel **75** (FIG. 7) by means of a fluid-actuated cylinder and piston

unit **130** connected thereto midway of the ends thereof. This unit **130** is carried by a ragid bracket **131** which extends upwardly and outwardly from the adjacent frame angle **65** which carries it. The head **125** may be controlled by means of an electromagnetic valve which is actuated by the switch **LS120**. The head **125** will apply the adhesive to the sheet S before the clamp is actuated to fold it and will move out of interfering position before the clamp plates are swung upwardly. The stock clamp later will be unfolded from the condition of FIG. 8 to the condition of FIG. 7, leaving the formed tube T on the mandrel **75**.

For moving the formed tube along the mandrel at the will of the operator a pusher unit of the type shown in FIGS. 1, 2 and 20 is used. It comprises a pusher carriage **136** which is mounted on a screw **137** for movement therealong upon rotation of the screw. The screw is supported at a level above the mandrel **75** parallel with its axis and with the screw axis in the same vertical longitudinal plane as the screw axis. The carriage is provided with a depending yoke-supporting arm **138** which carries at its lower end a yoke **140** that straddles the mandrel **75**. This arm **138** is provided with an adjustable joint **139** so that the yoke can be adjusted vertically in accordance with the vertical adjustment of the mandrel previously described. The yoke **140** snugly embraces the sides and top surfaces of the mandrel and is located behind the stock sheet, as shown by the broken lines in FIG. 1, as the sheet is formed into the tube and when the tube is completed, can be moved into contact with the trailing end of the tube, as shown in FIG. 20, to slide it along the mandrel. The final position of the pusher yoke **140** is shown by the full lines in FIG. 1.

The screw **137** is supported for rotation in an axially fixed position by the bearing units **141** and **142** carried by the upper sides of the respective transverse plate frames **66** and **67**. The screw is rotated at the will of the operator by means of an electric variable speed drive motor **143** having a reversing contactor (FIG. 35) and speed control and under the control of a manual feed switch **144** disposed in a convenient location at the front or unloading end of the machine. The screw is reversed by the carriage **136** striking and actuating a limit switch **LS145** at its forward position to return the carriage to its original starting or rear position where it will strike the limit switch **LS146**, which controls the actuating valve of the cylinder and piston unit **60** to cause a sheet to be lifted from the tray **40** and deposited ahead of the stock pusher bar **43**.

To further strengthen the screw support structure, inverted U-shaped braces **147** are connected to the respective plates **66** and **67** at their opposed downturned ends. It will be noted that these braces are spaced apart laterally in parallel relationship (FIG. 2) and are in a common plane parallel to the axis of screw **137**. They provide a support for the inner end of the horizontal support bar **56** which extends over these braces and is rigidly secured thereto. It will be noted that the bars **147** also support a transverse bar **148** which carries the depending lug **58** that supports the cylinder of the unit **60**, this bar being disposed in contact with and fixed to the lower surfaces thereof as shown in FIG. 3. The bar **148** also supports a limit switch **LS136***a* in association with the screw **137**.

Additional support is provided for the mandrel **75** at a point substantially outwardly or forwardly of its inner supported end and this support is such that it will not interfere with the advance, by the pusher **140**, of the formed tube T along the mandrel. This means comprises a pressure roller means **150** for engaging the mandrel supported tube on all four surfaces and this means is located on the forward side of and supported by the plate frame **67** as shown in FIGS. 1, 2 and 9. It comprises a pair of vertically disposed pressure rollers **151** which engage the formed tube opposite side faces and a pair of horizontally disposed pressure rollers **152** which engage the respective top and bottom faces of the tube. In order to obtain the proper spacing of each roller relative to the associated mandrel surface, which would be determined by the thickness of the sheet stock material, the axis of each roller is adjustable to different positions spaced outwardly of that surface. For this purpose the non-rotatable spindle or axle **153** for each roller is carried by adjustable brackets at its opposed ends which are bolted to the plate **67**. It will be noted from FIG. 9 that the bolt holes **154** in the plate **67** for receiving the clamping bolts are arranged in horizontal and vertical sets for the necessary horizontal adjustment of the respective vertical rollers **151** and the necessary vertical adjustment of the respective horizontal rollers **152**. It will be apparent that these rollers will brace the leading or free portion of the mandrel from all directions as the tube T is pushed therealong.

Located along the mandrel beyond the support roller unit **150** is a tape-applying unit **155** which is supported by the main frame **35**. This unit is shown best in FIGS. 1 and 10 to 12, inclusive. It is supported by a transverse bar **156** which is carried by the angles **65**. In its general construction it is similar to the stock clamp **80** previously described except that its pivoted clamp plate sections **81***a*, **82***a*, **83***a*, **84***a*, and **85***a* are narrow longitudinally to correspond substantially to the width of the tape to be used. This tape is adapted to connect the trailing end of a previously formed tube T, which has been advanced along the mandrel **75**, to the leading end of a newly-formed tube T so that there is no wastage of any length of the tube as will appear more clearly later. The section **83***a* is mounted for vertical movement by means of the two depending pins **157** which are vertically slidable in upright guide sleeves **158** carried by the bar **158***a*. Normally, the lower ends of the pins **157** engage the bar **156** to support it slightly below the tube T carried by the mandrel. At this time, the clamp sections **81***a*, **82***a*, **83***a*, **84***a*, and **85***a* are extended in a horizontal flat plane to receive a strip of adhesive tape A which will lie flat thereon with its adhesive side uppermost. This strip will be supplied by means of a tape dispensing unit **159** of a common type which will be controlled by a double-acting fluid-actuated cylinder and piston unit **160** carried thereby. The unit **159** is carried by a bracket **161** which is rigidly supported on the adjacent angle **65** in alignment with the bar **156**. When the tape unit **159** is actuated by means of inward swinging of its lever **159***a*, it will serve to eject therefrom a strip of tape and shoot it across the horizontally disposed clamp and pressure sections beneath the tube T and will also sever the predetermined length of strip from the roll. If the tape is the kind which must be moistened, the unit **159** will be equipped with wetting means **162**. At this time, the joint between the adjacent tubes T will be over the clamp section **83***a*. A limit switch **LS1** is engaged by the lever **159***a* when it returns to its original outer position and a limit switch **LS2** is engaged by the lever when it swings to its innermost actuating position.

The clamp sections of the unit **155** are folded upwardly around the tube T on the mandrel by means of a fluid-actuated cylinder and piston unit **165**. The cylinder of this unit is rigidly carried by and depends from the bar **158***a*. Linkage identical with the linkage at each end of the stock clamp **80** is provided between the end of the piston rod of the unit **165** and the various clamp sections. This linkage will serve to swing upwardly around the tubes T on the mandrel after the section **83***a* has moved upwardly to clamp the tape thereto, the sections **81***a* and **82***a* at one side and the sections **83***a* and **84***a* at the other side. Finally, the sections **81***a* and **85***a* will be swung inwardly over the mandrel, as shown in FIG. 11, with the section **81***a* first swinging inwardly and then the section **85***a* swinging inwardly to overlap the ends of the tape. It will be noted in FIG. 10 that the strip of tape is larger than the extended sections of the clamp **155** having one end flush with the adjacent end of the section **85***a* and the other end extending beyond the adjacent end of the section **81***a* to obtain the desired overlap. Both sections **81***a* and **85***a* will be recessed as indicated at **166** to fit over the seam of the tubes and it will be noted from

FIG. 11 that the inner edges of the sections **81***a* and **85***a* almost meet. Operation of the unit **165** will, therefore, wrap the strip of tape A about the joint between the tubes T and press it against the tubes to cause it to adhere thereto. Initial actuation of the unit **165** will also move the clamp section **83***a* upwardly to clamp the plate against the bottom side of the mandrel **75**. A limit switch LS3 is located so that it will be engaged by the linkage of the unit **155**. A limit switch LS4 is also supported in position to be engaged by the linkage of the unit **155**.

For scoring and cutting the tube T to form a box, with top and bottom cover flaps, from a predetermined length of tube T at the leading end thereof, are the cutter and scorer heads **171** and **172**, located adjacent the free forward or outer end of the mandrel **75** for acting transversely of the axis of the mandrel **75** to score and cut the tube and a cutter head **173** within the forward end of the mandrel **75** for longitudinally slitting the tube at its four corners. The locations of these various cutter heads are illustrated diagrammatically in FIG. 1. The forwardmost transverse cutter and scorer head **172** is located in substantial alignment with the forward end of the mandrel **75** and is carried by the transverse frame plate **69**. The other transverse head **171** is carried by the transverse frame plate **68** and is located a distance one-half the width of the tube T to the rear of the other head **172**. The head **173** is located in its rearwardmost position within and at the forward end of the hollow mandrel **75**.

The head **171** is shown best in FIGS. 13 to 16 and, as indicated, is carried by the plate **68**. This head is adapted to slit and score the tube T as well as score it at its opposite sides to form the cover flaps at those sides. It includes the four knives **175** which are mounted adjacent the four corners of an expansible and contractible square frame which surrounds the mandrel and which is normally expanded with its side bars spaced from corresponding surfaces of the mandrel. The knives are arranged in two opposed pairs, the knives of which are carried for simultaneous vertical movement toward and from each other on the vertically disposed side guide bars **176** and project inwardly therefrom. Each knife is rigidly carried by a slide block **177** which is mounted for vertical sliding movement in a slide way **178** formed in one face of the cooperating vertical bar **176**. Each slide block **177** is provided with an actuating pin **179** which extends outwardly through a horizontal slot **180** of the adjacent horizontal bar **181**. The ends of the horizontal bars **181** overlap the adjacent ends of the vertical bar **176**. The inner edge of each bar **181** has formed thereon a sharp scoring shoulder **182** which extends continuously therealong. The opposed bars **181** are mounted for vertical movement toward and from each other by means of the oppositely extending guide arms **183** which are rigidly connected at their inner ends to the respective bars **181** and the outer ends of which are slidably mounted on vertical guides **184** on one face of the plate frame **68**. At the opposite face of the plate, linkage is provided for moving the bars **181** simultaneously vertically and causes the guide blocks **177** to travel vertically in the slide ways **178**. This linkage comprises toggle links **185**, having their common pivot at **186** and connected at their outer ends at **187** to the links **188**. These links have their outer ends pivoted at **189** for vertical swinging movement and their inner ends pivotally connected by a pin and slot connection **191** to the adjacent bars **181** for imparting vertical movement thereto. The linkage is actuated by a fluid-actuated cylinder and piston unit **190**, the piston rod of which is connected to the toggle links at **186** and the cylinder of which is carried by a lateral extension of the frame **68**.

The cylinder and piston unit **190** produces vertical movement of the pair of knives **175** at each side toward and from each other simultaneously. For producing horizontal movement of the knives, a similar cylinder and piston unit **195** is provided at the bottom of the frame **68**. The piston of this unit is connected to identical linkage which includes the links **188***a* mounted for horizontal swinging movement and connected to the bars **176** at **191***a*. The cylinder and piston units **190** and **195** are actuated manually at the will of the operator. It will be apparent from FIG. 14 that when they are operated, the knife-carrying frame is contracted around the tube T on the mandrel to score both the top and bottom surfaces thereof. It will be noted (FIG. 14) that the knives of each pair will move into contact in substantially V-form with their sharp edges directed inwardly. The severing action will occur as the knives **175** move vertically apart which will be more readily apparent from subsequent reference to FIG. 19 which shows the head **172**. Supported for actuation by the unit **195** are the limit switches LS5 and LS6 and for actuation by the unit **190**, through the guide bars **83**, is the limit switch LS7.

The head **172** is practically identical with the head **171** but is adapted to transversely slit the top and bottom surfaces of the tube T and to vertically score the side surfaces thereof. The expansible and retractable frame structure is identical except that the bars **176***a* are at top and bottom and the bars **181***a* are at the sides. The actuation of the frame to contract and expand it is by means of the respective cylinder and piston units **190***a* and **195***a*. The simultaneous actuation of these units is manually controllable at the will of the operator. The expanded condition of the frame of this head **172** is shown in FIG. 17 and its contracted condition, after completion of the transverse slitting of the top and bottom sides of the tube and the scoring of the opposed vertical sides thereof is illustrated in FIG. 19. As indicated, all the parts of this head are carried by the transversely disposed plate frame **69**. Supported for actuation by the unit **195***a* are the limit switches LS8 and LS9 and for actuation by the unit **190***a* is the limit switch LS10. In FIG. 19, the action of the head **172** is illustrated as the frame expands and the knives **175***a* move outwardly relative to the tube T to produce the lateral slits in the top and bottom sides thereof. This same action would occur in connection with the head **171** but the knives would be moving vertically in their outward slitting movement. In the expansion of each of the frames to produce the slitting action, the cylinder **190** and **190***a* will act shortly before the associated cylinders **195** and **195***a* so that the knives will retract transversely across the associated walls of the tube T before they are moved outwardly away from the respective walls. Thus, as shown in FIG. 19, the translatory slitting movement of the knives has been completed before they have been moved outwardly in directions perpendicular to their slitting movement. Adjacent the forward end of the mandrel **75**, where the knives **175** of the head **171** will operate, the mandrel **75** is provided with apertures **194** in its sides (FIG. 14) to permit the sharp corners of the respective knives to completely pierce and extend through the wall of the mandrel supported tube T. These will be located one-half the width of the tube T behind the front end of the mandrel. The knives **175***a* of the front head will operate just ahead of the front end of the mandrel and will not contact therewith.

The head **173** for producing the longitudinal slits at the leading end of the tube T beyond the corresponding end of the mandrel **75** is illustrated in FIGS. 20 to 24. It comprises the four knives **196** which are directed outwardly at suitable angles through correspondingly laterally and wider angled longitudinally extending slots **197** (FIG. 24) formed in the forward or outer end of the mandrel. Each knife **196** is rigidly carried by the outer end of an arm **198**, at its outer side, which has its inward end hinged at **199** (FIGS. 20–22), for inward and outward swinging relative to the axis of the mandrel, to the forward end of a longitudinal bar **201** which is rigidly carried by and projects forwardly from a guide sleeve **200**. This guide sleeve is complemental to and is slidably mounted for axial movement within the mandrel **75**.

Centered within the mandrel **75** is a push rod **202** which

has a box pusher head **203** on its outer or forward end in the form of a flanged plate of such area that it can be withdrawn into the forward open end of the mandrel as shown in FIG. 21. The rod **202** is reciprocated axially of the mandrel by means of a fluid-actuated cylinder and piston unit **205** which is carried by an upstanding bracket **204** from the rear end of the main frame as shown in FIG. 1. The unit **205** is actuated at the will of the operator.

The swinging movement of the knives **196** is produced by means of the toggle linkage which comprises a pair of inner links **206** and a pair of outer links **207**. The outer ends of these links are pivoted to the respective hinged arms **198** and the inner ends thereof are pivoted to a central collar **208** axially slidable on the rod **202** between a fixed rear stop **209** and a fixed forward stop **210**. A compression spring **211** is interposed between the stop **209** and the collar **208**.

As the rod **202** is pulled rearwardly by retraction of the cylinder and piston unit **205**, assuming it is initially in the position shown in FIG. 20, the stop **210** engages the collar **208** and pushes on the links **206** and **207** to tend to expand them and also to exert a rearward force on the sleeve **200** causing it to slide rearwardly in the mandrel **75**. The spring **211** is expanded at this time. Rearward pull on the rod **202** also retracts the pusher head **203**, within the outer or forward end of the mandrel, and swings the knife carrying arms **198** outwardly to cause the knives **196** to move outwardly into the slots **197** and rearwardly therein slitting the leading end of the tube T thereon at its four corners, as further indicated in FIG. 21. Continued rearward movement of the rod **202** causes the knives to engage the inner ends of the slots **197** and to be swung inwardly until they pass rearwardly completely within the mandrel. If the unit **205** is now controlled to push the rod **202** outwardly, as shown in FIG. 22, the links **207** will be retracted to pull the knives **196** inwardly at the same time they are moved forwardly, the force for this being exerted through the expanded spring **211**. The knives will move forwardly until they are positioned substantially flush with the forward end of the mandrel **75**. The pusher head **203** moves to the outer end of the mandrel along with the knives and continued push on the rod **202** causes the spring **211** to be compressed by the rod sliding through the collar **208**. This causes the head to advance relative to the knives to push the severed box from the leading end of the mandrel as will later appear.

A table **210** is provided for receiving the loaded box when it is severed from the rest of the tube. As shown in FIGS. 1 and 1*a*, this table is inclined rearwardly and is pivoted at **211** to supports **212** for swinging forwardly and downwardly under hand pressure so that the box C will slide off the table onto the lower fixed shelf **38**. The table **210** is normally held in the tilted position shown in FIGS. 1 and 1*a* by a tension spring unit **213** with associated stop.

The machine is preferably hydraulically operated and the various cylinder and piston units previously referred to are connected in a hydraulic circuit along with various control valves as indicated in FIGS. 36 and 36*a*. The electric control circuit associated with the hydraulic circuit is illustrated in FIGS. 35 and 35*a* and includes the various switches mentioned above.

OPERATION

General

The general operation of the entire machine in the packaging procedure will now be described with reference to FIGS. 25 to 34 and since the capacity of the machine illustrated is two tubes T of predetermined length and the same procedure must be followed in forming both tubes, it will be assumed that the first tube is in the machine and in its forwardmost position and the forming of the second tube is to be started. This forming operation is started by the tube pusher carriage **136** being returned to its rearwardmost position at the will of the operator. This automatically causes a sheet to be lifted from the tray **40** and deposited ahead of the stock pusher bar **43**. As indicated previously, this sheet may be of the type shown in FIG. 25 provided with longitudinal score lines L. As the sheet reaches a position ahead of pusher bar **43**, the vacuum is released from the cups **52** and the pusher bar **43** pushes the sheet S onto the unfolded stock clamp and forming unit **80**. When the feed bar **43** reaches its feed limit, the movement is reversed. The flat stock S is now in a position beneath the mandrel **75** and supported by the unfolded clamp and as it reaches this position the sheet is clamped to the lower side of the mandrel. At this time, if the glue head **125** is used, it is actuated.

The folding operation is illustrated schematically in FIG. 26 and it will be understood that the folding occurs at the various scored lines L provided in the sheet S. The resulting formed tube T shown in FIG. 27 will have a girth determined by the girth of the mandrel. The length will depend on the length of the sheet S which will be predetermined for the particular machine. The sheet may have an adhesive area G at one edge as indicated in FIG. 26 or the adhesive, such as hot glue, may be applied thereto by the unit **125** of FIG. 7. When the tube T is formed by the clamp **80** folding it around the mandrel **75**, it will have the one edge overlapping the adhesive area G to provide a sealed seam O (FIG. 27).

The stock clamp **80** is held momentarily in its folded position around the mandrel **75** until the adhesive at the overlapping seam O has had sufficient time to set. Then the clamp is unfolded into flat and lowered condition to release the tube. This will now allow the formed tube T to be advanced along the mandrel **75** at the will of the operator by advancing the pusher head **140** along the mandrel **75**. The pusher head **140** bearing against the trailing end of the last formed tube T will slide it along the mandrel and its leading end will engage the trailing end of the previously formed tube T as indicated in FIG. 28. When the abutting joint of the two tubes T reaches the position of the tape-ejecting unit **159**, it is actuated automatically to eject a predetermined length of adhesive tape A on the unfolded sections of the clamp unit **155** beneath the tubes T on the mandrel at the abutting joint. As indicated in FIG. 28 this tape A will have its adhesive side upwardly. The tape clamp **155** will be folded around the abutting tube joint and cause the tape to adhere thereto. The tube sections T will then be joined by the tape A as shown in FIG. 29.

The leading tube T is brought forward until its leading edge is beyond the forward end of the mandrel **75** and the box pusher head **203** thereof as shown in FIG. 31. As indicated in this figure and FIG. 30, the leading end of the sleeve is provided with the two cover flaps F formed on the top and bottom thereof by the first cutting and scoring head **171** in a previous operation. In FIG. 30, the formation of the side cover flaps *f* at a rearwardly spaced position is also indicated but this is accomplished at a period in the operation of the machine by the heads **172** and **173**. The tube T is advanced off the mandrel at the will of the operator to an extent desired, depending on the merchandise which is being located in the hollow forwardly opening leading end thereof, as shown in FIG. 31 in which the merchandise is indicated as an article A' of a certain length. Before the article is loaded in the open end of the tube, an end liner square board B is inserted against the head **203** and after the article A' is loaded therein, another liner B is inserted as shown in FIG. 32 and this, along with the forwardmost cover flaps, will form the bottom closure for the box. The required merchandise or material may be successively pushed into the open leading end of the tube T against the liner B on the head **203** and the operator may control the tube pusher head **140** to move the tube farther forwardly over the man-

drel, increasing the size of the receiving container space in the tube to whatever length is needed to pack the particular merchandise. When all the merchandise to be packed in the one box is inserted in the container tube, then the operator operates the necessary controls to first cause the head **173** to operate to make the necessary longitudinal slits at the four corners and then the head **172** to operate the necessary transverse cuts to sever the box C of selected length from the leading end of the tube with the flaps *f* being formed on the trailing or rear end thereof and wtth the flaps *f* being formed on the leading end of the rest of the tube. At this time the severed box will be resting on the table **211** and the bottom flaps F can be folded in and sealed by tape D. The table **211** may be tilted by hand against the force of tension spring **213** and the box C slid off the table and down onto the shelf **38** where it will be upright with the flaps *f* extending upwardly. These flaps are then folded downwardly and secured by means of the tape strip E which will extend crosswise relative to the tape D, since the pair of flaps F are formed on two opposed sides of the box and the pair of flaps *f* are formed on the other two opposed sides. It will be apparent that there is no wastage of the tube T as the exact length of tube is selected by the operator to receive the merchandise before the tube is severed to provide the final box of the necessary volumetric capacity. Also, since successive sections of tube T are joined together in the machine, no short lengths of the tube are discarded.

The general operation discussed above is accomplished with the hydraulic system of FIGS. 36 and 36*a* and the electrical control system of FIGS. 35 and 35*a* which will now be referred to in detail in describing the control of the various operations.

Tube forming

At the time the tube feed yoke **140** approaches the forwardmost feed position, under control of the operator-actuated feed switch **144**, carriage **136** actuated limit switch **LS145** and also closed a second normally open contact **LS145–2**. Contact **LS145–2** is connected in series with a relay coil **1CRTD** which is energized with the closing of contact **LS145–2**. Relay **1CRTD** is of a type which includes a first normally open contact **1CR1** which is instantaneously closed and a normally open contact **1TD1** which closes a predetermined time after energization of the relay coil. Contact **1CR1** is connected in series with a normally closed contact **LS62–1** of limit switch **LS62** with these two series connected contacts connected in shunt relationship across contact **LS145–2** and forming a holding circuit for relay coil **1CRTD**.

The electrical actuating solenoid **AV1–1** of a spring-biased four-way valve **AV1** is connected in shunt relationship with relay coil **1CRTD** for simultaneous energization. Valve **AV1** is interposed in the vacuum conduit connected with the suction cups **52** and normally opens the cups to the atmosphere while blocking the vacuum line. Energization of solenoid **AV1–1** actuates the valve to connect the suction cups **52** to the vacuum source through the valve **AV1** and thereby enables the cups to provide the necessary lifting force.

A series circuit comprising the relay contacts **1TD1** and an electrical actuating solenoid of a four-way valve **AV2** is also connected in series with the relay holding circuit comprising contacts **1CR1** and **LS62–1**. A predetermined time after relay coil **1CRTD** is energized, contact **1TD1** will close resulting in energization of solenoid **AV2–1**. This delay in energization of solenoid **AV2–1** assures that the suction cups **52** will be properly evacuated to provide the necessary lifting force before the lifting transfer mechanism will be operated through pressurization of cylinder **60**. Valve **AV2** is connected in circuit with cylinder **60** to pressurize the cylinder for extension of its piston rod when solenoid **AV2–1** is energized. Valve **AV2** is of the double electric solenoid type with the spool remaining in the last attained position due to air pressure in the system.

When the piston rod of cylinder **60** has been fully extended in completing transfer of a tube blank sheet S onto the table **42**, limit switch **LS62** will have been actuated resulting in opening of normally closed contact **LS62–1**. Opening of contact **LS62–1** deenergizes solenoids **AV1–1** and **AV2–1** with valve **AV1** returning to its normal spring-biased position which connects the suction cups **52** to the atmosphere to release the vacuum.

The blank feeding operation is suspended at this point unless or until the carriage **136** has returned to its rearmost position and has actuated limit switch **LS146**. Actuation of limit switch **LS146** closes a normally open contact **LS146–2** which is connected in series with valve solenoid **AV2–2** and thus controls energization of solenoid **AV2–2**. A normally open contact **LS62–2** also series connected with solenoid **AV2–2** prevents energization of this solenoid even though contact **LS146–2** may be closed unless the transfer of a blank sheet to the table **42** has been completed. As previously described, completion of this portion of the blank sheet transfer results in actuation of limit switch **LS62** thus opening contact **LS62–1** and closing contact **LS62–2**. Closing of contacts **LS146–2** and **LS62–2** in proper operating sequence results in energization of solenoid **AV2–2** which actuates valve **AV2** to pressurize cylinder **60** to retract its piston rod and return the transfer mechanism to its original starting position. As soon as the piston rod of cylinder **60** begins to retract, limit switch **LS62** will be actuated resulting in opening of contacts **LS62–2** and **LS62–3** and closing of contact **LS62–1** and deenergize solenoid **AV2–2**.

Also connected in series with contact **LS146–2** is a series circuit comprising the normally open contact **LS62–3** of the limit switch **LS62** and the operating coil of a relay **2CR**. The coil of relay **2CR** is energized simultaneously with valve solenoid **AV2–2** as a result of concurrent actuation of limit switches **LS146** and **LS62** but will not be deenergized upon opening of contact **LS62–3** as relay coil **2CR** is connected in series with a holding circuit comprising a normally open relay contact **2CR1** and a normally closed limit switch contact **LS64–1**. A series connected normally open limit switch contact **LS63–1** and valve solenoid **AV3–1** are also connected in series with the relay holding circuit but the valve solenoid will not be energized until the piston rod of cylinder **60** has fully retracted and actuated limit switch **LS63** to close its normally open contact. Contact **LS63–1** is held closed when piston rod is retracted and opened during the previous operations when the piston rod was extended.

Energization of valve solenoid **AV3–1** actuates valve **AV3** to pressurize cylinder **45** to extend its piston rod and transfer a blank sheet S from the table **42** onto the folding clamp. At the completion of this transfer operation, the member **44** on the piston rod of cylinder **45** actuates limit switch **LS64** resulting in opening of contact **LS64–1** and closing of a contact **LS64–2**. Opening of contact **LS64–1** opens the relay holding circuit resulting in deenergization of relay **2CR** and valve solenoid **AV3–1**. Valve **AV3** will then return to its normal spring-biased position causing the piston rod of cylinder **45** to retract and return the pusher bar **43** to a position at the left of FIG. 4.

Closing of contact **LS64–2** initiates the tube forming operation through energization of the series connected operating coil of a relay **3CR**. Since contact **LS64–2** is only momentarily closed, a holding circuit comprising series connected normally open relay contact **3CR1** and normally closed contact **3TD1** of a time delay **3TD** is also connected in series with the relay coil **3CR**. A valve solenoid **AV4–1** of valve **AV4** is also connected in series with this holding circuit and will be energized simultaneously to actuate the spring-biased, four-way, electrical solenoid operated valve **AV4** in pressurization of cylinder **95** to

retract its piston rod and clamp the tube sheet S to the mandrel **75**.

Retraction of the piston rod of cylinder **95** in performing this clamping operation actuates limit switch LS**120** resulting in closing of contact LS**120–1** when the piston rod is fully retracted and energization of the operating coil of a time delay relay 2TD which is series connected with contact LS**120–1** and the relay holding circuit comprising contacts 3CR1 and 3TD1. Connected in series with the contact LS**120–1** are the series connected normally closed relay contact 2TD1 and valve solenoid AV5–1. If the glue head unit **125** is to be used, the manual switch **125***a* will be closed. Closing of contact LS**120–1** results in energization of valve solenoid AV5–1 which actuates the spring-biased, electric solenoid operated, four-way valve AV4 to pressurize cylinder **130** to extend its piston rod and project the glue head **125** over the marginal edge portion of the tube sheet S. A glue feed mechanism associated with the head **125** is also connected in series with contacts 2TD1 and is energized simultaneously with valve solenoid AV5–1 and functions to eject a predetermined quantity of glue onto the marginal edge portion of the tube sheet S.

After expiration of a predetermined time interval as determined by relay 2TD, contacts 2TD1 open resulting in deenergization of valve solenoid AV5–1 and the glue feed mechanism. Deenergization of valve solenoid AV5–1 permits valve AV5 to return to its normal spring-biased position causing cylinder **130** to retract its piston rod and return the glue head to an inoperative position.

Concurrently with opening of contacts 2TD1, a set of normally open contacts 2TD2 connected in series with the operating coil of a time delay relay 3TD and the contact LS**120–1** are closed resulting in energization of the relay 3TD. Relay 3TD controls the contact 3TD1 connected in the holding circuit of relay 3CR. Contacts LS**120–1**, 2TD2 are also connected in series with valve solenoid AV6–1 which operates a spring-biased, four-way valve. With contacts LS**120–1** and 2TD2 being closed at this point, solenoid AV6–1 is energized and actuates valve AV6 to pressurize cylinders **100** to retract its piston rod and operates the mechanism to fold the tube sheet S around the mandrel **75**. After a time interval determined by relay 3TD of sufficient duration to assure gluing of the tube, relay 3TD functions to open contact 3TD1 in the relay holding circuit thus deenergizing relay 3CR and opening contact 3CR1. This results in deenergization of timer relays 2TD and 3TD and valve solenoids AV4–1 and AV6–1, permitting these valves to return to their normal spring-biased positions causing extension of the piston rods of the units **100** and release of the tube forming clamps from about the mandrel.

This concludes a tube forming operation and the operator may again operate the tube feed switch **144** as desired to advance the formed tube T.

Tube taping

When a newly formed tube has been advanced by the operator approximately one-half its length, the carriage **136** engages and actuates the limit switch **136***a* and closes its contact LS**136***a***–1**. Contact LS**136***a***–1** is connected in series with a signal light L which is located for visibility from the front of the machine and is energized at this point and indicates to the operator that the tube has advanced to the taping position and the operator releases the feed switch **144** stopping further forward movement of the tube. Subsequently, the operator actuates the normally open push button switch S1, which may be located at the front of the machine convenient to the operator, to initite the taping operation.

Closing of switch S1 energizes a series connected valve solenoid AV7–1 through the normally open limit switch contact LS1–1 which is held closed at this time and the normally closed relay contacts 4CR1 and 5CR1. Energization of valve solenoid AV7–1 actuates valve AV7 which is an electric solenoid operated, two position four-way valve to pressurize cylinder **160** to operate the tape dispenser **159** in dispensing a predetermined length of tape onto the tape clamp **155**. As indicated, limit switch LS1 is positioned on the apparatus to be actuated by cylinder **160** when its piston rod is fully retracted and, when thus actuated, contact LS1–1 will be held closed along with another normally open contact LS1–3 while a third normally closed contact LS1–2 will be held open. Contact LS1–2 is also connected in series with valve solenoid AV7–1 and the contacts 4CR1 and 5CR1 and forms a holding circuit to assure operation of valve AV7, even though switch S1 may only be momentarily actuated by the operator. Contact LS1–2 closes as soon as the piston rod of cylinder **160** begins to extend while contacts LS1–1 and LS1–3 will be opened.

When the piston rod of cylinder **160** has fully extended, a limit switch LS2 is engaged and actuated by the mechanism to close a normally open contact LS2–1. Contact LS2–1 is connected in series with a valve solenoid AV7–2 which will be energized at this point and actuate valve AV7 to pressurize cylinder **160** and retract its piston rod to complete a tape dispensing operation. Concurrently with energization of solenoid AV7–2, the operating coil of a relay 1CR also connected in series with contact LS2–1 will be energized to open its associated contact 1CR1 and deenergize solenoid AV7–1. Relay 4CR also closes a normally open contact 4CR2 which is series connected with a normally closed limit switch contact LS3–1 and forms a holding circuit for the solenoid AV7–2 and relay 4CR.

Relay 4CR and solenoid AV7–2 remain energized while the piston rod of cylinder **160** is retracted and when the piston rod is fully retracted, limit switch LS1 will be actuated resulting in closing of contact LS1–3 and energization of valve solenoid AV8–1 which is series connected to the relay holding circuit. Energization of valve solenoid AV8–1 actuates valve AV8 to pressurize cylinder **165** to extend its piston rod and operate the tape clamp mechanism **155** in applying the tape strip about the abutting ends of the adjoining tubes T.

Retraction of the piston rod of cylinder **165** results in actuation of limit switch LS3 to open contact LS3–1 and close contact LS3–2. Opening of contact LS3–1 opens the holding circuit for relay 1CR resulting in opening of contact 1CR2 and deenergization of solenoids AV7–2 and AV8–1. Closing of contact LS3–2 which is connected in series with the operating coil of a relay 5CRTD results in energization of this relay to open its normally closed contact 5CR1 and close normally open contact 5CR2. Contact 5CR2 is connected in series with a normally closed limit switch contact LS4–1 and forms a holding circuit for relay 5CRTD. Contact LS4–1 is held open when the piston rod of cylinder **165** is extended and closes as soon as this piston rod begins to retract.

After expiration of a time interval determined by the time delay function of relay 5CRTD, a normally open contact 2TD1 closes with the time delay being sufficient to assure proper adhesion of the tape to the tubes. Contact 2TD1 is connected in series with a valve solenoid AV8–2 and the relay holding circuit formed by contacts LS4–1 and 5CR2 resulting in energization of solenoid AV8–2 and actuation of valve AV8 to extend the piston rod of cylinder **165** in disengaging the tape clamp from around the tubes. When the piston rod has fully extended, contact LS4–1 will be opened and deenergize relay 2CRTD thus opening contacts 5CR; 5CR2 and 5TD1. This completes the tape applying operation and the operator may again operate the feed switch **144** to continue feeding the tube.

Tube flap cutting and scoring

Manual switches S2 and S3 may be located convenient to the operator for simultaneous operation. Closing of

manual switch S2 energizes solenoid AV9–1 through the normally closed contacts LS6–1 and LS7–1 of the respective limit switches. Energization of solenoid AV9–1 actuates valve AV–9 to cause retraction of the piston rod of cylinder 190. Retraction of piston rod operates the lever system to displace the knives 175 along a vertical path to the center of the apparatus and concurrently displaces the guides 183. At the initial movement of guide 183, limit switch LS5 is actuated to close its normally open contacts LS5–1 and LS5–2 with contact LS5–1 completing a holding circuit through normally closed contact LS6–2 for continued energization of solenoid AV9–1 and thus permit release of the manual switch S2.

At the completion of the retraction stroke of the piston rod of cylinder 190, the vertical guides 183 will have been displaced to a position where limit switch LS6 will have actuated resulting in opening of contact LS6–1 which will prevent subsequent closing of the manual switch S2 from having further effect on the operation. Contact LS6–2 will now be closed and energizes solenoid AV10–1 which actuates the valve AV–10 in pressurizing cylinder 195 to retract its piston rod and operate the associated lever mechanism in horizontally displacing the knife guides 183 toward the center of the apparatus.

When the knife guides 176 are displaced to the center, the guides 183 will also have been displaced to permit actuation of limit switch LS7. Actuation of limit switch LS7 results in opening of the normally closed contacts LS7–1 and LS7–2 and closing of contact LS7–3. Contact LS7–3 is connected in series with contact LS5–2 forming a holding circuit which bypasses contact LS6–2 for continued energization of solenoid AV10–1.

Opening of contact LS7–2 breaks the holding circuit for solenoid AV9–1 which is now deenergized and valve AV–9 returns to its normal position under spring bias to pressurize cylinder 190 to extend its piston rod. Extension of the piston rod operates the lever mechanism to vertically displace the knives 175 in a relatively separating movement in performance of a cutting operation. As the knives begin the cutting operation, the concurrent displacement of the vertical guides 175 actuates limit switch LS6 resulting in closing of contact LS6–1 and opening of contact LS6–2. Closing of contact LS6–1 is ineffective as contact LS7–1 was previously opened and will thus prevent subsequent actuation of the manual switch S2 from being effective in subsequently energizing solenoid AV9–1 to initiate a succeeding cycle. Opening of contact LS6–2 places control for energization of solenoid AV10–1 in the holding circuit comprising contacts LS5–2 and LS7–3.

Upon completion of the extension of the piston rod of cylinder 190, limit switch LS5 is actuated resulting in opening of contacts LS5–1 and LS5–2. Opening of contact LS5–2 breaks the holding circuit for solenoid AV10–1 which becomes deenergized and thus permitting return of valve AV–10 to its normal spring biased position. Return of valve AV–10 to its normal position results in pressurization of cylinder 195 to extend its piston rod and operate the associated lever mechanism in horizontally displacing the knife slides 176 to the outwardly separated position. Initial outward movement of the horizontal guides 183 actuates limit switch LS7 resulting in closing of contacts LS7–1 and LS7–2 and opening of contact LS7–3 to return the circuit to its initial operating position where subsequent actuation of the manual switch S2 will initiate a subsequent cyclic operation of the apparatus.

As indicated, the manual switch S3 is operated at the same time as the manual switch S2. It will control the indicated similar circuit for the knife-operating units 190*a* and 195*a* for actuating the knife-carrying head 172. This head 172 will operate exactly as the head 171 but will move the knives at right angles to the movement produced by the head 171.

Tube corner slitting

A manual switch S4 may be suitably located on the machine convenient to the operator for actuating the head 173 for producing the longitudinal slits at the four corners of the leading end of the tube T. This switch controls the valve AV13 which, in turn, controls the cylinder and piston unit 205. The valve AV13 is a spring-biased, four-way valve, which, in its normal biased position, keeps the cylinder and piston unit 205 extended. To actuate the unit 205 to pull the rod 202 rearwardly and actuate the corner slitting head 173, the manual switch S4 is closed by the operator to close the solenoid contacts AV13–1 to energize the solenoid so as to overcome the spring force and move the valve AV13 to a position for retracting the rod 202 so as to actuate the knife head 173 to slit the four corners. As soon as the switch S4 is allowed to open, the spring pressure will return the valve AV13 to its normal position so as to move the rod 202 forwardly again and push the head 203 forwardly.

Motor reversing operation

As the tube feed yoke 140 reaches its forwardmost position, element 136 actuates limit switch LS145. Actuation of limit switch LS145 closes its two normally open contacts LS145–1 and LS145–2. Contact LS145–1 is connected in series with motor contactor reversing solenoid relay coil R of the motor 143 which is energized at this time and, through operation of the associated contactor, reverses the motor to drive the tube feed mechanism to rearmost position. A holding circuit formed by a normally open relay contact R1 and series connected normally closed limit switch contact LS146–1 maintains the motor reversing contactor energized until the carriage 136 has reached the rearmost position and actuates limit switch LS146 to open contacts LS146–1. Opening of contact LS146–1 results in deenergization of relay coil R, opening of this holding circuit and return of the motor contactor to its normal forward configuration with the motor 143 off and returned to control by the manual feed switch 144.

Conclusion

It will be apparent that the above described apparatus comprises means for readily packaging merchandise or material requiring differences in volumetric spacing for packaging. The machine forms a tube into the leading end of which the merchandise can be packed as the tube is advanced at the will of the operator. The operator selects the necessary length of tube for the particular packaging job and then operates the machine to sever it from the main part of the tube. During the advance of the tube and the severing of the selected length therefrom, the necessary closure flaps are formed on the opposite ends of the severed portion. The machine is such that the final box or container is of the exact required size for the packaging job and there is no waste of material nor waste of time in selecting or forming a particular size container required for the specific packaging job.

Having thus described this invention, what is claimed is:

1. The method of packaging mechandise which comprises forming on a mandrel which has a leading end a sheet of material into an elongated hollow tube which fits around and embraces the mandrel, and has an open leading end, sliding the tube along the mandrel until its open leading end is outwardly beyond the leading end of the mandrel to provide a container portion with a hollow cavity at the open leading end of the tube ahead of the leading end of the mandrel into which the merchandise is to be packed, packing the merchandise in the cavity through the leading open end of the tube and severing the packed portion of the tube at a transverse joint at the leading end of the mandrel from the remainder of the tube on the mandrel.

2. The method of packaging merchandise according to claim 1 which comprises forming closure flaps on the adjacent respective ends of the tube and container portion as it is severed at said transverse joint.

3. The method of packaging merchandise which comprises forming on a mandrel which has a leading end a sheet of material into an elongated hollow tube which fits around and embraces the mandrel, sliding the tube along the mandrel until its leading end is outwardly beyond the leading end of the mandrel to provide a container portion with a hollow cavity at the leading end of the tube ahead of the leading end of the mandrel into which the merchandise is packed, packing the merchandise in the cavity and severing the packed portion of the tube at a transverse joint at the leading end of the mandrel from the remainder of the tube on the mandrel, forming closure flaps on the adjacent respective ends of the tube and container portion as it is severed at said transverse joint, said mandrel being of quadrangular cross-section and the tube formed thereon being of complemental cross-section, so that it has four longitudinally extending sides disposed at right angles to each other, said severing operation being such that it forms two closure flaps on two of the sides of the severed container portion which extend rearwardly from the trailing end of the container portion and two closure flaps on the leading end of the tube still supported on the mandrel which are on the other two sides of the tube and project forwardly therefrom, all the flaps being longitudinally coextensive and being separated from each other by longitudinal slits.

4. The method of claim 3 in which the tube is subjected to a scoring operation along with the severing operation to transversely score the portions of the respective flaps with their side walls so that they are hinged thereto.

5. The method of claim 4 in which the sheet is prescored to facilitate folding around the mandrel and to provide overlapping longitudinally extending seam portions which are secured together.

6. The method of claim 3 including forming on the mandrel from a second sheet of material a second tube with its leading end abutting the trailing end of said first tube, and joining the abutting ends of said tubes together for sliding as a unit along said mandrel.

7. The method of claim 6 in which an adhesive tape is wrapped transversely around said abutting ends of the tubes and is caused to adhere thereto.

8. The method of claim 3 in which the sheet is wrapped around the mandrel to form a joint with overlapping longitudinally extending seam portions secured together.

9. A machine for packaging merchandise comprising a mandrel, means for forming a sheet of material around said mandrel into a tube with its leading and trailing ends open, means for sliding the formed tube along the mandrel until its leading end is beyond the forward end of the mandrel so as to provide a forwardly opening container portion beyond the mandrel adapted to receive the merchandise, and means for severing the container portion at a transverse joint at the forward end of the mandrel from the remainder of the tube still supported on the mandrel.

10. A machine according to claim 9 including means for supporting the mandrel toward its rear end, and supporting roller means cooperating with the mandrel at a location forwardly of said first supporting means and permitting the sliding of the formed tube along said mandrel between said roller means and the mandrel.

11. A machine according to claim 10 including means for feeding the sheet into cooperation with said forming means and said mandrel.

12. A machine according to claim 10 in which said forming means comprises a forming clamp adapted to be actuated from an open position in cooperative relationship with said mandrel to a closed position where it folds the sheet around the mandrel.

13. A machine according to claim 12 including means for supporting the clamp in open flat position below the mandrel and spaced therefrom to receive and support the sheet therebetween, and means for lifting the open flat clamp to cause it to grip the sheet to the mandrel at its lower side.

14. A machine according to claim 12 in which the mandrel is of square cross-section so that it has a bottom side, two vertical sides and a top side, said clamp comprising hinged plate sections including a bottom section, and two side sections for cooperation with the corresponding sections of the mandrel, and two top plate sections hinged to the respective side plate sections and adapted to move into overlapping relationship over the top side of the mandrel, and means for moving the plate sections into closed position around the mandrel and including means for moving one of the top sections over the top side of the mandrel first and then the other top section into overlapping relationship therewith so as to form an overlapping seam of overlapping longitudinal edges of the sheet at the top side of the tube.

15. A machine according to claim 14 including an adhesive applying unit for applying adhesive to one of said overlapping edges of the sheet while it is supported by the open clamp.

16. A machine according to claim 12 in which said means for sliding the tube along the mandrel comprises a pusher head reciprocable longitudinally of the mandrel and in its advancing movement engaging the formed tube to advance it along the mandrel beyond said forming clamp, said pusher head being retractable to a position behind said clamp, to permit the feeding of a second sheet into cooperation with said clamp, said pusher head in its successive advancing movement pushing the succeeding tube into engagement with the preceding tube to provide an abutting transverse joint.

17. A machine according to claim 16 comprising a tape-applying clamp positioned along said mandrel composed of clamp sections which are hinged together for folding movement around the mandrel from an open extended position where they receive the tape in association with said mandrel.

18. A machine according to claim 17 including means for supplying a strip of tape on said tape-applying clamp when the sections thereof are in open extended position.

19. A machine according to claim 18 in which the mandrel is of square cross section so that it has a bottom side, two vertical sides and a top side, said tube-forming clamp comprising hinged plate sections including a bottom section and two side sections for cooperation with the corresponding sections of the mandrel, and two top plate sections hinged to the respective side plate sections and adapted to move into overlapping relationship over the top side of the mandrel, means for moving the plate sections into closed position around the mandrel and including means for moving one of the top sections over the top side of the mandrel first and then the other top section into overlapping relationship therewith so as to form an overlapping seam of overlapping longitudinal edges of the sheet at the top side of the tube, said tape applying clamp comprising hinged clamp sections including a bottom section and two side sections for cooperating with the corresponding sides of the tube on the mandrel and two top sections hinged to the respective side sections, and means for moving the top tape clamp sections with the tape around the abutting joint of the formed tubes into closed position and including means for moving one of the top sections over the top side first and then the other top section over the top side to overlap the ends of the tape.

20. A machine according to claim 9 in which said severing means comprises severing heads for producing transverse and longitudinal cuts in the tube to produce severing means comprises severing heads for producing coextensive closure flaps on the trailing end of the con-

tainer portion and the leading end of the tube still supported on the mandrel.

21. A machine according to claim **20** in which said mandrel is of square cross section and the forming means embraces said mandrel and forms a tube of square cross-section thereon which has four sides disposed relatively substantially at right angles, said severing means comprising a severing and scoring head for producing hinged rearwardly projecting flaps on the trailing end of two of the sides of the container portion and a second severing and scoring head for producing longitudinally coextensive forwardly projecting flaps on the other two sides of the leading end of the tube portion remaining on the mandrel, and a third severing head for producing longitudinal slits at the four corners of the tube to separate the flaps.

22. A machine according to claim **21** in which each of said severing and scoring heads comprises a frame surrounding the mandrel and being collapsible and expansible relative thereto, said frame carrying knives for producing transverse slits in two of the sides of the tube and scoring ribs for producing aligning transverse scores in the other two sides of the tube, and means for collapsing and expanding said frame.

23. A machine according to claim **22** in which the third severing head comprises four supporting arms carrying knives for movement out through the corners of the tube and longitudinally thereof to slit said corners.

24. A machine according to claim **23** including a pusher head in cooperation with said third severing head and movable forwardly reltive to said knives to push the severed container portion forwardly after it is severed from the remainder of the tube.

25. A machine for packaging merchandise according to claim **9** including a fluid-actuated sheet-feeding unit for feeding the sheet into cooperation with said mandrel and the forming means, said forming means comprising a fluid-actuated, forming clamp unit foldable around the mandrel,

said sliding means comprising an electrically-actuated pusher unit reciprocable relative to the mandrel and the forming clamp unit, said severing means comprising a plurality of fluid-actuated severing head units disposed along the mandrel and including heads for producing transverse slits and aligning score lines and longitudinal slits so as to produce closure flaps on the trailing end of the severed container portion and on the leading end of the remainder of the tube portion, and a container pusher unit actuated in response to actuation of the longitudinal slitting head for pushing the severed container forwardly away from the tube remaining on the mandrel, and an electric control circuit for controlling actuation of all of said units.

26. A machine according to claim **25** including a fluid-actuated unit for applying adhesive to the sheet after it is fed into association with said forming clamp unit, said control circuit including means for controlling said last-named unit.

27. A machine according to claim **26** including a fluid-actuated tape-applying clamp unit located along the mandrel for wrapping tape around the formed tube on the mandrel, said control circuit including means for controlling said last-named unit.

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