July 31, 1962 P. F. BOWMAN 3,046,849

BOX FORMING MACHINES

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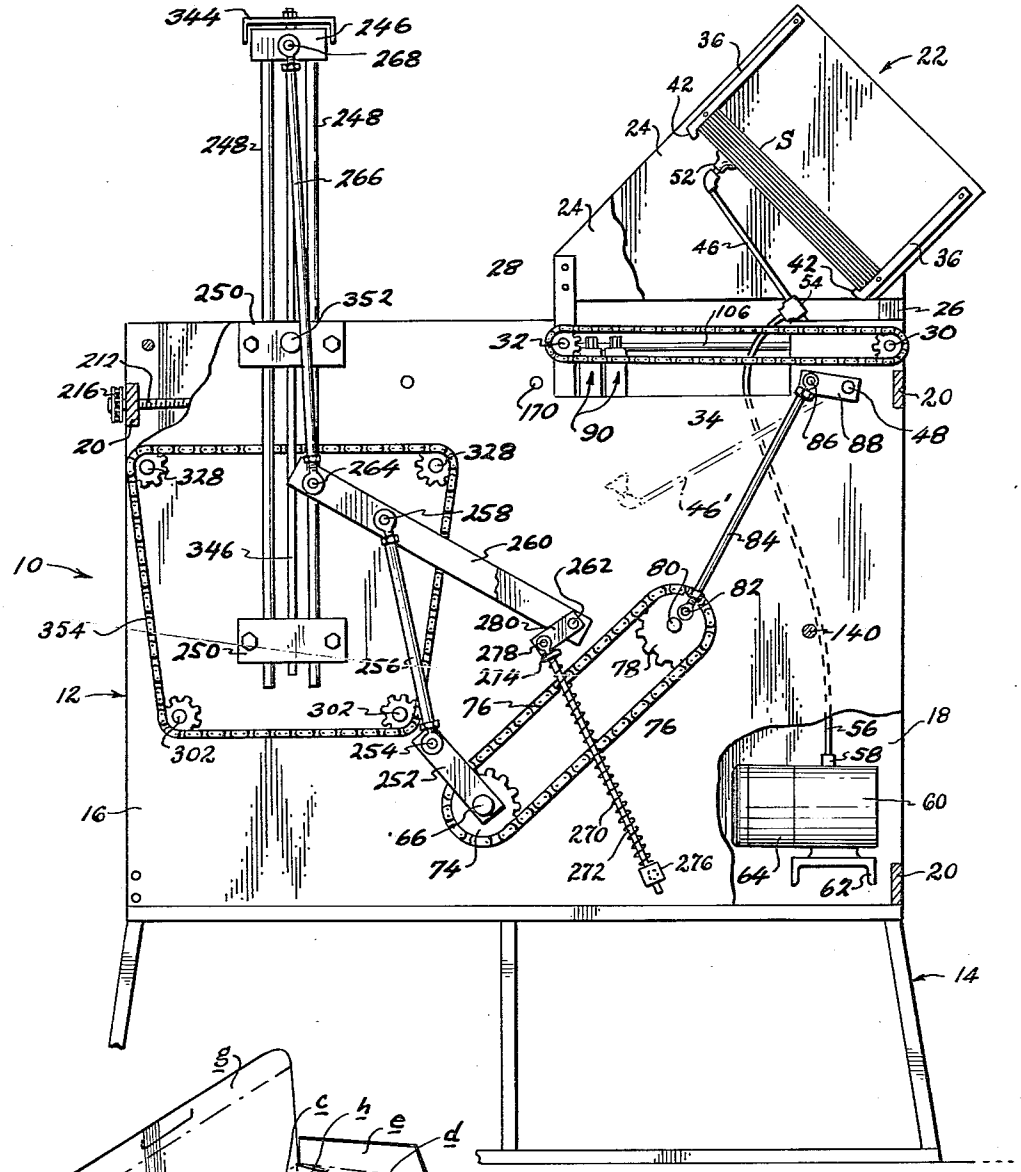


Fig. 1.

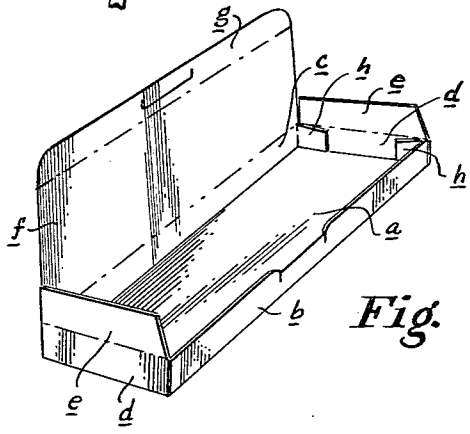


Fig. 9.

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BOX FORMING MACHINES

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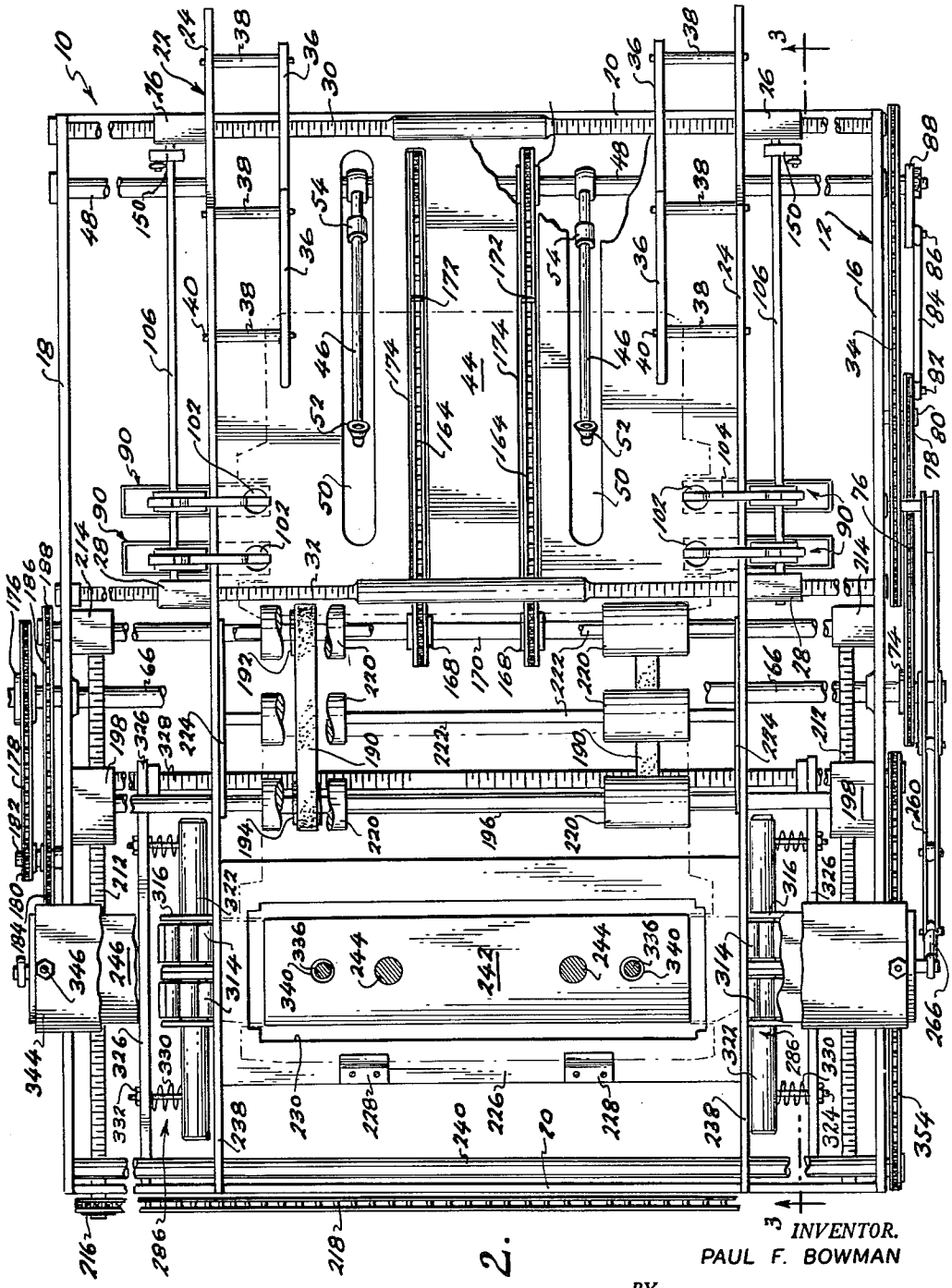


Fig. 2.

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BOX FORMING MACHINES

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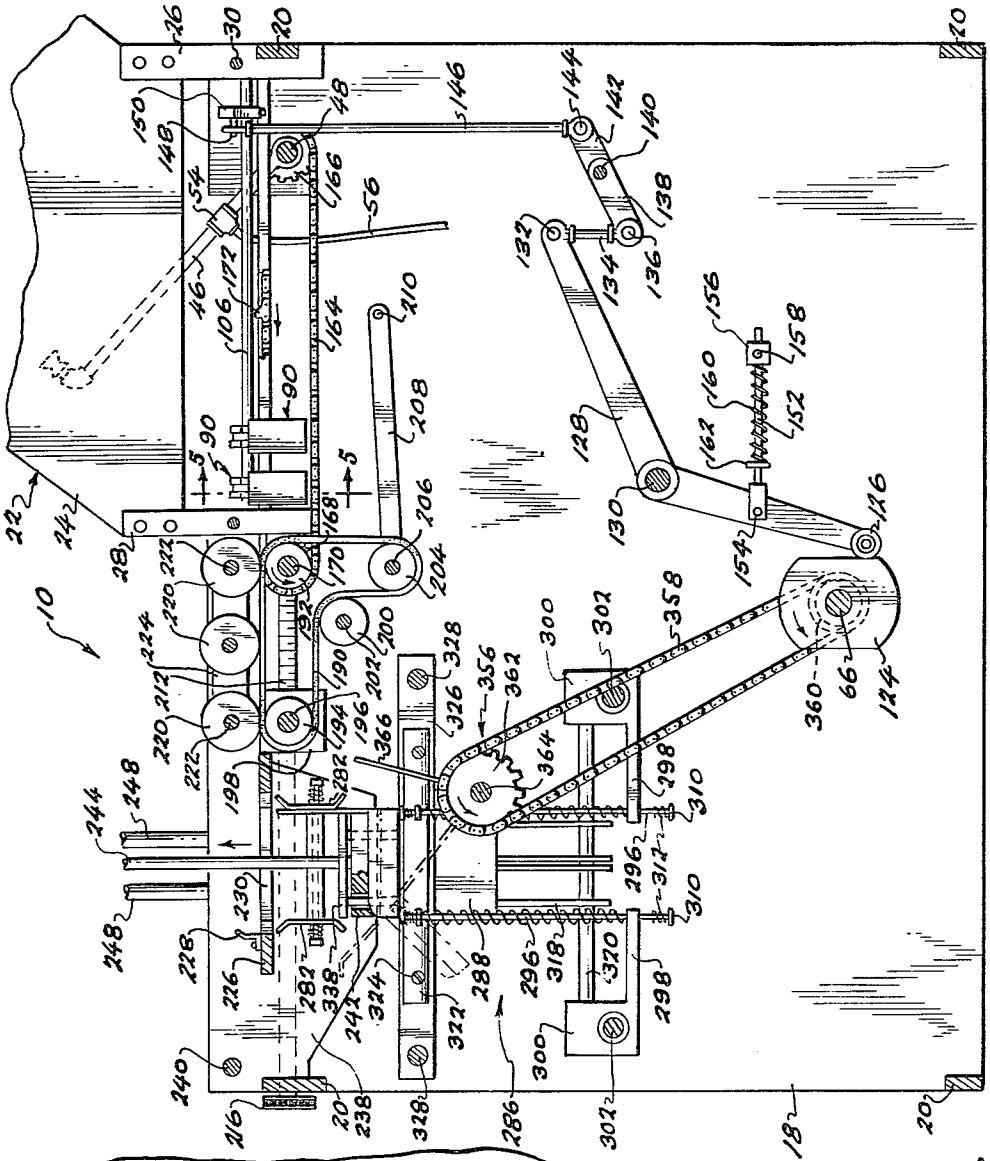


Fig. 3.

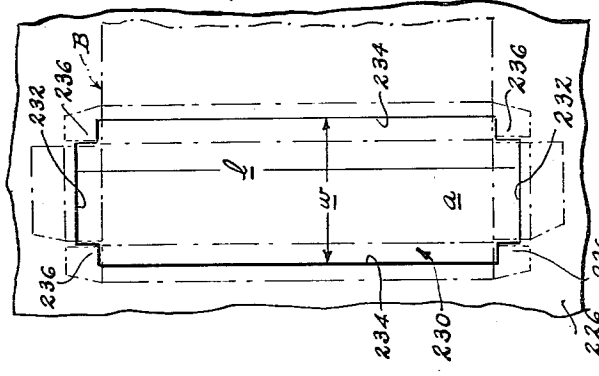


Fig. 10.

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BOX FORMING MACHINES

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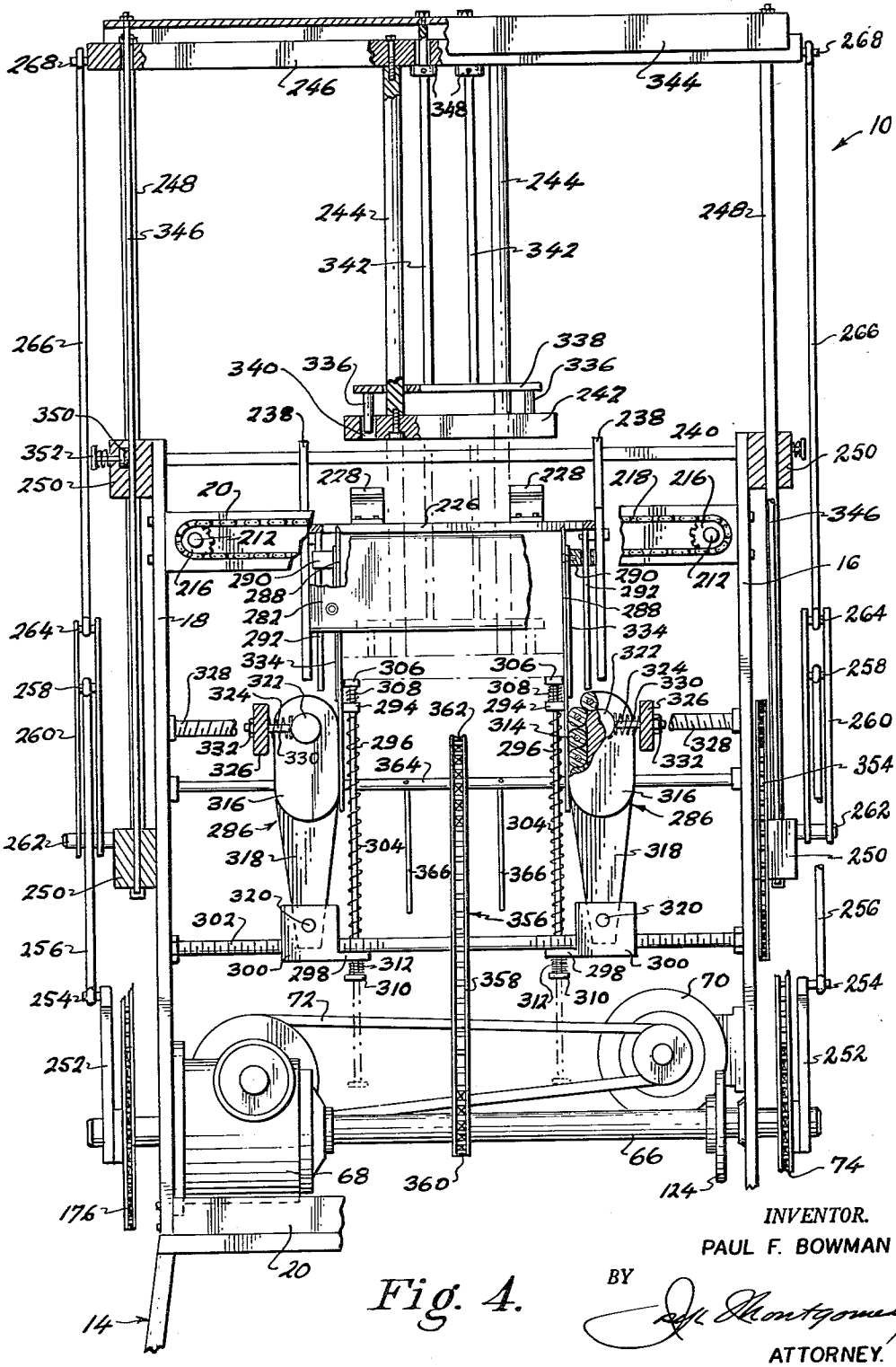


Fig. 4.

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BOX FORMING MACHINES

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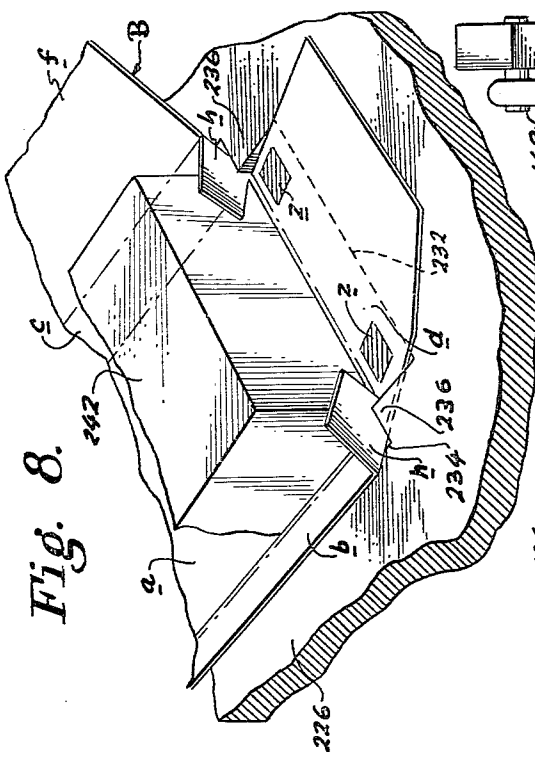


Fig. 8.

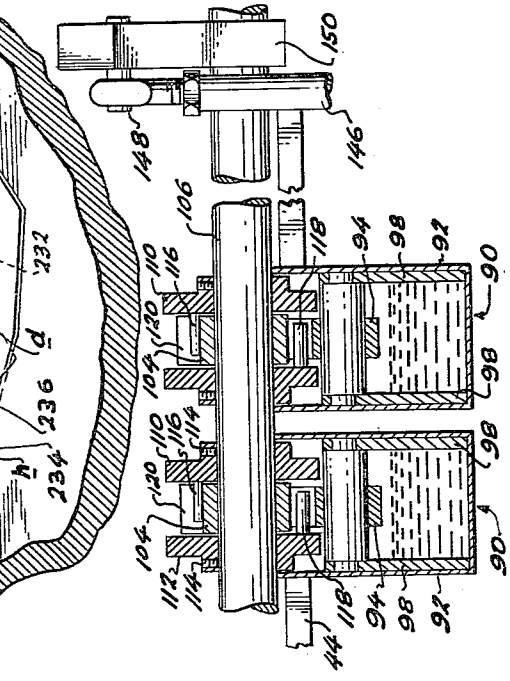


Fig. 6.

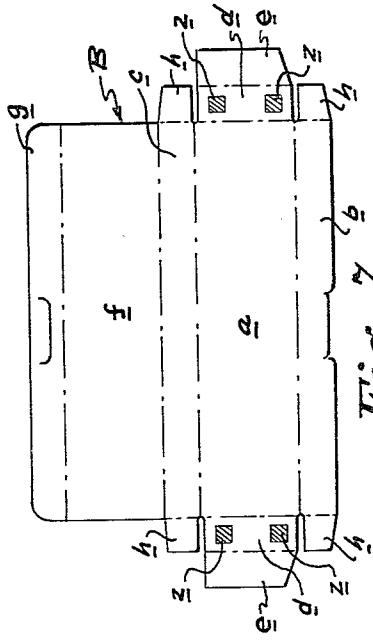


Fig. 7.

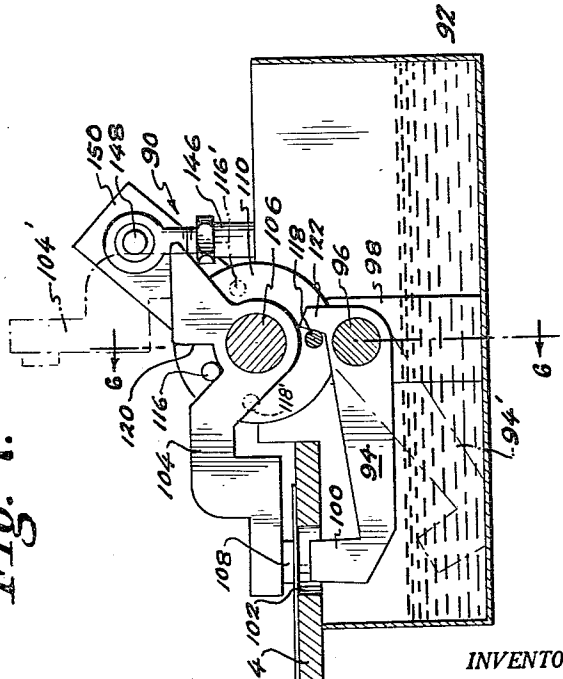


Fig. 5.

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United States Patent Office 3,046,849 Patented July 31, 1962

3,046,849

BOX FORMING MACHINES

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Filed May 15, 1961, Ser. No. 110,270
13 Claims. (Cl. 93—51)

This invention relates generally to an improved box making machine.

An object of the invention is to provide an improved machine for formng, from a single blank of suitable stock, a box or carton having a bottom with front, back and side walls joined to the margins or edges thereof, flaps extending from the end walls, and a lid or cover extending from the back wall, with tabs extending from the opposite ends of the front and back walls being adhesively secured to the inner surfaces of the end walls so as to maintain the front, back and end walls in erect positions.

Another object is to provide a machine for forming boxes of the described character having improved means for neatly applying the adhesive by which the tabs are secured to the inner surfaces of the end walls, so that such adhesive can be applied at limited zones of the end walls without the danger of the unwanted smearing of adhesive on other portions of the blank or box.

Still another object is to provide a machine for forming boxes of the described character with an improved arrangement for shaping each blank into the desired box configuration while ensuring that the tabs will be disposed at the inside of the end walls and firmly applied against the zones of adhesive on the latter for obtaining a secure bond therebetween.

A further object is to provide a machine for forming boxes of the described character which is capable of rapid and reliable operation with a minimum of supervision.

A still further object of the invention is to provide a machine of the described character capable of being conveniently adjusted for forming boxes of various dimensions.

In accordance with an aspect of this invention, a machine for forming boxes of the described character generally comprises a magazine for holding a stack of suitably shaped blanks from which the latter are removed, one at a time, and deposited on a support surface where a glue or adhesive applying device deposits adhesive only on limited zones of the portions of the blank corresponding to the inner surfaces of the end walls of the box to be formed from the blank, a conveying mechanism operative to transport the blank to which adhesive has been applied onto a forming plate having a suitably shaped opening through which the blank is driven downwardly by a mandrel so that the portions of the blank for defining or forming the front, back and end walls of the box are folded upwardly with the tabs at the ends of the front and back wall forming portions being folded inwardly at the inner sides of the end wall forming portions, a pressure applying mechanism acting inwardly against the end walls of the box on the mandrel and cooperating with the latter to ensure the firm adherence of the tabs to the zones of adhesive on the end walls, a stripping mechanism for removing the formed box from the mandrel during the return upward movement of the latter, and an ejecting mechanism for discharging the completed box from the box forming machine.

In a preferred embodiment of the invention, the device for applying adhesive to restricted or limited zones of each blank following removal of the latter from the stack in the magazine includes rockable upper arms disposed adjacent the opposite sides of the support surface on which the blank is situated during the adhesive applying operation and having glue applying elements adjacent their free ends, rockable lower arms disposed below the upper arms and being movable in adhesive containing reservoirs reaching under the support surface with the latter having openings through which adhesive transferring tips on the lower rockable arms can make contact with the adhesive applying elements of the related rockable upper arms, and an actuating mechanism for rocking the upper and lower arms with an operating cycle that occurs twice during the time required for the removal of each blank from the stack in the magazine so that, during alternate operating cycles of the adhesive applying device, adhesive is transferred from the tips of the rockable lower arms to the adhesive applying elements of the rockable upper arms at a time when the support surface is bare of a blank, and the adhesive thus transferred to the adhesive applying elements of the upper arms is thereafter applied to the blank situated on the support surface.

Further, in the preferred embodiment of the invention, the mechanism for applying inwardly directed pressure to the end walls of the formed box as the latter moves downwardly with the mandrel includes vertical pressure plates yieldably urged to raised positions under the forming plate and being displaced downwardlly by the mandrel following the initial portion of the downward stroke of the latter, and roller assemblies backing up the pressure plates in rolling contact with the latter and being spring urged inwardly to cause the pressure plates to bear firmly against the end walls of the box formed on the mandrel during the terminal portion of the downward stroke of the latter while the pressure plates move at the same speed as the mandrel so as to avoid any marring of the end walls or disturbance of the latter during the application of pressure for securing a tight adhesive bond between the end walls and the tabs of the front and back walls.

The above, and other objects, features and advantages of the invention, will be apparent in the following detailed description of an illustrative embodiment thereof which is to be read in connection with the accompanying drawings, forming a part hereof, and wherein:

FIG. 1 is a side elevational view of a box forming machine embodying the present invention, and which is shown partly broken away and in section;

FIG. 2 is an enlarged top plan view of the machine of FIG. 1, with a part of the mandrel supporting head of such machine being broken away to expose the underlying forming plate and mandrel;

FIG. 3 is a longitudinal sectional view taken along the line 3—3 of FIG. 2;

FIG. 4 is an end elevational view, partly broken away and in section, of the box forming machine as viewed from the end thereof at which the formed boxes are discharged or ejected;

FIG. 5 is an enlarged detail sectional view taken along the line 5—5 of FIG. 3;

FIG. 6 is a sectional view taken along the line 6—6 on FIG. 5;

FIG. 7 is a plan view of a one-piece blank from which a box is formed by the machine embodying the invention;

FIG. 8 is a fragmentary, enlarged perspective view illustrating the manner in which portions of the blank of FIG. 7 are folded in the machine embodying the invention;

FIG. 9 is a perspective view of a box formed in the machine embodying the invention; and

FIG. 10 is a plan view showing the opening of a forming plate in relation to the blank appearing in broken lines and from which a box is formed in accordance with this invention.

Referring to the drawings in detail, and initially to FIGS. 1, 2 and 4, it will be seen that a box forming machine embodying the present invention and there general-

ly identified by the reference numeral **10** comprises a frame **12** supported on a base **14**. Frame **12** includes vertical plates **16** and **18** constituting opposite side frame members and being held rigidly in spaced apart parallel relationship by cross frame members **20** which extend laterally between the ends of side frame members **16** and **18** adjacent the top and bottom thereof.

Mounted on top of frame **12**, at the inlet or front end of the box forming machine, is a magazine **22** for supporting a stack of flat blanks of cardboard stock or the like from which the desired boxes are to be formed. The magazine **22** (FIGS. 1 and 2) includes vertical, adjustably spaced apart side plates **24** supported, adjacent their lower edges, on front and back posts **26** and **28**, respectively. Posts **26** and **28** are formed, adjacent their lower ends, with threaded laterally extending bores receiving the oppositely threaded end portions of laterally extending rods **30** and **32**, respectively, which have their ends journalled in suitable bearings carried by side frame members **16** and **18**. The rods **30** and **32** are rotatably connected, for example, by a chain and sprocket transmission **34** (FIGS. 1 and 2), so that such rods will rotate simultaneously for moving the side plates **24** of the magazine toward and away from each other, and thereby adapting the magazine to hold blanks intended for use in forming boxes of various dimensions.

As shown in FIG. 1, a stack S of suitably shaped blanks is held in an inclined position between side plates **24** of the magazine by parallel retaining bars **36** spaced inwardly from side plates **24** by tubular spacers **38** (FIG. 2) extending around bolts **40** by which bars **36** are secured to side plates **24**. The lower ends of bars **36** are formed with feet **42** (FIG. 1) directed inwardly toward each other to form supporting ledges for the lowermost blank in stack S, but permitting such lowermost blank to be withdrawn from the stack for deposit on an underlying table or supporting surface **44** (FIG. 2).

In order to effect the removal of the bottom blank from stack S in magazine **22** and the deposit of such blank on the supporting surface or table **44**, the machine **10** further includes a pair of parallel tubular arms **46** extending radially from a shaft **48** which passes laterally under table **44** adjacent the front or inlet end of the machine and has its opposite ends journalled in side frame members **16** and **18**. Table **44** is formed with elongated slots **50** (FIG. 2) through which the tubular arms **46** can pass during swinging movement in vertical planes in response to turning of shaft **48**. The free ends of tubular arms **46** are provided with upwardly directed suction cups **52** engageable with the underside of the lowermost blank in stack S when the tubular arms **46** are raised to the position shown in full lines on FIG. 1, and each tubular arm **46** is connected, as by a T-shaped connector **54**, to a flexible hose **56** which leads to the inlet **58** of a fan or blower **60** constituting a vacuum source. Blower **60** is mounted on a bracket **62** adjacent the bottom of frame **12** and is driven by an associated electric motor **64**. Thus, when tubular arms **46** are raised to contact the suction cups **52** with the underside of the lowermost blank in stack S, the vacuum established in tubular arms **46** causes adherence of the lowermost blank to the suction cups **52** for disengagement from the feet or ledges **42** when the arms **46** are thereafter swung downwardly through slots **50** to positions below table **44**, for example, to the positions indicated in broken lines at **46'** on FIG. 1. It will be apparent that, as the arms **46** move downwardly through the slots **50**, the blank gripped by suction cups **52** is engaged by the top surface of table **44** to halt the downward movement of the blank and thereby cause separation of the suction cups **52** from the blank which remains on the supporting surface or table **44**.

In order to effect the above described swinging or oscillating movement of arms **46**, the illustrated box forming machine **10** further includes a main drive shaft **66** extending laterally across the lower portions of frame **12** intermediate the opposite ends of the latter and having its end portions journalled in suitable bearings carried by side frame members **16** and **18**. As shown in FIG. 4, the main drive shaft **66** is driven by a speed reducer **68** which is, in turn, driven by an electric motor **70** through a belt and pulley transmission **72**. A sprocket **74** (FIGS. 1 and 4) is fixed on the end portion of main drive shaft **66** projecting outwardly from side frame member **16** and drives a chain **76** which runs around a sprocket **78** rotatable on a stub shaft **80** extending from side frame member **16** at a location spaced upwardly and toward the front or inlet end of the machine with respect to the main drive shaft (FIG. 1). A crank pin **82** extends from sprocket **78** and provides a pivotal connection between the latter and one end of a connecting rod **84** having its opposite end pivotally connected, as at **86**, to the end of a crank arm **88** secured on an end portion of shaft **48** which projects through side frame member **16**.

The radial distance between the axis of rotation of sprocket **78** and the crank pin **82** is smaller than the radial distance between pivot **86** and the rocking axis of arm **88** so that the latter is angularly displaced or oscillated approximately through 90 degrees in response to the continuous rotation of sprockets **74** and **78** with the rotated main drive shaft **66**.

As is apparent in FIG. 7, each blank B delivered from the stack S in the manner described above and intended to be formed into the box illustrated in FIG. 9 includes a rectangular bottom forming portion *a*, front and back wall forming portions *b* and *c* foldably joined to portion *a* along the opposite longitudinal margins of the latter, end wall forming portions *d* foldably joined to portion *a* along the opposite end margins of the latter and having flap forming portions *e* foldably extending therefrom, a lid forming portion *f* foldably joined to back forming portion *c* along the length of the latter and having a flap forming portion *g* foldably joined to the longitudinal margin of the lid forming portion remote from back forming portion *c*, and tab forming portions *h* foldably extending from the opposite ends of front and back wall forming portions *b* and *c*.

After the blank B has been deposited on the table or supporting surface **44** with its front wall forming portion *b* extending away from the front or inlet end of the machine **10**, an adhesive applying mechanism included in the latter functions to apply adhesive to two limited zones on the upwardly facing surface of each of the end wall forming portions *d* of the blank, for example, to the shaded zones *z* indicated on FIG. 7. Such adhesive applying mechanism preferably includes a pair of adhesive applying devices located adjacent each of the opposite sides of the table **44** and each generally identified by the reference numeral **90**.

As shown in FIGS. 5 and 6, each adhesive applying device **90** includes an upwardly opening reservoir **92** for adhesive extending under the adjacent side edge portion of table **44**. A lower arm **94** is rockable within reservoir **92** on an axle **96** carried by supports **98** and has an adhesive transferring tip **100** adapted to project upwardly into a related hole **102** in table **44** when arm **94** is in the raised or elevated position illustrated in full lines on FIG. 5, and an upper rockable arm **104** is freely rockable on a shaft **106** extending parallel to the adjacent side edge of table **44** and having its opposite ends journalled in uprights or posts **26** and **28** which support magazine **22**. The upper arm **104** carries an adhesive applying element **108** adjacent its free end and is rockable between a raised or elevated position, shown in broken lines at **104'** on FIG. 5, and a lowered position shown in full lines, and in which arm **104** extends over the table **44** either to contact the adhesive applying element **108** with a related zone *z* of an end wall defining portion *d* of a blank B when situated on table **44**, or to contact the adhesive applying element **108** with the adhesive transferring tip **100** of the related lower arm **94** if no blank is then situated on table **44**.

In order to effect the necessary rocking movements of arms **94** and **104** of each adhesive applying device **90**, the

latter further includes disks 110 and 112 secured, as by set screws 114, on shaft 106 at the opposite sides of the upper arm 104 and respectively carrying axially projecting pins 116 and 118. The pin 116 is received in a notch 120 formed in upper arm 104, while the pin 118 is engageable with a nose 122 formed on the lower arm 94 (FIG. 5). The notch 120 has a circumferential extent substantially larger than the diameter of pin 116 received therein so that, when disks 110 and 112 are disposed so as to position the related pins 116 and 118 as shown in full lines on FIG. 5, the pin 116 permits further counterclockwise displacement of upper arm 104 extending adhesive applying element 108 into related hole 102 for contact with tip 100 of lower arm 94 which is moved to its raised or elevated position by engagement of pin 118 with nose 122. However, when disks 110 and 112 are displaced in the clockwise direction from the positions illustrated on FIG. 5, for example, to the broken line positions indicated at 116' and 118', pin 116 engages an end of notch 120 to rock upper arm 104 to its raised position shown in broken lines at 104', while the pin 118 moves away from nose 122 to permit the lower arm 94 to fall against the bottom of reservoir 92, as indicated in broken lines at 94', in which position the tip 100 is submerged within the adhesive in reservoir 92.

In accordance with the present invention, arms 94 and 104 of each adhesive applying device 90 are twice moved between the positions shown in full lines and broken lines, respectively, on FIG. 5 during each operating cycle of the machine, that is, during each complete oscillation of the arms 46 effective to deposit a blank B on table 44. Thus, during the upward swinging movement of arms 46, at which time a blank is not present on table 44, arms 94 and 104 of each device 90 are raised and lowered, respectively, and adhesive applying element 108 reaches into related hole 102 to contact the tip 100 and receive adhesive transferred from the latter, and thereafter, when the arms 46 have deposited a blank on table 44, as previously described in detail, arms 94 and 104 of each device 90 are again respectively raised and lowered, but this time, due to the presence of a blank B on table 44, the element 108 of the arm 104 merely contacts the related zone *z* of the blank to apply adhesive thereto, whereas tip 100 of the lower arm 94 does not reach through hole 102 and thereby avoids the transfer of adhesive to the underlying surface of the blank.

From the foregoing, it will be apparent that the devices 90 are effective to apply adhesive only to the desired zones *z* on the upwardly facing surface of the blank B, and there is no danger that adhesive will drip or smear onto other areas of the blank.

In order to effect the necessary angular movements or oscillations of shafts 106 which actuate adhesive applying devices 90 in the manner described above, machine 10 further includes a radial cam 124 (FIGS. 2 and 3) fixed on main drive shaft 66 adjacent the side frame member 16 and being peripherally engaged by a cam follower roller 126 (FIG. 3) which is rotatably carried by one end of a bell crank 128 rockably mounted intermediate its ends on a stub shaft 130 projecting from the adjacent side frame member. The end of bell crank 128 remote from roller 126 is pivotally connected, as at 132, to an adjustable link 134 which is, in turn, pivotally connected at 136 to a radial arm 138 secured to a shaft 140 having its opposite ends journalled in bearings carried by side frame members 16 and 18. Radial arms 142 are also secured to shaft 140 at locations lying approximately in vertical planes passing through shafts 106 and extend in diametrically opposed directions to the arm 138. The free ends of arms 142 are pivotally connected, as at 144, to the lower ends of upwardly extending link rods 146 which, at their upper ends, have pivotal connections 148 with radial arms 150 secured on the shafts 106 adjacent the support posts 26 (FIGS. 3, 5 and 6). In order to maintain cam follower roller 126 in contact with the periphery of cam 124, a rod 152 is pivotally connected, as at 154, to one arm of bell crank 128 and slides through a block 156 which is rockable on a pivot 158 carried by adjacent side frame member 16, and a helical compression spring 160 extends around the rod 152 between the block 156 and a collar 162 secured on the rod (FIG. 3).

It will be apparent that, when roller 126 is engaged by a radially large portion of cam 124, link rod 146 is moved downwardly to cause displacement of the arms 94 and 104 of each adhesive applying device 90 to the positions shown in broken lines on FIG. 5. On the other hand, when roller 126 engages a radially small portion of cam 124, as in FIG. 3, spring 160 causes upward movement of link rod 146, and arms 94 and 104 of each adhesive applying device 90 are moved to the positions shown in full lines on FIG. 5. Since the previously described arrangement for effecting the swinging movements of the arms 46 produces one operating cycle of the latter for each revolution of the main drive shaft 66, and since it is necessary for the adhesive applying devices 90 to perform two operating cycles during each operating cycle of the arms 46, the radial cam 124 of the arrangement for actuating the adhesive applying devices has two diametrically opposed radially large portions with two radially small portions interposed therebetween, as is apparent in FIG. 3.

After adhesive has been applied to the limited zones *z* of the blank B, the latter is conveyed off table 44 in the direction away from the front or inlet end of the machine. As shown in FIGS. 2 and 3, such movement of the blank B off table 44 is effected by endless chains 164 running around sprockets 166 which are freely rotatable on the shaft 48 and around sprockets 168 which are fixed on a laterally extending, rotated shaft 170 having its ends journalled in suitable bearings carried by the side frame members 16 and 18. Shaft 170 is disposed below and adjacent to the laterally extending edge of table 44 remote from the front or inlet end of the machine and is at the same level as the shaft 48 so that chains 164 have horizontal upper and lower runs. Further, chains 164 carry lugs 172 which, during movement along the upper runs of the chains, project upwardly through longitudinal slots 174 formed in table 44. Shaft 170 is rotated in the counterclockwise direction, as viewed in FIG. 3, so that the upper runs of the chains 164 move in the direction away from the front or inlet end of the machine, whereby the lugs 172 are engageable with the longitudinal edge of the flap forming portion *g* of a blank B lying on the table to displace such blank off the table over the shaft 170.

The shaft 170 is also driven from the main drive shaft 66 by way of a chain and sprocket transmission (FIG. 2) including a large diameter sprocket 176 secured on an end of drive shaft 66 projecting beyond side frame member 18 and driving a chain 178 which runs around a relatively small diameter sprocket 180 rotatable on a stub shaft 182 and connected to a relatively large diameter sprocket 184 also rotatable on stub shaft 182 and driving a chain 186 which runs around a relatively small diameter sprocket 188 fixed to shaft 170. The described chain and sprocket transmission effects suitably rapid rotation of shaft 170 so that lugs 172 on chains 164 travel through two complete circuits of the path of the chains during each operating cycle of the machine 10.

The blank B conveyed off table 44 in the manner described above passes onto, and is further conveyed in the same direction by conveyor belts 190 which run around drive pulleys 192 fixed on rotated shaft 170 (FIGS. 2 and 3) and idler pulleys 194 which are rotatable on a laterally extending shaft 196 mounted, at its opposite ends, in blocks 198 which are movable horizontally along the side frame members 16 and 18, as hereinafter described in detail, so as to adjust the horizontal distance between the parallel shafts 170 and 196 and thereby vary the length of the horizontal upper runs of the conveyor belts 190.

In order to permit adjustment of the length of the

upper runs of belts **190**, the lower runs of the belts pass over idler pulleys **200** rotatable on a shaft **202** having its opposite ends carried by the side frame members **16** and **18**, and then under a weighted dancer roller **204** rotatable on a shaft **206** having its opposite ends carried by arms **208** which are pivoted on an axle **210** carried by the side frame members **16** and **18**. Thus, as pulleys **194** are moved toward and away from drive pulleys **192** for varying the length of the upper runs of belts **190**, dancer roll **204** correspondingly moves downwardly and upwardly about the pivoting axis of its supporting arms **208**.

The blocks **198** supporting the opposite ends of shaft **196** are formed with tapped bores extending horizontally therethrough and receiving adjustment screws **212** which are rotatably mounted, at their opposite ends, in bearing blocks **214** (FIG. 2) secured to the adjacent side frame members **16** and **18** and in bearings carried by the upper cross frame member **20** at the discharge or back end of the machine. The ends of the adjustment screws **212** which are rotatably supported by such cross frame member **20** have sprockets **216** secured thereon, and an endless chain **218** runs around the sprockets **216** (FIGS. 2 and 4) to ensure the uniform adjustment of both blocks **198**.

During movement by the conveyor belts **190**, the blank B is held in frictional contact with the horizontal upper runs of the belts by means of idler or hold-down rollers **220** disposed above the upper horizontal runs of the belts **190** and being freely rotatable on parallel, laterally extending shafts **222** mounted, at their opposite ends, in support plates **224** (FIGS. 2 and 3).

The upper horizontal runs of conveyor belts **190** deliver the blank B onto a horizontal forming plate **226** having stops **228** projecting upwardly at the side thereof remote from conveyor belts **190** so as to arrest the movement of the blank in a position on the forming plate **226** where it is correctly aligned or registered with a generally rectangular opening **230** provided in the forming plate. Referring particularly to FIG. 10, wherein the blank B appearing in broken lines is shown superimposed on opening **230** of forming plate **226**, it will be seen that the width *w* and the length *l* of the opening **230** are larger than the width and length, respectively, of the bottom forming portion *a* of the blank B so that, when the latter is registered or positioned properly with respect to opening **230**, the end edges **232** of the latter underlie end wall forming portions *d* of the blank, while the longitudinal edges **234** of opening **230** underlie the front and back wall forming portions *b* and *c* of the blank. Further, opening **230** has right-angled projections **236** at its four corners which substantially underlie the tab forming portions *h* of the blank B when the latter is properly positioned over the opening.

The forming plate **226** is suitably secured, at its opposite ends, to vertical, longitudinally extending side plates **238** which are secured, at one end, to the posts **28** supporting magazine **22** and, at the other end, are slidable on a rod **240** extending between the top portions of side frame members **16** and **18** at the back or discharge end of the machine. Thus, side plates **238** are movable toward and away from each other with the laterally adjustable posts **28** to accommodate forming plates of different dimensions used in forming correspondingly different sized boxes, while the previously described adjustability of the pulleys **194** supporting the conveyor belts **190** also permits accommodation of differently dimensioned forming plates.

In accordance with the present invention, the previously described blank B having adhesive applied to the zones *z* of the end wall forming portions *d* thereof is formed into the box shown in FIG. 9 by being pressed downwardly through the opening **230** of forming plate **226**. The blank is pressed downwardly through opening **230** by a rectangular, vertically reciprocable mandrel **242** which substantially corresponds, in its dimensions, to bottom forming portion *a* of blank B, and which is suspended, by vertical rods **244** from a laterally extending, horizontal cross head **246**. The opposite end portions of cross head **246** are secured to vertical depending guide rods **248** (FIGS. 1 and 4) which are vertically slidable in guide blocks **250** secured to the outer surfaces of side frame members **16** and **18**. Thus, mandrel **242** is guided to reciprocate vertically between a raised position shown in full lines and a lowered position shown in broken lines on FIG. 4. Such reciprocation of the mandrel is effected by crank arms **252** secured on the opposite ends of main drive shaft **66** and pivotally connected, as at **254**, to the lower ends of connecting rods **256** having their upper ends pivotally connected, as at **258**, to levers **260** at locations intermediate the ends of the latter. The levers **260** are rockably mounted, at one end, on stub shafts **262** extending from the adjacent side frame members **16** and **18**, while the other or free ends of the levers **260** are pivotally connected, as at **264**, to the lower ends of link rods **266** having their upper ends pivotally connected to the ends of cross head **246**, as at **268** (FIGS. 1 and 4). Thus, during each revolution of main drive shaft **66**, the described mechanism is effective to stroke mandrel **242** downwardly from the raised position to the lowered position shown in FIG. 4, and thereafter to return the mandrel to its raised position. The crank arms **252** are angularly fixed on the drive shaft **66** so that the mandrel will be in its raised position when a blank arrives on the underlying forming plate **226**.

As shown in FIG. 1, the weight of mandrel **242** is counterbalanced by helical compression springs **270** at the opposite sides of frame **12** and each extending around a rod **272** and bearing, at its opposite ends, against a collar **274** fixed on the upper end of rod **272** and a guide block **276** pivoted on the adjacent side frame member **16** and having a bore through which the rod **272** slidably projects. The upper end of rod **272** is pivotally connected, as at **278**, to an arm **280** which is rockable on the stub shaft **262** at the related side of the frame and angularly fixed relative to the lever arm **260**. Thus, the force of each spring **270** is transmitted to the related lever arm **260** to urge the latter upwardly in opposition to the effect of the weight of mandrel **242**.

When the mandrel **242** moves downwardly to force a blank B through opening **230** in forming plate **226**, the end edges **232** and the longitudinal edges **234** of opening **230** are disposed substantial distances from the fold lines of end wall forming portions *d* and of front and back wall forming portions *b* and *c*, respectively, of the blank, while the corner projections **236** of plate **226** projecting into opening **230** engage tab forming portions *h* of the blank at locations close to the fold lines between the tab forming portions *h* and the front and back wall forming portions *b* and *c*. Thus, as the mandrel **242** moves a blank B downwardly through opening **230**, tab forming portions *h* are folded upwardly and inwardly at a relatively rapid rate relative to front and back wall forming portions *b* and *c*, while the latter and end wall forming portions *d* are folded upwardly at a relatively slower rate relative to the bottom forming portion *a* which is engaged by mandrel **242** (FIG. 8). From the above, it will be seen that the mandrel **242** and the shape of the opening **230** cooperate to ensure that tab forming portions *h* will be disposed inside of end wall forming portions *d*, and therefore engageable with zones *z* of adhesive, when portions *b*, *c* and *d* of the blank are folded upwardly to define the front, back and end walls of the box.

As the blank is moved downwardly by mandrel **242** below forming plate **226**, the front and back wall forming portions *b* and *c* of the blank are slidably engaged and further folded upwardly to vertical positions against the front and back surfaces of the mandrel by laterally extending, substantially vertical pressure plates **282** (FIGS. 3 and 4) which are suspended from the side plates **238**.

Further, in order to ensure that end wall forming portions *d* of the blank will be pressed firmly against the tab forming portions *h* so as to obtain a secure bond by the adhesive at zones *z*, the box forming machine **10** embodying this invention further includes pressure applying devices located at the opposite sides of the downward path of travel of the mandrel **242** and each generally identified by the reference numeral **286**.

Each of the side pressure applying devices **286** (FIGS. 2, 3 and 4) includes a generally vertical pressure applying plate **288** secured, at its upper end, to blocks **290** which are slidable loosely, that is, with substantial lateral clearance, on rods **292** depending from forming plate **226** (FIG. 4). Apertured lugs **294** project inwardly from the plate **288** and receive vertical rods **296** which extend slidably downward through suitable openings provided in ledges **298** projecting from blocks **300** having laterally extending tapped bores which receive threaded portions of laterally extending adjustment screws **302** which are journalled, at their opposite ends, in side frame members **16** and **18**. Helical compression springs **304** are mounted on rods **296** between lugs **294** and ledges **298** so as to yieldably urge the related plate **288** upward to the position shown on FIG. 4. A shelf defining member or head **306** is provided at the top end of each rod **296** and extends into the path of the downward travel of mandrel **242**, with a bumper spring **308** (FIG. 4) being interposed between the head or shelf **306** and the related lug **294**. An abutment or head **310** is also provided at the lower end of each rod **296**, and a bumper spring **312** is disposed on the rod **296** between ledge **298** and head **310**.

Each side pressure applying device **286** further includes a pair of endless chains **314** (FIGS. 2 and 4) made up of pivotally linked together rollers and being movable along closed paths having vertical side runs within housing **316** which are disposed at the outside of the vertical path of travel of the related plate **288**. The housings **316** of each device **286** have arms **318** extending downwardly therefrom and pivotally supported, at their lower ends, on a rod **320** which is carried by blocks **300** (FIGS. 3 and 4). The housings **316** for the roller chains **314** of each pressure applying device **286** further have rods **322** projecting from the opposite sides of the upper portions thereof (FIGS. 2, 3 and 4), and adjustment bolts **324** extend outwardly from the rods **322** and pass slidably through back-up bars **326** which are supported, adjacent their opposite ends, on adjustment screws **328** journalled in side frame members **16** and **18**. Helical springs **330** (FIGS. 2 and 4) are provided on each bolt **324** between rods **322** and back-up bar **326** to urge the roller chain containing housings **316** laterally toward the adjacent plate **288**, and a nut **332** on each bolt **324** in back of bar **326** can be turned to vary the magnitude of the force exerted by springs **330**.

As is apparent particularly in FIG. 4, roller chains **314** follow vertical runs along the outer surfaces of plates **288** so that springs **330** acting on each housing **316** cause such roller chains to exert inwardly directed forces against the plates **288**, while the rolling contact between roller chains **314** and plates **288** substantially minimizes the frictional resistance to vertical movement of the plates. The upper portions of the plates **288** further have shims **334** of suitable thickness secured to the outer surfaces thereof (FIG. 4), so that, as plates **288** move downwardly past roller chains **314**, the latter engage shims **334** to further urge the plates **288** laterally towards each other.

It will be apparent that, as the blank B is moved downwardly by mandrel **242** through opening **230** of forming plate **226**, end wall forming portions *d* of the blank are further folded upwardly against the end surfaces of the mandrel, with tabs *h* interposed therebetween, by sliding contact of portions *d* with the upper parts of plates **288**. When the downwardly moving mandrel reaches a lowered position in which it engages shelves **306**, the initial impact of such engagement is absorbed by springs **308** and transmitted to lugs **294** so that, thereafter, plates **288** follow the downward movement of the mandrel against the resistance of the springs **304**. During such downward movement of plates **288**, shims **234** are interposed between plates **288** and roller chains **314** so that the latter transmit increased forces from springs **330** to plates **288** which thereby firmly press together the end walls *d* and the tabs *h* so as to obtain a firm bond at the zones *z* of adhesive therebetween.

After the mandrel **242** has reached the lower end of its downward stroke and commences its upward return stroke, the formed box is stripped from the mandrel for discharge or ejection from the machine **10**. This stripping function is performed by stripping pins **336** carried by a plate **338** disposed above mandrel **242** and being capable of downward projection through holes **340** formed in the mandrel (FIGS. 2, 3 and 4). The plate **338** has openings through which the suspension rods **244** of the mandrel loosely extend, and the plate **338** is, in turn, suspended from rods **342** which pass loosely through openings in the cross head **246** and are secured, at their upper ends, to the central portion of a cross member **344** extending above cross head **246** and being vertically movable relative to the latter. The opposite ends of cross member **344** are secured to the upper ends of elongated rods **346** which extend loosely downward through holes in cross head **246** and are vertically guided in bores formed in the guide blocks **250** (FIGS. 1 and 4). The extent to which the stripping pins **336** can project downwardly through holes **340** below the bottom surface of mandrel **242** is limited by the engagement of plate **338** with the top surface of the mandrel, while the upward movement of pins **336** relative to the mandrel is limited by collars **348** secured on the suspension rods **342** and engageable against the underside of cross head **246**.

In accordance with the present invention, movement of plate **338** and stripping pins **336** with mandrel **242** is frictionally resisted, for example, by a leather or other pad **350** housed in each of the upper guide blocks **250** and pressed, as by an adjustment screw **352**, against the surface of the rod **346** extending slidably through the related guide block (FIG. 4). When mandrel **242** commences its downward stroke, the frictional resistance to movement of rods **346** through the upper guide blocks causes plate **338** to lag behind the movement of mandrel **242** by a distance determined by the engagement of collars **348** with the underside of cross head **246**. Thus, during the downward stroke of mandrel **242**, stripping pins **336** are retracted relative to the bottom surface of mandrel **242**. However, when the mandrel reaches the lower end of its downward operative stroke and commences its upward return stroke, as in FIG. 3, the previously described frictional resistance to movement of plate **338** and stripping pins **336** with the mandrel causes the latter to move upwardly against the underside of plate **338** so that pins **336** then project downwardly from the lower surface of mandrel **242** and strip the formed box from the mandrel.

As mandrel **242** continues to move upwardly, the formed box also moves upwardly by reason of its being held between pressure plates **288** which are driven upwardly with the mandrel by springs **304**. However, when plates **288** have moved upwardly to positions where the shims **334** are no longer engaged by roller chains **314**, so that the gripping pressure of plates **288** on the ends of the formed box is relaxed, the formed box is ejected from the machine **10**, as hereinafter described in detail.

It will be apparent that mandrel **242** is easily replaceable at the lower ends of the rods **244** so that the mandrel and forming plate **226** can be produced in sets which are selectively employed in the machine **10** for forming boxes having various dimensions. When boxes having different dimensions are to be produced, side pressure applying devices **286** are easily adjusted laterally in accordance with the dimensions of the boxes merely by effecting rotation of the adjustment screws **302** and **328**. In order to ensure the uniform adjustment by such screws **302** and

328, the ends of the latter projecting through side frame member 16 are rotatably connected by a chain and pulley transmission 354 (FIGS. 1, 2 and 4).

The successively formed boxes are ejected from the machine 10 by a device generally identified by the reference numeral 356 (FIGS. 3 and 4). The box ejecting device 356 includes a chain 358 running around sprockets 360 and 362 which are respectively mounted on main drive shaft 66 and on a shaft 364 having its ends journalled in side frame members 16 and 18. Thus, shaft 364 is driven from shaft 66, and carries a pair of radially projecting fingers 366 disposed to engage behind the stripped box and propel the latter longitudinally out of the discharge or back end of the machine 10 when the pressure of plates 288 is relaxed, as described above.

From the above description of the box forming machine 10 embodying the invention, it will be apparent that the latter makes possible the rapid and reliable forming of boxes from one-piece blanks, while ensuring the maintenance of high quality and uniformity in the produced boxes, and while making possible the forming of boxes having varying dimensions through the convenient manipulation of the various adjustments on the machine.

Although an illustrative embodiment of the invention has been described in detail herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to that precise embodiment, and that various changes and modifications may be effected therein without departing from the scope or spirit of the invention, except as defined in the appended claims.

What is claimed is:

1. A machine for forming boxes from one-piece flat blanks each having a rectangular bottom defining portion, front, back and end wall defining portions foldably joined to the margins of the bottom defining portion and tabs foldably joined to the ends of the front and back wall defining portions; said machine comprising means operative to apply adhesive to limited zones of the end wall defining portions of each blank, forming means acting on each blank after adhesive has been applied to be latter and including a forming plate having an opening therein and a rectangular mandrel coextensive with the bottom defining portion of the blank and movable through said opening to push the bottom defining portion of a blank disposed against said plate through said opening in the latter, said opening having substantial clearance with respect to the longitudinal and end edges of said rectangular mandrel and smaller clearance with respect to the corners of the latter so that, as the bottom defining portion of a blank is pushed through said opening, the tabs are folded with respect to the front and back wall defining portions at a relatively fast rate while the front, back and end wall defining portions are folded with respect to the bottom defining portion, thereby ensuring the disposition of the folded tabs inside of the folded end wall defining portions for engagement with said zones of adhesive on the latter, pressing members disposed adjacent the path of travel of said mandrel after the latter passes through said opening of the forming plate, means urging said pressing members against the ends of said mandrel so that the tabs and end wall defining portions of the folded blank pushed through said opening of the forming plate are securely pressed together between said pressing members and said ends of the mandrel to ensure a firm bond between said tabs and end wall defining portions at said zones of adhesives, means mounting said pressing members to move in the direction of movement of said mandrel, and means operative to move said pressing members with said mandrel while said pressing members are urged against said ends of the mandrel, thereby avoiding sliding of said pressing members relative to the end wall defining portions of the folded blank while the tabs and end wall defining portions are being pressed together.

2. A box forming machine as in claim 1; wherein said means urging the pressing members against the ends of the mandrel includes endless chains of linked together rollers, housing supporting the roller chains for movement along closed paths having runs extending parallel to the direction of movement of said pressing members with said mandrel, and spring actuated means urging said housings toward said pressing members so that said rollers are in rolling contact with said pressing members during movement of the latter with said mandrel and urge said pressing members toward the adjacent ends of the mandrel.

3. A machine for forming boxes from one-piece flat blanks each having a rectangular bottom defining portion, front, back and end wall defining portions foldably joined to the margins of the bottom defining portion and tabs foldably joined to the ends of the front and back wall defining portions; said machine comprisng means operative to apply adhesive to limited zones of the end wall defining portions of each blank, forming means acting on each blank after adhesive has been applied to the latter and including a forming plate having an opening therein and a rectangular mandrel coextensive with the bottom defining portion of the blank and movable through said opening to push the bottom defining portion of a blank disposed against said plate through said opening in the latter, said opening having substantial clearance with respect to the longitudinal and end edges of said rectangular mandrel and smaller clearance with respect to the corners of the latter so that, as the bottom defining portion of a blank is pushed through said opening, the tabs are folded with respect to the front and back wall defining portions at a relatively fast rate while the front, back and end wall defining portions are folded with respect to the bottom defining portion, thereby ensuring the disposition of the folded tabs inside of the folded end wall defining portions for engagement with said zones of adhesive on the latter, pressing plates disposed adjacent the paths of travel of the ends of said mandrel after the latter passes through said opening of the forming plate, means mounting said pressing plates for movement with said mandrel, roller means in rolling contact with the surfaces of said pressing plates facing away from the mandrel, and spring actuated means urging said roller means against said pressing plates to press the latter toward said ends of the mandrel during movement of said pressing plates with said mandrel so that the tabs and end wall defining portions of the folded blank pushed through said opening of the forming plate are securely pressed together between said pressing plates and said ends of the mandrel to ensure a firm bond between the tabs and end wall defining portions at said zones of adhesive.

4. A box forming machine as in claim 3; wherein said roller means include endless chains of linked together rollers and housings for the roller chains defining closed paths of travel having runs extending parallel to the direction of movement of said pressing plates with the mandrel, said rollers being in simultaneous rolling engagement with said housings and said pressing plates to move along said closed paths in response to movement of said pressing plates with said mandrel.

5. A box forming machine as in claim 3; further comprising shims secured to said surfaces of the pressing plates facing away from the mandrel and coming between said pressing plates and roller means during movement of said pressing plates with said mandrel, thereby to increase the force with which said pressing plates are spring urged toward said ends of the mandrel.

6. A machine for forming boxes from one-piece flat blanks each having a rectangular bottom defining portion, front, back and end wall defining portions foldably joined to the margins of the bottom defining portion and tabs foldably joined to the ends of the front and back wall defining portions; said machine comprising a magazine for holding a stack of the blanks, a horizontal support surface, delivery means operative to remove a blank from the stack in said magazine and to deposit the removed

blank on said support surface, means operative to apply adhesive to limited zones of the upwardly facing surfaces of the end wall defining portions of the blank on said support surface, a horizontal forming plate having an opening therein, a vertically reciprocable mandrel movable through said opening, conveying means operative to transport the blank to which adhesive has been applied from said support plate onto said forming plate, drive means for said mandrel coordinated with said conveying means to move said mandrel downwardly through said opening when a blank is disposed on said forming plate, said opening of the forming plate and said mandrel cooperating, during the downward movement of said mandrel through said opening, to upwardly fold said front, back and end wall defining portions and to fold said tabs inwardly relative to said front and back wall defining portions for engagement with said zones of adhesive on the end wall defining portions, pressing means disposed below said forming plate and cooperating with said mandrel as the latter moves downwardly below said forming plate to press together therebetween the folded tabs and end wall defining portions and thereby ensure a firm bond at the zones of adhesive, said support plate having openings therein located so as to be covered by said zones of the end wall defining portions of the blank deposited on said support surface; said means operative to apply adhesive to the limited zones including an upper arm for each zone having an adhesive applying element thereon and being rockable between a raised position clear of said support surface and a lowered position where said element can project downwardly into the related opening of said support surface, adhesive containing means disposed below said support surface, a lower arm associated with each upper arm and having an adhesive transferring portion, said lower arm being rockable in said adhesive containing means between a lowered position where said adhesive transferring portion picks-up adhesive and a raised position where said adhesive transferring portion projects upwardly into the related opening of said support surface, and actuating means operative to cyclically rock the related upper and lower arms between said raised and lowered positions, respectively, and said lowered and raised positions, respectively, at a frequency twice that at which said delivery means disposes the successive blanks on said support surface so that, during every other rocking cycle when a blank is absent from said support surface, said adhesive applying element contacts said adhesive tranferring portion through the related opening to receive adhesive from said adhesive transferring portion, and, during the intervening rocking cycles, said adhesive applying element contacts the blank covering the related opening of said support surface to apply the adhesive thereto.

7. In a machine of the described character; the combination of a support surface, means for individually delivering blanks to said support surface, means for removing the successive blanks from said support surface, means for applying adhesive to at least one limited zone of the upwardly facing surface of each blank during residence of the latter on said support surface, said support surface having an opening positioned to underlie said limited zone of a blank on the support surface, and the adhesive applying means comprising an upper arm for each zone having an adhesive applying element thereon and being rockable between a raised position clear of said support surface and a lowered position where said element can project downwardly into the related opening of said support surface, adhesive containing means disposed below said support surface, a lower arm associated with each upper arm and having an adhesive transferring portion, said lower arm being rockable in said adhesive containing means between a lowered position where said adhesive transferring portion picks-up adhesive and a raised position where said adhesive transferring portion projects upwardly into the related opening of said support surface, and actuating means operative to cyclically rock the related upper and lower arms between said raised and lowered positions, respectively, and said lowered and raised positions, respectively, at a frequency twice that at which said delivery means disposes the successive blanks on said support surface so that, during every other rocking cycle when a blank is absent from said support surface, said adhesive applying element contacts said adhesive transferring portion through the related opening to receive adhesive from said adhesive transferring portion, and, during the intervening rocking cycles, said adhesive applying element contacts the blank covering the related opening of said support surface to apply the adhesive thereto.

8. In a machine of the described character; the combination as in claim 7, wherein said actuating means includes shaft means turnable between first and second positions and carrying two actuating pins, said upper arm having a notch loosely receiving one of said pins and said lower arm having a nose engageable by the other of said pins, said pins being disposed relative to said shaft means so that, in said first position of the latter, said one pin moves said upper arm to said raised position of the latter while said other pin moves away from said nose to permit said lower arm to drop to said lowered position of the latter, while, in said second position of the shaft means, said other pin acts against said nose to move said lower arm to raised position thereof and said one pin is disposed to permit said upper arm to drop to said lowered position thereof with clearance remaining between said notch and said one pin.

9. In a machine for forming boxes from one-piece flat blanks each including a rectangular bottom defining portion, front, back and end wall defining portions foldably joined to the margins of the bottom defining portion and tabs foldably joined to the ends of the front and back wall defining portions, and each having adhesive applied to limited zones of one surface of the end wall defining portions; the combination of a horizontal forming plate adapted to receive each blank with the zones of adhesive facing upwardly and having an opening in the forming plate, and a rectangular mandrel coextensive with the bottom defining portion of the blank and movable vertically down through said opening to push the bottom defining portion of a blank disposed on said plate through said opening in the latter, said opening having substantial clearance with respect to the longitudinal and end edges of said rectangular mandrel and smaller clearance with respect to the corners of the latter so that, as the bottom defining portion of a blank is pushed through said opening, the tabs are folded with respect to the front and back wall defining portions at a realtively fast rate while the front, back and end wall defining portions are folded with respect to the bottom defining portion, thereby ensuring the disposition of the folded tabs inside of the folded end wall defining portions for engagement with said zones of adhesive on the latter, pressing means disposed below said forming plate and cooperating with said mandrel as the latter moves downwardly below said forming plate to press together therebetween the folded tabs and end wall defining portions and thereby ensure a firm bond at the zones of adhesive, said pressing means including vertically movable, upstanding pressing plates disposed adjacent the paths of movement of the ends of said mandrel below said forming plate, means yieldably urging said pressing plates upwardly against the underside of said forming plate, shelf defining means on said pressing plates engageable by said mandrel during downward movement of the latter below said forming plate so as to cause downward movement of said pressing plates with said mandrel, and means urging said pressing plates laterally toward said ends of the mandrel during movement of said pressing plates with the latter so that the folded tabs and end wall defining portions of the blank are pressed together between said ends of the mandrel and said pressing plates.

10. In a box forming machine; the combination as in

claim 9, wherein said means urging the pressing plates laterally toward the ends of the mandrel includes roller means in rolling contact with the outwardly facing surfaces of said pressing plates, and spring actuated means urging said roller means toward the related roller means.

11. In a box forming machine; the combination as in claim 10, wherein each of said roller means includes an endless chain of linked together rollers, and a housing for said chain defining an inner race on which said rollers roll during movement along a closed path having at least one substantially vertical run adjacent said outwardly facing surface of the related pressing plate so that each roller, during movement along said run, is in simultaneous rolling engagement with the vertically moving pressing plate and said inner race.

12. In a box forming machine; the combination as in claim 9, further comprising means operative to strip the formed box from said mandrel in response to initial upward movement of the latter, and ejecting means operative to discharge the stripped box from between said pressing plates.

13. In a box forming machine; the combination as in claim 12, wherein said means urging the pressing plates laterally toward the ends of the mandrel during movement with the latter exerts a relatively increased force during a final increment of the downward movement of the mandrel, and wherein said ejecting means acts on the stripped box to discharge the latter from between the pressing plates after the mandrel has moved upwardly to the extent necessary to relax the force exerted on said pressure plates by said means urging the pressure plates toward the mandrel, whereby the box is free to be ejected.

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