Sept. 14, 1943. L. E. LA BOMBARD 2,329,353

METHOD OF AND APPARATUS FOR FOLDING BLANKS

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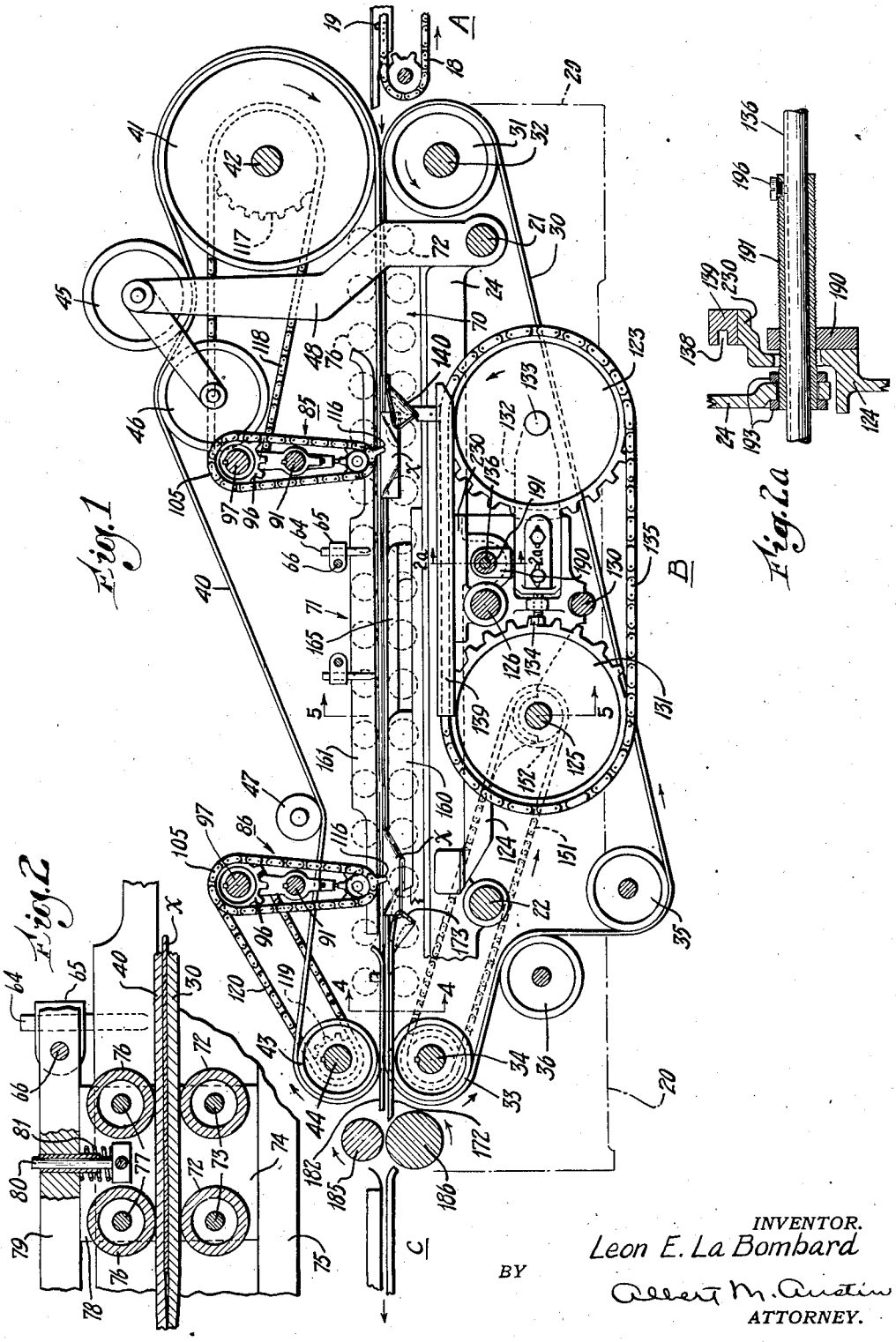


Fig. 1



Fig. 2



Fig. 2a

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METHOD OF AND APPARATUS FOR FOLDING BLANKS

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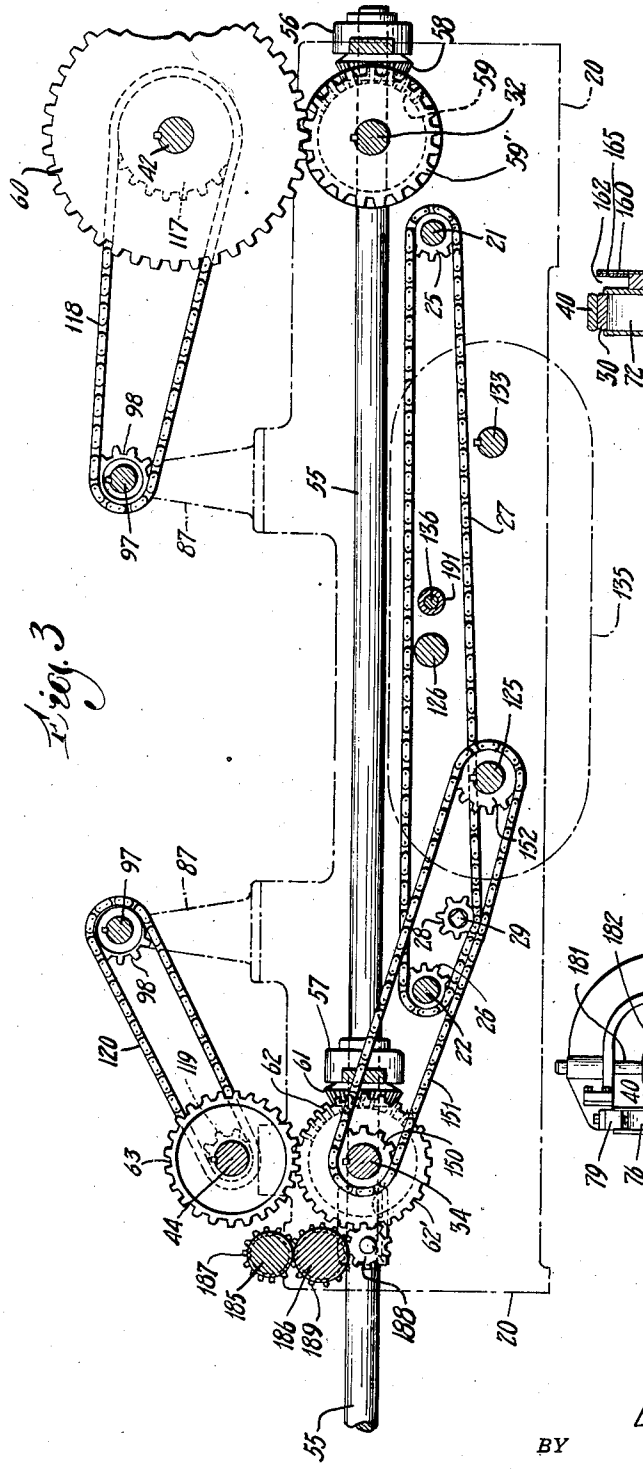


Fig. 3

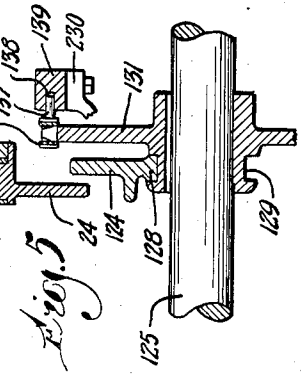


Fig. 5

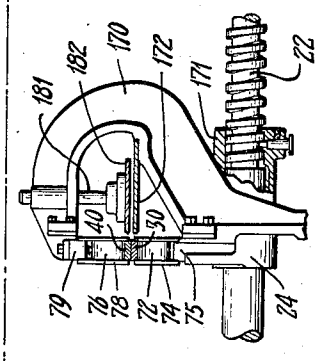


Fig. 4

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METHOD OF AND APPARATUS FOR FOLDING BLANKS

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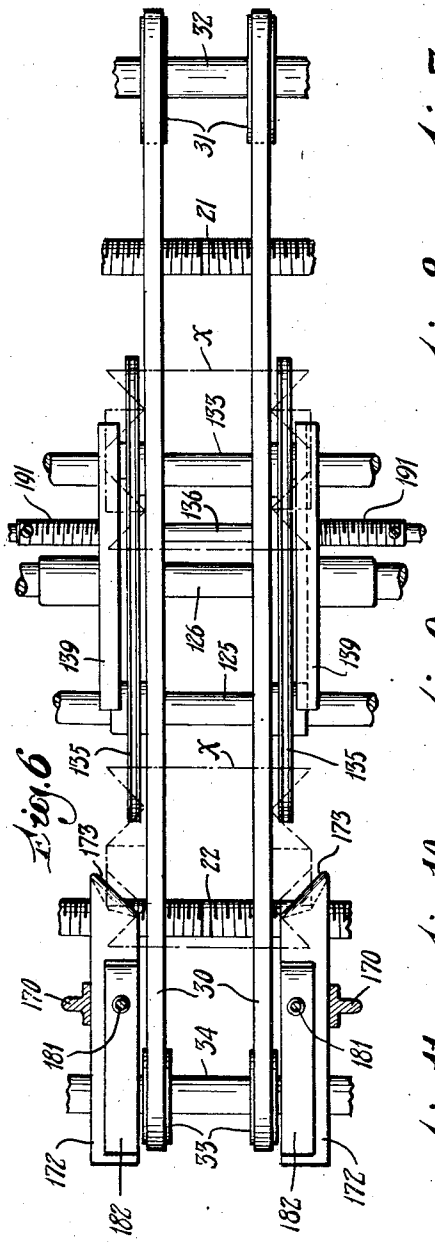


Fig. 6

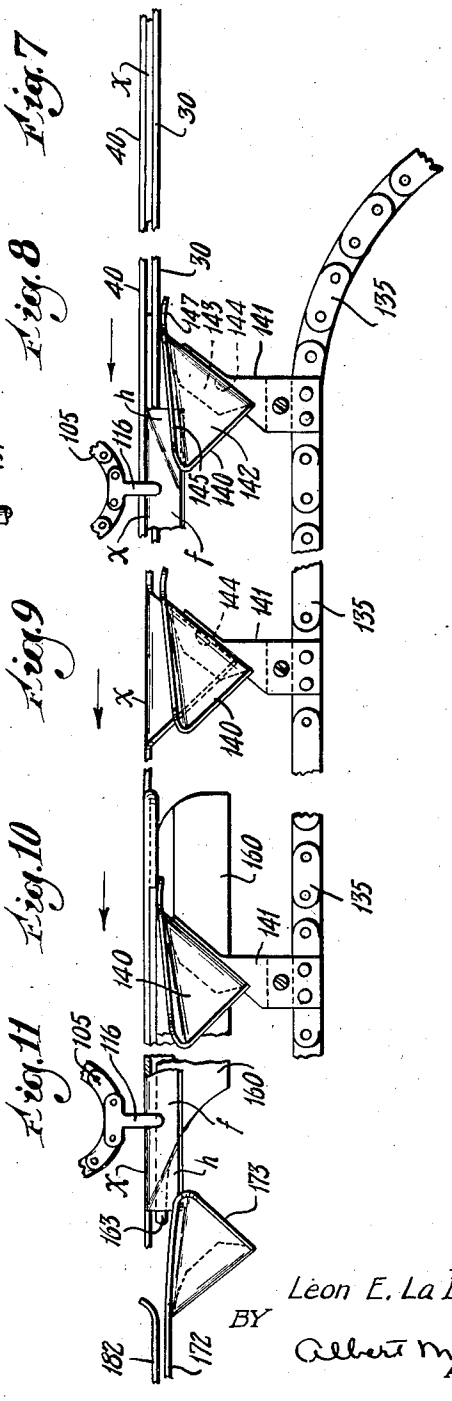


Fig. 7

Fig. 8

Fig. 9

Fig. 10

Fig. 11

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METHOD OF AND APPARATUS FOR FOLDING BLANKS

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Fig. 12

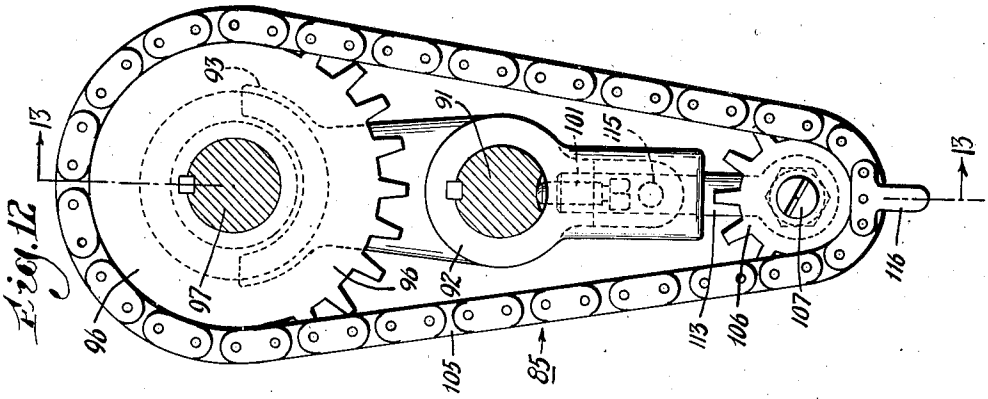
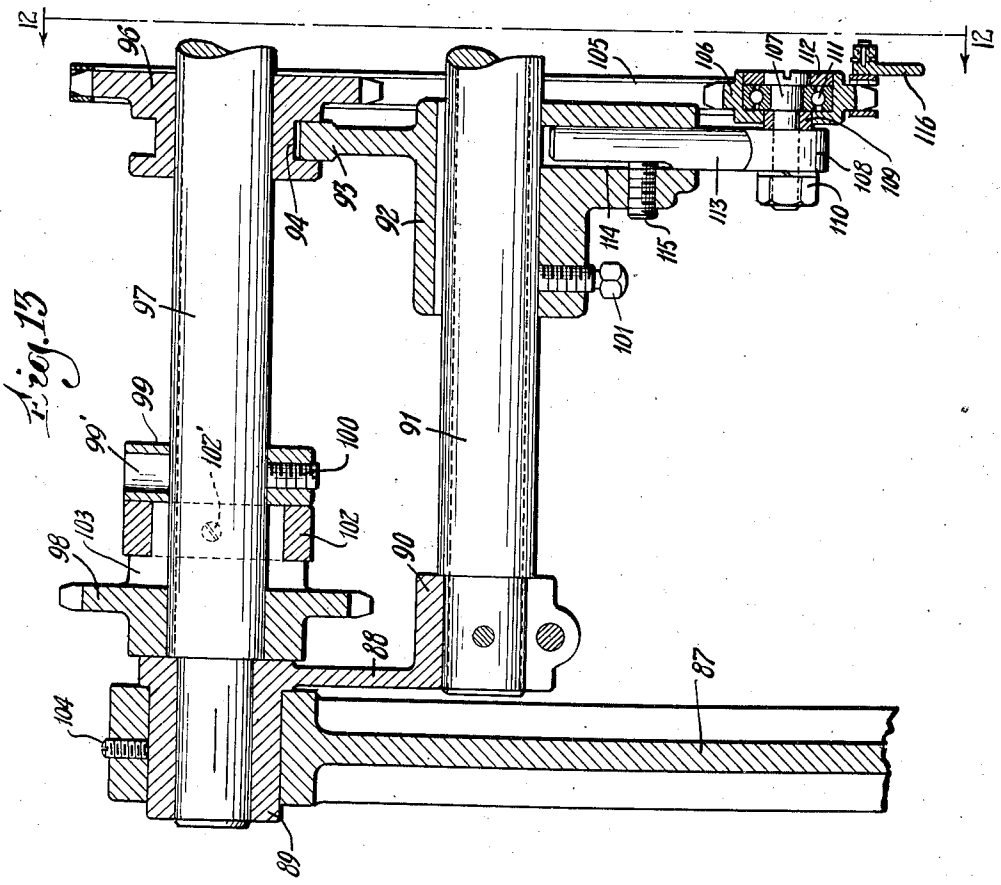



Fig. 13




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METHOD OF AND APPARATUS FOR FOLDING BLANKS

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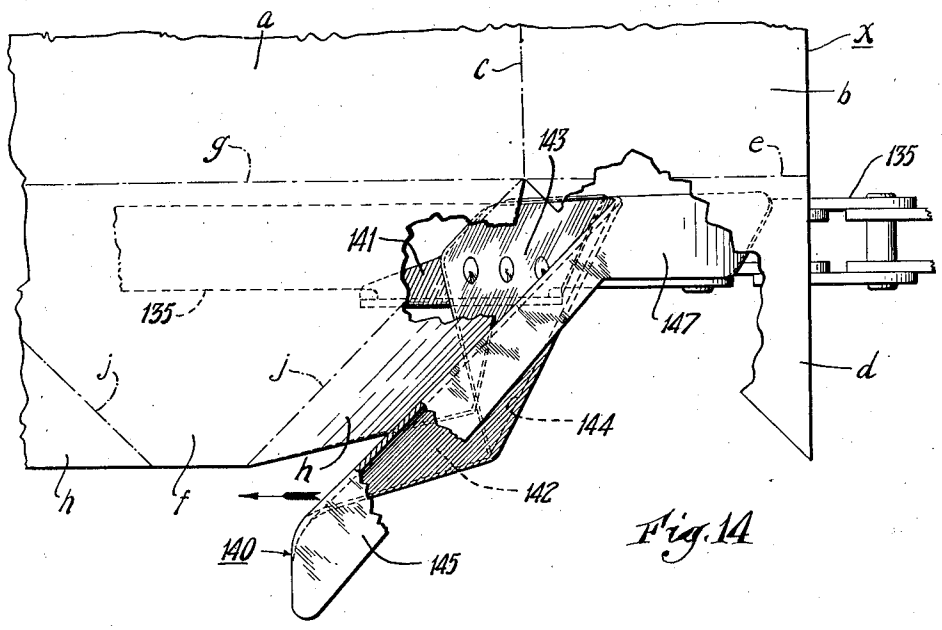



Fig. 14

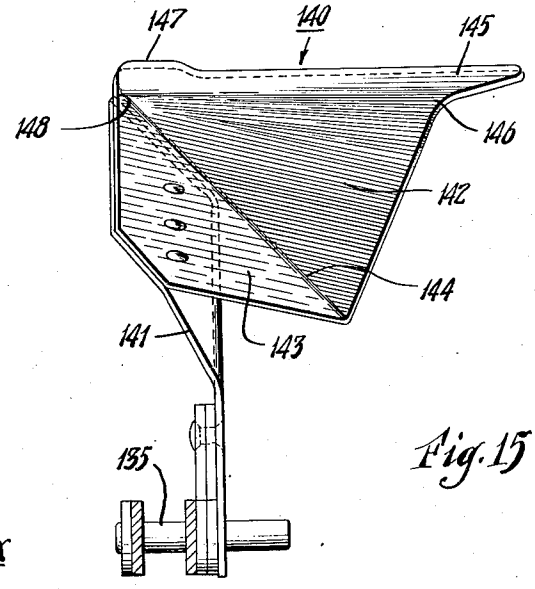
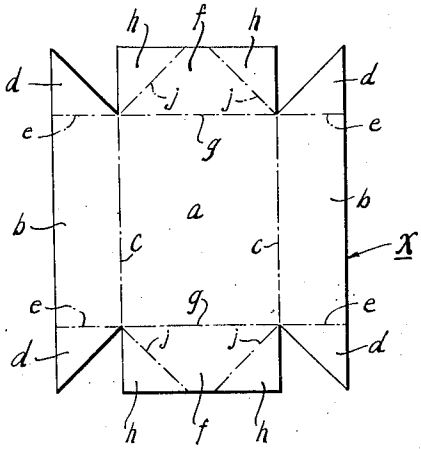



Fig. 15

Fig. 16




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METHOD OF AND APPARATUS FOR FOLDING BLANKS

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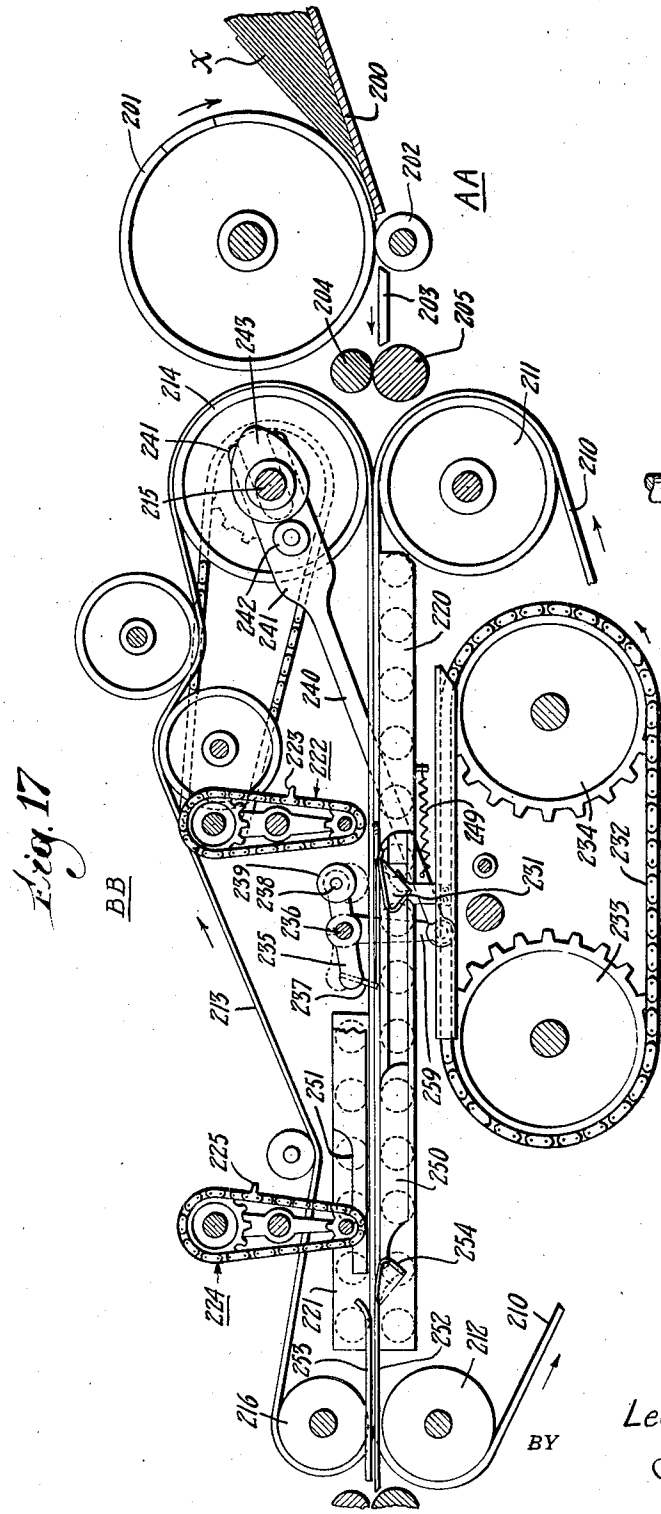



Fig. 17

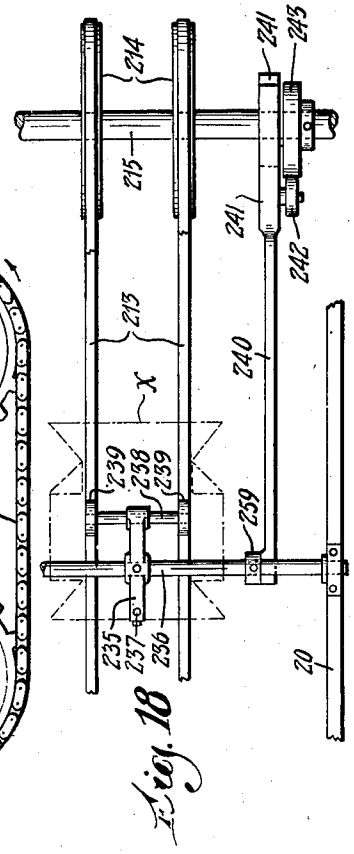



Fig. 18

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Patented Sept. 14, 1943 2,329,353

# UNITED STATES PATENT OFFICE

2,329,353

## METHOD OF AND APPARATUS FOR FOLDING BLANKS

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Application February 7, 1940, Serial No. 317,646

16 Claims. (Cl. 93—49)

This invention relates to a method of and apparatus for folding blanks, and more particularly to the folding of blanks of paperboard or the like for making boxes, cartons, etc.

Heretofore in folding blanks it has been customary to apply a folding force to the surface or face of the portion to be folded, and accordingly, in the case of many different types of folds it has been found necessary to support the blank adjacent the line of fold in order to accurately determine the fold and to prevent tearing of the blank as often happened when the blank was bowed. In many types of folds this has required relatively complicated apparatus for performing the folding operation, and especially where it is desired that the blank be caused to travel during folding. One type of fold which is usually difficult to make is a "forward fold," namely one in which the folded portion of the blank is turned about the line of fold toward the direction of movement of the blank. The present invention contemplates a method of and apparatus for performing folds including forward folds, in a simple, positive and accurate manner.

In accordance with the invention, a folding force is applied against an edge of the blank in a direction toward the line about which the blank is to be folded to deflect the edge, and adjacent portion of the blank, out of the plane of the remainder of the blank, whereafter the movement of the edge away from the plane of the blank is positively halted, which "breaks" or folds the blank along a predetermined line of fold, and thereafter the folding force is continued to continue the movement of the folded portion of the blank about the line of fold.

The invention also contemplates the provision of a machine for folding blanks which, in accordance with the above-mentioned illustrative embodiment, includes a suitable conveyor for advancing the blanks through the machine with the portions to be folded suitably exposed and presented for folding. The marginal portion or portions of the blank to be folded are deflected out of the plane of the remainder of the blank by deflector members of suitable construction. One or more folder members are carried by endless traveling members periodically into position to engage the rear corners of the marginal portions to be folded, which folder members are advanced at a faster speed than the blank thereby to fold the corners about fold lines inclined to the path of movement of the blank. Each folded marginal portion of the blank is received from the folder member by suitable holding means, such as a bar extending along the path of movement of the blank and maintained in folded condition. Where the forward corner of the marginal portion of the blank is to be folded, it is carried into engagement with a folder member, which preferably is stationary and which operates generally in a manner analogous to the traveling folder member, after the marginal portion of the blank first has been deflected by suitable means.

It is often desirable in manufacturing various articles from blanks, as for example, cartons and the like, to fold the blanks along lines making an angle of less than 90° with the principal fold lines or the edges of the blank. One example of such folding is in the manufacture of boxes of the type known as flat folded or collapsible wall boxes which have a bottom wall and side walls standing upright therefrom. In order to permit such boxes to be collapsed, it is necessary to provide, in certain of the walls, fold lines forming an angle of less than 90° with the principal fold lines which occur between adjacent walls. Angular folds are generally considered to be more difficult to make than the so-called straight folds. The present invention is especially well adapted for making such folds and is described in connection with its application to the manufacture of boxes having angular folds, but the invention is not thus limited.

An object of the present invention is the provision of a method of making folds in blanks in a simple, efficient and rapid manner.

Another object of the invention is the provision of a method of making angular or diagonal flaps wherein the fold can be made without the necessity for supporting the marginal portion of the blank in which the fold is made.

Another object of the invention is the provision of a machine for making partially finished, or completed collapsed or flat folded boxes or cartons, which machine is simple, accurate and has a high production rate.

Still another object of the invention is the provision of a machine for making forward straight or angular folds in blanks, in which machine it is not necessary to provide highly accurate timing of the blanks through the machine.

Still another object of the invention is the provision of a machine for making angular or diagonal folds in blanks which will accurately make the folds and does not require deep scoring of the blank.

Various other features and advantages of the

invention will be apparent from the following particular description and from an inspection of the accompanying drawings.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, and the manner in which it may be carried out, may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part hereof, in which:

Fig. 1 is a fragmentary side elevational view partially in cross section of a folding machine constructed in accordance with an illustrative embodiment of the invention;

Fig. 2 is an enlarged fragmentary cross-sectional view of a detail of the blank conveyor of the machine shown in Fig. 1;

Fig. 2A is an enlarged, fragmentary cross-sectional view taken along the line 2A—2A of Fig. 1;

Fig. 3 is a side elevational, somewhat diagrammatic view showing particularly the drive mechanism of the machine;

Fig. 4 is an enlarged fragmentary, vertical cross-sectional view taken along the line 4—4 of Fig. 1;

Fig. 5 is an enlarged, fragmentary, vertical cross-sectional view taken along the line 5—5 of Fig. 1;

Fig. 6 is a fragmentary, horizontal, sectional view taken approximately along a line passing between the upper and lower conveyor belts of Fig. 1, with certain of the structure omitted for the sake of simplifying the showing;

Figs. 7 to 11, inclusive, are fragmentary, diagrammatic, side elevational views of successive portions of the machine, and illustrating the progress of the blank through the machine, the cooperative relation between the blank and certain portions of the machine, and certain steps in the angular folding operation;

Fig. 12 is an enlarged fragmentary and partially sectional view showing a deflector mechanism;

Fig. 13 is a vertical cross-sectional view taken along the line 13—13 of Fig. 12;

Fig. 14 is an enlarged plan view of a folder member and a portion of a blank;

Fig. 15 is a front elevational view of the folder member shown in Fig. 14;

Fig. 16 is a plan view of one form of blank which can be folded by the machine constructed in accordance with the present invention;

Fig. 17 is a side elevational and somewhat diagrammatic view of another form of folder mechanism constructed in accordance with the invention; and

Fig. 18 is a fragmentary and somewhat diagrammatic top plan view showing particularly the stop mechanism of the structure of Fig. 17.

In the following description and in the claims, various details will be identified by specific names for convenience, but they are intended to be as generic in their application as the art will permit. Like reference characters denote like parts in the several figures of the drawings.

In order to facilitate explanation of the operation of the machine in accordance with the present invention, there is shown in Fig. 16 one form of blank *x*, from which a box can be made in accordance with the present invention. It will be understood, however, that the invention is not limited to the folding of a box of this particular type but is capable of application to folding many other types and sizes of blanks.

The blank *x* includes a top or bottom wall *a*, and side walls *b*, foldable about score lines *c*. The side walls are provided with attaching flaps *d* foldable about score lines *e*. End walls *f* are foldable about score lines *g* and are provided with angular score lines *j* defining triangular corner portions *h* to which the end flaps *d* are adapted to be adhesively secured.

The blank is formed into a box by folding it in suitable sequence along the several score lines and by adhesively attaching the end flaps *d* to the corresponding triangular corner portions *h*, the box being completed in folded condition in a manner customary for this type of box and adapted to be set up by raising the side and end walls in the usual manner. The blank *x* is adapted to be made into a box of the so-called infolded type, wherein the side walls are folded inwardly onto the bottom.

Referring now to Fig. 1 of the drawings, there is shown for the purpose of illustration, a folding machine comprising a feeding-and-timing section A, a folding section B and a delivery section C. It will be understood that the folding section B will usually be employed as a component part of a machine for performing other operations on the blanks. It is, therefore, also within the contemplation of the present invention to provide a machine for making either semi-finished, or completely finished, collapsed boxes. Such machine, as hereinafter more fully described, has, in addition to the folding section B, additional sections for performing one or more additional operations as for example, making additional folds in, gluing, applying window material to, stacking, delivering the blanks, etc.

The feeding and timing section A may be of any known construction, as for example, a mechanism including means (not shown) for withdrawing the blanks individually from a stack and means, such as carrier chains 18, having lugs 19 for engaging the blanks and delivering them to the folding section B in spaced and timed relation.

The folding section B includes relatively fixed side frames 20 (one of which is shown) suitably secured to each other or to a common base (not shown). Journaled in the fixed side frames 20 are doubly threaded shafts or screws 21 and 22 which adjustably support movable frames 24, 24 (one of which is shown). The adjustable side frames 24, 24 can be adjusted laterally toward or away from one another by turning the screws 21 and 22.

For the purpose of adjusting the spacing of the adjustable side frames 24, 24 on the screws 21 and 22 simultaneously, an adjusting mechanism may be provided (see Fig. 3) which includes a sprocket 25 on the screw 21, a sprocket 26 on the screw 22, a chain 27 chained over the sprockets 26 and 25, and a driving sprocket 28 carried on a shaft 29. When the shaft 29 is turned, it causes the doubly threaded screws 21 and 22 to turn accordingly in unison and thus adjust the lateral spacing of the frames 24, 24.

A conveyor is provided for carrying the blanks through the folding section B and includes generally similar, right-hand and left-hand portions, associated respectively with the adjustable side frames 24, 24 on the two sides of the machine (see also Fig. 6). For convenience, the mechanism on one side only of the machine will be explained in detail hereinafter, it being under-

stood that, except where otherwise expressly stated, the other mechanism is similar, but enantiomorphic.

A lower carrier belt 30 is trained over a front pulley 31 mounted on a shaft 32 and over a rear pulley 33 mounted on a shaft 34. The shafts 32 and 34 are journaled in the fixed side frames 20, 20 and the pulleys 31 and 33 are engaged by suitable means (not shown) carried by the adjustable side frames 24, 24, whereby, when the adjustable side frames 24, 24 are moved, the pulleys 31 and 33, and the belt 30 are adjusted accordingly. One or more belt take-up pulleys 35, 36 also may be provided.

Two upper carrier belts 40, 40 (one of which is shown) are provided and each belt 40 is trained over a front pulley 41 carried on a shaft 42 and around a rear pulley 43 carried on a shaft 44. Suitably mounted belt take-up pulleys 45, 46 and 47 may be provided. The shafts 42 and 44 are journaled in the fixed side frames 20, 20 and the pulleys 41 and 43 are connected in a suitable manner to the corresponding frame 24 for adjustment of the pulleys and associated belt 40 therewith. The take-up pulleys 45 and 46 are supported by a bracket 48 carried by the frame 24.

For the purpose of carrying blanks through the machine, the belts 30 and 40 are caused to travel at the same speed by a drive mechanism, illustrated more particularly in Fig. 3. A drive shaft 55, which may be rotated in any suitable manner, is journaled in relatively fixed bearings 56 and 57 and carries a front bevel gear 58 meshing with a bevel gear 59 which drives the shaft 32. A spur gear 59' rigid with the bevel gear 59 drives a gear 60 which in turn drives the shaft 42. At the rear end of the machine a bevel gear 61 driven by the drive shaft 55 meshes and drives a bevel gear 62 which in turn drives the shaft 34. A spur gear 62' meshes with a gear 63 which drives the shaft 44.

Lower and upper pressure units 70 and 71 (Figs. 1 and 2) are provided for the purpose of supporting the active or working runs of the belts 30 and 40 respectively, and for pressing them together under sufficient pressure to grip the blanks therebetween for advancing the blanks through the machine by the movement of the belts. The lower pressure unit 70 includes a series of rollers 72 mounted respectively on shafts 73, which shafts are journaled in pairs in plates 74 which in turn are secured in a frame 75 carried by the adjustable side frame 24. The rollers 72 bear against the under surface of and support the lower carrier belt 30 and are free to rotate as the belt is caused to travel.

The upper pressure unit 71 includes a series of rollers 76 carried on shafts 77 respectively, which shafts are journaled in pairs in plates 78. The plates 78 are individually mounted for vertical movement by means of plungers 80 working in a frame 79, and are normally urged downwardly by a spring 81 to press the rollers 76 into engagement with the upper surface of the upper carrier belt 40. The rollers 76 are free to rotate upon movement of the upper carrier belt 40, and yieldingly hold the upper belt against the lower belt but permit the introduction of blanks between the belts.

When blanks are delivered between the nip of the carrier belts 30 and 40, by the feeding and timing mechanism A, the blanks are engaged by the active runs of the belts and are advanced at the same speed as the belts. The sets of belts are positioned to engage blanks inwardly of the inner ends of the angular folds. In order to adjust the lateral spacing of the paired sets of belts to accommodate blanks of different widths, the side frames 24, 24 are adjusted in the manner above described by turning the shaft 29, and the belts 30, 30 and 40, 40 and their associated mechanisms are adjusted accordingly.

In order to initially deflect the lateral marginal portions of the blank out of the plane of the remainder of the blank for engagement by folder members (to be described hereinafter), one or more, and in the present case, two deflector mechanisms 85 and 86 are disposed along the path of the blanks, at each side of the machine. Inasmuch as the deflector mechanisms 85 and 86 are generally similar, only one of these will be described in detail, it being understood that the others are similar except as otherwise expressly pointed out.

One of the deflector mechanisms 85 is illustrated somewhat in detail in Figs. 12 and 13, to which figure reference now is made. The deflector mechanism 85 is mounted on a bracket 87 extending upwardly from the corresponding side frame 24 and is adjustable bodily thereon, about a horizontal axis, for a purpose hereinafter explained.

A supporting arm 88 has a bushing portion 89 which is received in a bore in the bracket 87, and a clamp portion 90 in which is inserted and secured a shaft 91. A member 92 is carried on and secured in a non-rotatable but axially adjustable manner to the shaft 91 as by a set screw 101. The member 92 has a yoke portion 93 which is inserted in a groove 94 in the hub of a sprocket 96. The sprocket 96 is carried on and non-rotatably secured to a shaft 97 journaled in the bushing 89 and carrying fixedly thereon a driving sprocket 98.

The driving sprocket 98 has a split hub 103, which receives a clamp collar 102 secured by a set screw 102', and which clamps the hub against the shaft 97. Thus, the angular position of the shaft 97 relative to the sprocket 98 can be adjusted to vary the relation between the sprockets 98 and 96. A collar 99, secured by a set screw 100, may be provided to permit angular adjusting movement of the shaft 97 by inserting a turning rod or wrench (not shown) in a socket 99' in the collar 99.

A deflector chain 105 is trained around the sprocket 96 and around a lower sprocket 106 of small diameter rotatably carried by a stud bolt 107 journaled in a bearing 108 and suitably secured as by a spacer 109 and nut 110. Preferably, the lower sprocket 106 is journaled on the stud 107 by a ball bearing 111, secured by a lock ring 112.

The bearing 108 is carried by a stud 113 received in a bore 114 in the member 92 and secured therein as by a set-screw 115. Thus the distance of the lower sprocket 106 from the upper sprocket 96 may be readily adjusted in order to tighten the chain 105.

The chain 105 detachably carries a depresser finger 116 adapted to engage and deflect the marginal portion of the blank. Where the deflector chain 105 is designed to make one complete circuit per single blank and to depress a single marginal portion thereof, only one deflector finger 116 is provided. However, in certain cases, as for example, where small sized blanks are being run, it is desirable to operate upon more than a single blank per trip of the deflector chain. In that case additional deflector

fingers are attached to the deflector chain at equal intervals around the length of the chain. In an analogous manner, it may be desired to deflect various portions of a single blank selectively, in which case the deflector fingers 116 are suitably spaced around the length of the chain 105.

The deflector mechanism 85 is actuated by a drive chain 118 trained around the sprocket 98 (see Figure 3) and around a sprocket 117 carried by the shaft 42. In an analogous manner, the rearward deflector mechanism 86 is driven by a chain 120 trained around the sprocket 99 and around a sprocket 119 on the shaft 44.

Means other than fingers carried on chains can be provided for deflecting the marginal portions of the blanks, as for example, oscillating fingers, rotating arms or vacuum, or air pressure. In certain cases, as where the blank has relatively wide side flaps or marginal portions which tend to droop out of the plane of the remainder of the blank, means may be provided for supporting out of the way of the folder members, those flaps which are not to be folded.

For the purpose of making what is referred to herein as the angular fold, a folder mechanism including a folder member and supporting and actuating means therefor is disposed at each side of the machine (see Figs. 1 and 6). Since similar mechanisms are provided at the two sides of the machine, only one will be described in detail.

A frame 124 is supported on a shaft 126 and held against turning by a shaft 125 both of which shafts are mounted by the main side frames 20. The frame 124, is not supported directly on the shaft 125, but is provided with a yoke 128 which enters a slot 129 in the hub of a sprocket 131 mounted on the shaft 125. The lateral spacing of the frame 124 and the mechanism carried thereby from the similar frame 124 on the other side of the machine is adjusted by a shaft 136 having suitable engagement with the two frames.

Referring now to Fig. 2A, the shaft 136 is secured as by a set screw 196 in an externally threaded collar 191 threaded through a nut rigidly secured to the frame 124. The collar 191 extends through the adjustable side frame 24 and is connected thereto by flanges 193 secured to the collar 191. The shaft 136 extends through to the other side of the machine and a similar mechanism cooperates therewith. The frames 124 thus can be adjusted relatively to the frames 24 in a lateral direction by turning the shaft 136.

An endless chain 135 is trained around the sprocket 131 and a sprocket 123 carried on a shaft 133. The shaft 133 is journaled in an arm 132 adjustably carried by the frame 124. For the purpose of adjusting the distance of the sprocket 123 from the sprocket 131, an adjusting screw 134 preferably is provided.

The upper run of the chain 135 may be guided and supported by a track 139 having a slot 138 (Fig. 5) therein which receives pins 137 carried by the chain 135. The track 139 is carried by a bracket 130 extending from the frame 124 and adjustable laterally therewith.

The chain 135 detachably carries a folder member or "folder" 140 adapted to engage and fold a corner of the marginal portion of the blank along an angular line of fold. Although in the present illustrative embodiment, only one such folder member is shown on the chain 135, it is within the contemplation of the invention to provide two or more folder members on the chain if desired. Where each of such folder members is to fold a separate blank, the folder members usually will be spaced at equal distances around the length of the chain. On the other hand, where it is desired to make successive folds in a single blank the folder members may be suitably spaced on the chain.

The folder member 140 is rigidly supported on the chain 135 by an upstanding bracket 141 detachably secured on the chain, and includes an inclined folder surface 142 extending outwardly and downwardly from an apex 148 formed by the upper edge 146 and the lower edge 144. An abutment is provided at the lower edge 144 as by a shelf 143, which preferably is wide enough for engagement with a corner of the blank as hereinafter described. A tail 147 extends rearwardly from adjacent the apex 148 and the upper edge 146 may be formed with rearwardly extending flange or a rolled edge to prevent marring of the blanks.

Referring now particularly to Fig. 3, the sprocket 131 is driven from the main drive shaft by a chain 151 trained around a sprocket 150 secured to the shaft 34 and around a sprocket 152 secured on the shaft 125.

When the main drive shaft 55 is driven, it operates through the mechanism just described to drive the sprockets 131 and cause the chain 135 to travel, thereby causing the folder member 140 to travel similarly. The folder member 140 thus is repeatedly brought into position to engage the marginal portion of a blank, which has been deflected by the deflector mechanism 85 into the path of the folder member 140. The folder member 140 travels past the blank in the direction of travel of the blank and at a faster speed and, in the course of such travel effects a folding operation on the rearward corner of the marginal portion of the blank to fold it downwardly and forwardly about the angular fold line. This operation is described more in detail hereinafter.

Mounted over the path of the blanks and in position to overlie the marginal portions of the blanks are upper guide plates or holder bars 161, which are adapted to limit the upward movement of the marginal portions when the folds are made. The holder bars 161 preferably extend from adjacent the point of engagement of the folder member 140 and blank to adjacent the rear end of the folding section. The holder bars 161 are carried by studs 64 vertically adjustable in blocks 65 which are in turn laterally adjustable on studs 66 secured in the frames 79 and the bars 161 therefore can be adjusted vertically and horizontally and can be positioned either inside or outside of the chains 105 of the depresser mechanisms 85 and 86.

Disposed along the path of movement of the marginal portion of the blank, are lower folder bars 160 (see Figs. 1 and 10), which receive the marginal portion of the blank after it has been folded by the folder member 140, and retain this portion of the blank in folded condition. It will be noted that the holder bar 160 is spaced slightly from the belts 38 and 40 to provide a space 162 which space permits the infolded edge portion of the blank to enter therein. The holder bar 160 preferably is formed with a longitudinally extendable forward end 165 which preferably telescopes with the forward end of the holder bar 160 proper.

The end or tail portion 163 of the lower holder

bar 160 is made flexible to permit it to move inwardly during the folding of the forward corner portion of the blank, as will be explained hereinafter.

Disposed along the path of movement of the blank at the rearward end of the machine, is a mechanism for folding rearwardly the forward corner of the marginal portion of the blank.

Referring particularly to Figs. 1 and 4, the rear folder mechanism includes a bracket 170 secured to the side frame 24 and carrying a lower holder plate 172. Disposed forwardly of, and preferably formed integral with the lower folder plate 172, is a folder member 173 which preferably is formed similarly to the folder member 140 but which faces rearwardly.

Inasmuch as the blank is traveling forwardly when it reaches the folder member 173, it is not necessary to cause the folder member 173 to move, but this member can be fixed and the blank allowed to move into engagement therewith to effect the folding. The deflector mechanism 86 depresses the marginal portion of the blank and causes it to enter the folder member 173, whereafter the folding of the forward corner of the marginal portion of the blank is accomplished in a manner analogous to the manner in which the rearward corner is folded by the folder mechanism 140.

After the forward corner has been folded, the blank enters between the lower holder plate 172 and an upper holder plate 182 carried by an adjustable rod 181 vertically slidable in the bracket 170. The folded corner portions of the blank thus are maintained in folded position.

Disposed adjacent the rearward end of the holder plates 172 and 182 are presser rolls 185 and 186 driven by gears 187 and 189 respectively (see Fig. 3), from the gear 62' by an intermediate gear 188 meshing with the gear 62' and the gear 189. The presser rolls 185 and 186 firmly press down the folded portions of the blank as the blank passes therethrough.

The blank is delivered by the presser rolls 185 and 186 to the delivery section C whereupon the blanks can be collected for subsequent further operations thereon, or can be conveyed to a folding, gluing or other mechanism for immediate carrying out of such additional operations as may be desired.

The folding operation is illustrated somewhat diagrammatically in Figs. 1, 7 to 11, and 14, inclusive in connection with blanks similar to blank $x$ of Fig. 16 for the purposes of illustration. Blanks $x$ are delivered successively and in timed and spaced relation by the feeding and timing section A into the nip of the belts 30 and 40 and advanced along the folding section B preferably at a constant speed of travel.

When each blank $x$ reaches a position under the forward deflector mechanisms 85, the deflector fingers 116 engage the marginal portions $f$ of the blank and deflect them slightly out of the plane of the remainder of the blank and into the paths of the folder members 140, respectively, the deflector fingers 116 being so positioned on the chains 105 and the chains driven at such speed, that the fingers 116 engage the marginal portions $f$ respectively as the blanks pass under the deflector mechanisms 85. However, it is not necessary that the deflector fingers engage any precise point on the marginal portions $f$ as a slight movement of the marginal portion out of the plane of the remainder of the blank is sufficient to carry it into the path of the corresponding folder member 140.

The folder chains 135 are driven at such speed, and the folder members 140 are so located on the chains that the folder members 140 are brought into engagement with the rear corners of the blank $x$ during the time the marginal portions $f$ of the blank are deflected by the deflector fingers 116. The inclined folding surface 142 moves into engagement with the blank and engages the edge of the extreme corner portion, and upon further movement relative to the blank, deflects the marginal portion $f$ of the blank further out of the plane of the body of the blank. The folder surface 142 is inclined in a forward and outward direction from the apex, and is also inclined rearwardly and downwardly from the upper edge 146, thus, as the inclined folder surface 142 moves into engagement with and along the marginal portion of the blank, it acts as an inclined plane to force the marginal portion downwardly and inwardly.

The marginal portion of the blank is deflected downwardly and inwardly until the rear edge strikes the abutment provided by the shelf 143. The apex 148 travels substantially along the line of juncture of the marginal portion $f$ with the bottom $a$ and the abutment extends downwardly and forwardly at such an angle from the apex 148 that, when the rear edge of the blank strikes the abutment, the edge and abutment are in accurate engagement throughout their mutual lateral extent, as shown in Fig. 9.

When the rear edge of the marginal portion $f$ strikes the abutment, the movement of the rear edge out of the plane of the blank is halted; the marginal portion is raised, and the blank is "broken" or folded along a line of fold which is determined accurately by the shape and disposition of the folder member 140, which line in the present illustrative embodiment is inclined substantially 45° to the path of movement of the blank. The positive halting of the downward movement of the edge of the blank positively and accurately determines the line along which the blank folds.

Further movement of the folder member 140 relative to the blank causes the upper edge 146 of the inclined folder surface 142 to bear against the folded corner $h$ of the blank below the plane of the marginal portion and to effect further movement of the folded corner portion $h$ about the line of fold $j$. The shelf 143 is disposed at such an angle, relative to the inclined folding surface so that the extreme corner edge of the blank $x$ rides up along the surface of the shelf 143 as the corner portion $h$ is further turned about the line of fold.

Still further movement of the folder member 140 relative to the blank causes the upper edge 146 of the inclined folder surface 142 to ride along the corner portion $h$, and the tail 147, assisted by the edge 146, completes the turning movement of the corner portion $h$, and holds it in folded condition until the blank $x$ is carried into position engaging the lower holder bar 160 and the edge of the folded corner $h$ enters the groove 162. Shortly after this the folder member 140 will have moved out of engagement with the blank and the blank then advances to its position under the rearward deflector mechanism 86.

The blank $x$ is advanced until the marginal portions pass under the rear deflector mechanisms 86 which deflect these portions out of the plane of the blank $x$. The forward corners $d$ of the marginal portions $f$ are carried into en-

gagement with the forward folding members 173 and folded thereby along lines *f* in a manner analogous to that in which the rear corners were folded.

The blank *x* is then carried into the space between the holder plates 172 and 182, and then between the rolls 185 and 186 and is delivered thereby to the delivery section *c*.

It will be noted that the tail portion 163 of the lower holder bar 160 is reduced in height and is flexible, which permits it to be deflected inwardly when the forward corner *h* of the blank *x* is folded inwardly and thus the tail portion 163 does not interfere with this folding operation, but, however, performs its intended function of retaining the rearward corner portion *h* in folded condition.

In certain cases it may be desirable to feed the blank directly to the folding section and to omit the separate timing section. In such a case, the timing or registering is effected in the folding section, and preferably, the folding is partially or entirely carried out while the blank is stationary. There is shown in Figs. 17 and 18, an embodiment of my invention constructed with this concept.

In this construction, a suitable feeding mechanism AA is provided which includes a chute or hopper 200 for supporting a stack of blanks, a feed or pull-out wheel 201 and a cooperating roll 202. A supporting floor or table 203 and cooperating feed rolls 204 and 205 are provided for guiding the leading edge of each blank into the nip of the belts of the folding section BB.

The folding section or mechanism BB may be generally similar to that above described except as hereinafter expressly pointed out. The folding mechanism BB includes lower carrier belts 210 trained around pulleys 211 and 212 and upper and cooperating carrier belts 213 trained around pulleys 214 and 216. A lower pressure unit 220 is provided for each lower belt and cooperating therewith are upper pressure units 221 which extend only partially along the length of the lower pressure units 220, for a purpose hereinafter to be explained.

Deflector mechanisms 222 and 224 having deflector fingers 223 and 225 respectively are provided in a manner generally similar to that in the construction described above.

A folder member 231 is carried by a chain 232 trained around sprockets 233 and 234 in a manner generally similar to that described above, and operates in a generally similar manner.

Disposed adjacent the path of travel of the belts 210 and 213 is a stop mechanism including a lever 235 rockably mounted by a shaft 236. The lever 235 carries a stop pin 237 adapted to be rocked into position in front of the leading edge of a blank carried by the belts 210 and 213 for the purpose of halting the blank.

At the other end of the lever 235 is a shaft 238 carrying rollers 239 adapted to bear respectively upon the two working runs of the upper belt 213, when the lever 235 is rocked in a clockwise direction.

Inasmuch as the working run of the upper belt 213 does not have any pressure unit cooperating therewith forwardly of the stop mechanism, the belts 210 and 213 grip the blanks with sufficient force only to carry the blanks into engagement with the stop pin 237. When the stop pin 237 is in operative position and the blank thus is halted in position against the stop pin 237, the belts slip relatively to the blank. However, when the lever 235 is rocked clockwise (as viewed in Fig. 17) to lift the stop pin 237 out of the path of the blanks, the rolls 239 bear against the upper belt 213 and press it against the lower belt 210 with sufficient force to again advance the blank.

The shaft 236 is rocked by a lever 250, pivotally connected to a pushrod 240 having a bifurcate head 241 engaged around the shaft 215 which carries the pulley 214. The shaft 215 also carries a cam 243 driving a follower 242 pivoted on the head 241 of the pushrod 240. When the shaft 215 is rotated to bring the high portion of the cam 243 against the follower 242 the pushrod 240 is driven rearwardly to rock the shaft 236 in a clockwise direction against the tension of a spring 249. However, when the cam 243 is rotated further, the follower 242 rides onto the low portion of the cam and the spring 249 causes the shaft 236 to be rocked in a counter-clockwise direction.

The mechanism is provided with lower and upper holder bars 250 and 251 and with lower and upper holder plates 252 and 253, as well as with a stationary folder member 254, all of which members are similar in construction and operation to the equivalent members in the previously described embodiment of the invention.

The operation of the modified form of the device is generally similar to the first described form. The blanks are successively withdrawn from the stack by the pull-out wheel 201 and delivered to the nip of the belts 210 and 213, which carry the blank to the stop mechanism. The stop mechanism is so timed that the stop pin 237 is in operative position when a blank reaches the stop mechanism. The blank is halted by the stop pin 237 and while thus halted, is engaged by the folder member 231 which is carried into engagement with and past the blank to fold the rear corner of the marginal portion of the blank, the marginal portion of the blank having been previously deflected by the deflector mechanism 222 into position to be engaged by the folder mechanism 231. The mechanism is so timed, that after the folder mechanism 231 has folded the corner portion along the angular line of fold, the stop mechanism operates to release the blank and allow it to be carried forwardly into the folder bars 250 and 251.

It will be understood that the mechanism may be timed so that only an initial portion of the fold is carried out while the blank is halted or, if desired, the fold may be completed before the blank is allowed to proceed. However, the blank is maintained in folded condition by the folder member 231 until it is inserted between folder bars 250 and 251. The blank is then advanced to the remainder of the machine and the folding of the forward corner is effected in a manner similar to that previously described.

As indicated in the foregoing description of the apparatus, numerous adjustments are provided for in order to adapt the machine for use in folding various types of blanks of varying shapes, sizes and proportions.

The right and left hand adjustable frames 24, their associated conveyor mechanisms, deflector mechanisms, folder mechanisms, holder bars, etc., are adjustable toward and away from each other in a lateral direction to adapt the machine for use with blanks of various widths. The upper holder bars also are adjustable laterally but independently of the frames 24 and, as above stated, can be disposed either inside or outside of the depresser chains 105. Also, the upper holder bar,

as well as the upper holder plate can be adjustable vertically to provide for operations on blanks of different thicknesses.

The mechanism also may be adjusted for operating upon blanks having marginal portions of various widths. For example, the frames 124 which carry the folder mechanism can be adjusted laterally with regard to their respective side frames 24 in order to adjust the distance of the folder members 140 relative to the cooperating belts 30 and 40. It will be noted, however, that by reason of the novel construction of the folder members 140, it is not necessary that they engage the portion of the blank to be folded at any particular point of the active surface of the folder member; any single adjustment of the folder member, therefore, will permit folding of a wide variety of blanks. It is, of course, necessary that the folder member 140 be sufficiently close to the conveyor so that it will engage the corner of the blank to fold the same. Additionally, the deflector mechanisms are so constructed, that the chains 105 and their cooperating sprockets 96 and 106 (Figs. 15 and 16) can be adjusted axially on the supporting shafts 91 and 97 so that the deflector fingers 116 will engage the marginal portions of the blanks. In this connection it will be noted that the lateral distance at which the deflector fingers 116 engage the marginal portions of the blank is not ordinarily critical but it is sufficient merely that the deflector fingers be engaged by the folder members 140 and the marginal portions of the blank and deflect them sufficiently to be engaged by the folder members 140.

The machine also can be adjusted for accommodating blanks of various dimensions measured longitudinally of the direction of travel. The folder member 140 can be adjusted to various positions on the folder chain 135 and where relatively short blanks are fed through the machine at close intervals, a plurality of folder members 140 are attached to the chain. In an analogous manner the deflector fingers 116 can be adjusted on the chains and one or more such fingers can be provided. While ordinarily the position at which the deflector fingers engage the marginal portions of the blank, in a fore-and-aft direction, is not critical, nevertheless, this position can be varied by adjusting the arm 88 and its associated mechanism angularly about the shaft 97, thereby changing the fore-and-aft position of the lower sprocket 106 relative to the conveyor. Furthermore, by changing the angular adjustment of the deflector mechanism, the level at which the finger engages the blank can be adjusted. The extendable telescoping end 165 of the lower holder bar 160 can be adjusted longitudinally in order to provide their engagement with the blank at various fore-and-aft positions as may be required.

Since the timing of the blanks is not critical, it is not necessary to use carrier chains with register pins, or any other positive type of feed but cooperating carrier belts or other friction feeding means can be employed. Thus, marring, denting or rupturing of the blanks is minimized.

While the invention has been illustrated in connection with a machine wherein the corners of the marginal portions are folded downwardly, it is within the contemplation of the invention to make the angular fold in an upward direction. In this event, the folder mechanisms and deflector mechanisms together with their associated structures are inverted so that the marginal portions of the blanks are deflected upwardly out of the plane of the remainder of the blank, and the folder members engage the blank from above. By inverting one of the folder members relatively to the other, one marginal fold can be made in one direction (for example upwardly), and the other in the opposite direction.

The folds may be made in various marginal portions other than those shown, as for example, in the end flaps, end walls or the like, and can be made along lines making other than 45° angles with the main fold lines, or can be made along the main fold lines. The invention is applicable to the making of what might be termed a "straight fold," that is, a fold wherein a marginal portion of the blank is folded about a line which is substantially perpendicular to the direction of travel of the blank. In that event, the folder member is formed with a folding surface located in a plane parallel to the edge to be folded and inclined to the plane of the blank. The folder member and blank are moved relatively into engagement along a line perpendicular to the line of fold and the folding operation is analogous to that described herein.

As stated above, the machine is capable of making various folds in blanks of a wide range of types, sizes and proportions. Moreover, the machine in many respects does not require critical timing or adjustment. Also, inasmuch as many of the adjustable portions of the structure are carried by single frames, as for example, the frame 24 and the frame 124, the various adjustments can be made quickly and easily and the machine, therefore, need only be idle for a relatively short "set up" time, thus greatly increasing the overall efficiency of operation.

The construction of the machine and the manner in which it operates are such that the machine can be run at comparatively high speeds and thus a high rate of production obtained. Moreover, owing to the fact that it is not necessary to obtain exact registry for a folding operation, the machine may be run at a higher speed than if exact registry were required.

The folding operation is performed in a highly accurate and positive manner and it is not necessary that any of the scores be previously broken and in fact, the score lines need not be deeply made. The folding operation is such that if the blank or the marginal portion thereof is bowed for any reason, the blank will be straightened along the fold line, at the initiation of the folding action, and thus eliminate the tendency to rupture. Also, it is not necessary to support the marginal portion of the blank against the folding action. The blank is not gripped or forcibly struck on its face by folding elements or other members, and therefore, is not marred in any way.

While certain novel features of the invention have been disclosed herein, and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. The method of folding the corner portion of a blank about a diagonal line of fold intersecting adjacent edges of the blank, which comprises applying to the corner portion a folding force in a direction toward the line of fold to deflect the edge and adjacent portion of the blank away from the plane of the blank, positively halting the movement of an edge and adjacent por-

tion and applying said folding force to said portion adjacent said line of fold to continue the movement of said corner portion about the line of fold.

2. Apparatus for folding blanks including, means for feeding blanks, a folder member having a surface inclined to the path of movement of said blank, and means for effecting relative translational movement between said folder member and said blank to engage said surface and the edge of a marginal portion of said blank to fold said marginal portion along a fold line inclined to the path of movement of said blank.

3. A machine for folding blanks including means for supporting a blank, a folder member having a surface inclined to the plane of said blank for deflecting the edge of said blank, an abutment associated with said surface for limiting the movement of the edge of said blank on said surface and means for effecting relative translational movement of said blank and said folder member to engage the edge of said blank and said surface and to cause movement of said edge and surface while in engagement through a position wherein said edge and said abutment meet.

4. Apparatus for folding blanks including, means for advancing a blank, timed means for halting said blank, means for deflecting corner portions of said blank, means operating on said blank when said blank is halted for folding said corner portions against the body of the blank about lines inclined to the direction of movement of said blank into said halted position, means for then advancing said blank, and means for making additional folds in said blank during movement of said blank along lines parallel to the direction of movement of the blank.

5. A folder member including a support, a wall carried by said support and defining a folder surface diverging from an apex, an abutment extending along the lower edge of said surface and a tail portion extending rearwardly from adjacent said apex.

6. A folder member adapted to be moved into engagement with a blank, including a support, a wall carried thereby and defining a folder surface inclined laterally and longitudinally, relatively to the normal path of movement of said support, an abutment extending along the lower edge of said folder surface and inclined downwardly and forwardly relatively to the said path of movement, and a surface extending rearwardly from adjacent at least a portion of the top edge of said folder surface.

7. A folder member including a folder surface adapted to be inclined to the plane of a blank to be folded, an abutment at an edge of said folder surface to engage an edge of the blank and a surface extending from said folder surface to support the folded portion of the blank.

8. The method of making angular folds in blanks which comprises advancing a blank along a predetermined path, applying a folding force edgewise of said blank having a component perpendicular to the line of fold and a component inclined to the plane of the blank to deflect the adjacent portion of the blank out of the plane of the blank, positively halting the movement of said adjacent portion out of the plane of the blank, and applying a force to said adjacent portion to fold it against the blank.

9. A machine for making angular folds in blanks comprising means for advancing a blank along a predetermined path, a folder member having a surface inclined laterally and longitudinally relatively to said path and extending substantially parallel to the line of fold of said blank, means for advancing said folder at a higher speed than said blank to engage said surface with the edge of said blank and bend the edge away from the plane of said blank, and an abutment associated with said surface for halting movement of said edge away from the plane of said blank.

10. A machine for making angular folds in blanks comprising means for advancing a blank along a predetermined path, a folder member having a surface inclined laterally and longitudinally relatively to said path, means for deflecting the marginal portion of said blank into the path of said surface, means for effecting relative movement between said blank and said folder to cause engagement therebetween and to cause said marginal portion to be bent out of the plane of the blank, and an abutment associated with said surface for engaging the edge of said marginal portion and exerting an edgewise folding force on said marginal portion.

11. The method of folding a portion of a blank against the body of the blank about a fold line which comprises applying a folding force against an edge of said portion, in a direction toward said fold line, to deflect said portion out of the plane of the blank, abruptly halting the movement of said edge away from said plane, and applying a folding force to said portion adjacent said fold line to complete the folding of said portion against said body.

12. The method of folding a portion of a blank with respect to the body thereof about a fold line therebetween, which comprises effecting relative movement between said blank and a non-yielding abutment in a direction substantially parallel to the plane of the blank, causing said abutment to positively engage the edge of said portion in substantially the plane thereof in a direction substantially toward said fold line and causing said portion to swing about the point of engagement of said edge with said abutment, said point acting as a pivot fixed with respect to the plane of said blank.

13. Apparatus for folding a blank of paperboard or the like comprising a holder for said blank, a folder, means for effecting relative movement of said folder and holder in a direction substantially parallel to the plane of the blank, an abutment fixedly mounted on said folder and having a substantially fixed relationship with the plane of said blank where it operates on the blank, said abutment being so related to said blank as to engage the edge of the flap to be folded, causing said flap to rotate about said abutment as a center and causing said body to move in conformity with the positively controlled action of said abutment.

14. Apparatus for folding a blank of paperboard or the like comprising a path along which the blanks move, a folder, a path along which said folder moves, means for moving said folder along said folder path in substantially the same direction as, and faster than, the movement of said blanks, an abutment fixedly mounted on said folder and having a fixed relationship with the direction of said folder path at the point where it operates on the blanks, said abutment being so related to said blanks as to engage the edge of the flap to be folded, causing said flap to rotate about said abutment as a center and causing said body to move in conformity with the positively controlled action of said abutment.

15. The method of folding a blank of paperboard or the like which comprises deflecting a part of the blank out of the plane of the body of the blank, applying a force to said part substantially edgewise of said part and in the plane of said part to "break" the fold, and thereafter completing the fold.

16. The method of folding a blank of paperboard or the like which includes guiding a part of the blank along an inclined surface to deflect said part out of the plane of the body of the blank, abruptly engaging an edge of said part to apply a force edgewise of said part and in the plane of said part with an abutment to "break" the fold, and thereafter guiding said part along another inclined surface to complete the fold of said part against the body of said blank.

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