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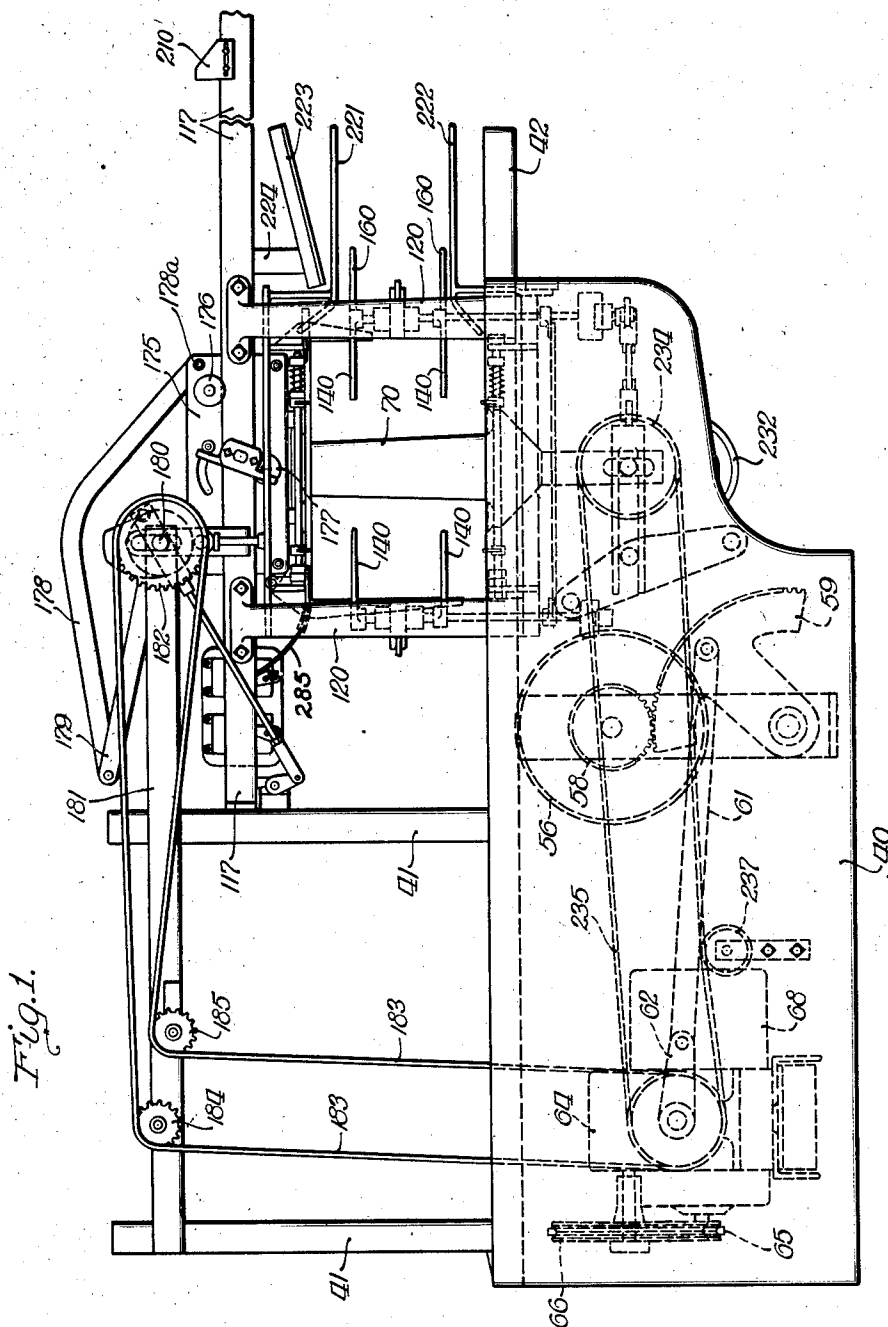
J. L. FERGUSON

2,280,773

CARTON OPENING, FOLDING, AND POSITIONING MACHINE

Filed Aug. 3, 1940

14 Sheets-Sheet 1



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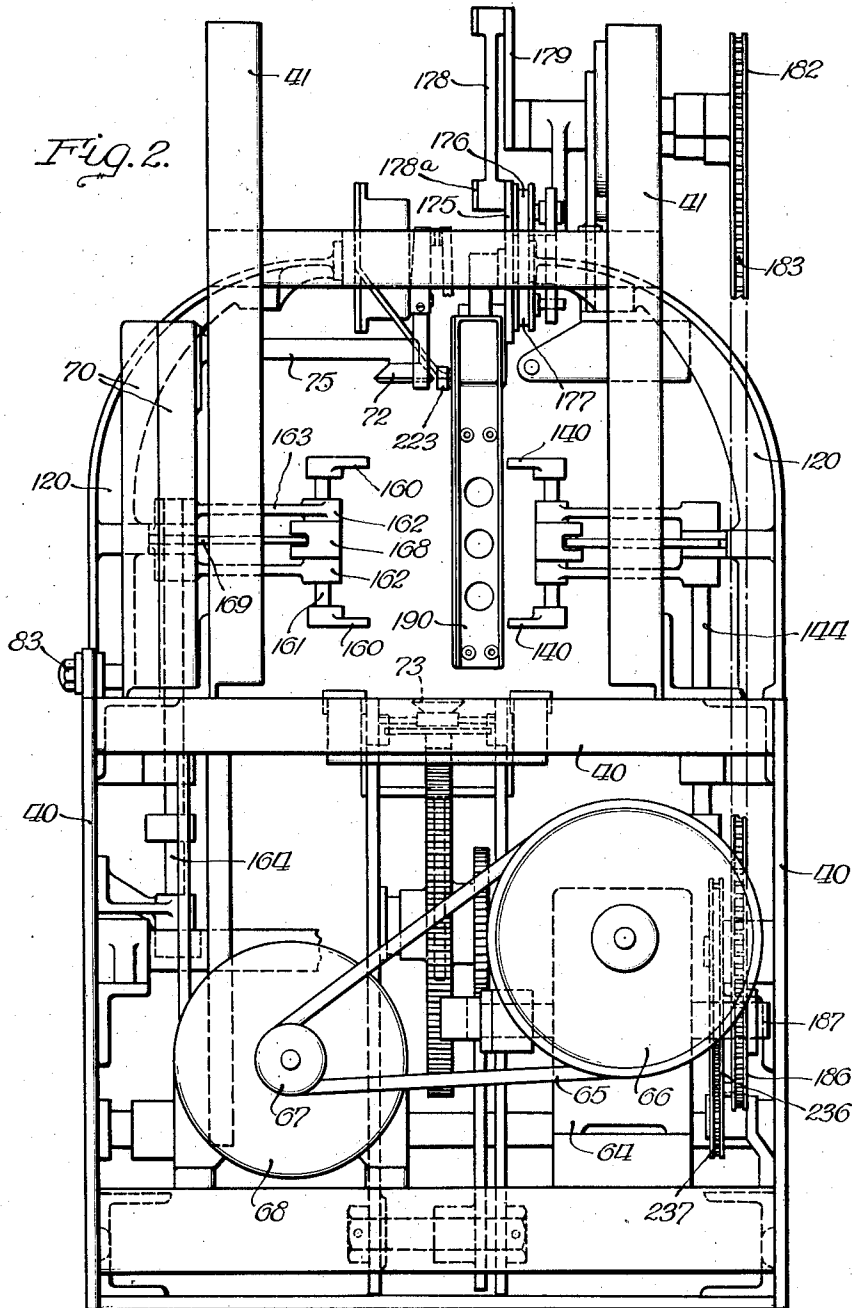
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CARTON OPENING, FOLDING, AND POSITIONING MACHINE

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14 Sheets-Sheet 2



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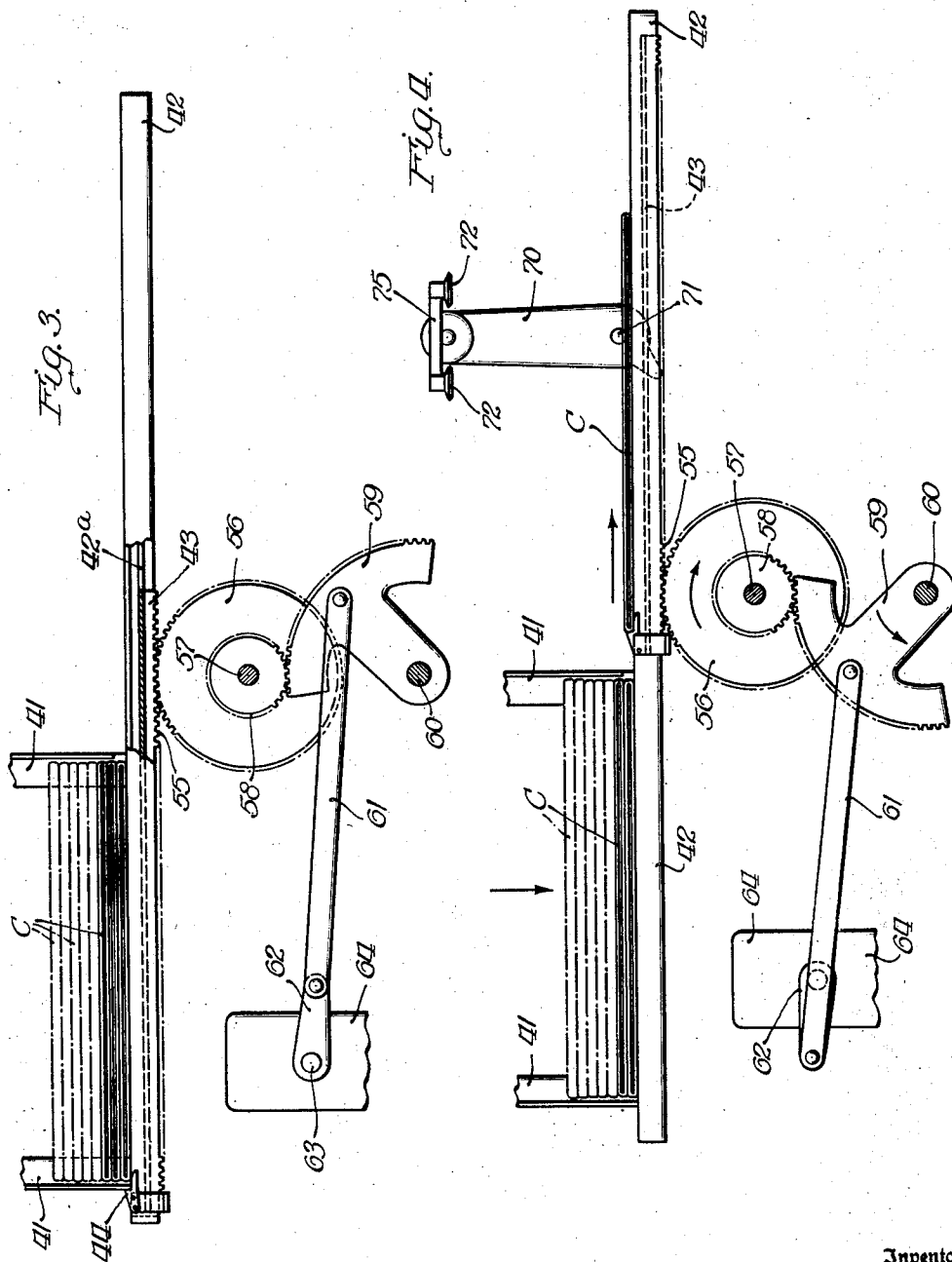
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CARTON OPENING, FOLDING, AND POSITIONING MACHINE

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14 Sheets-Sheet 3



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CARTON OPENING, FOLDING, AND POSITIONING MACHINE

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14 Sheets-Sheet 5

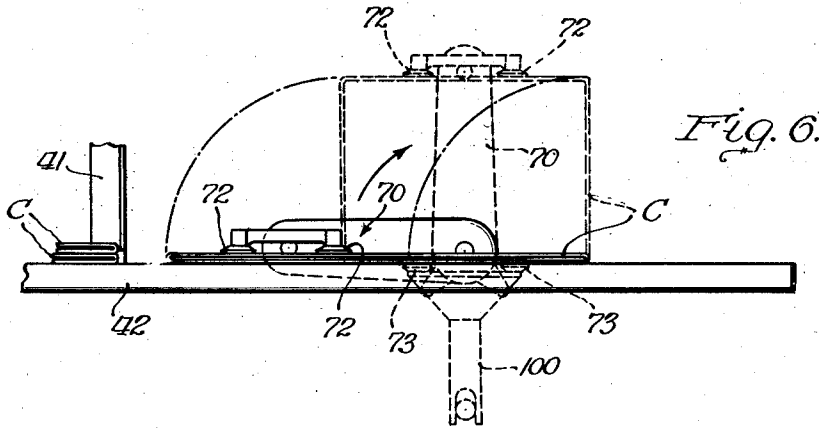


Fig. 6.

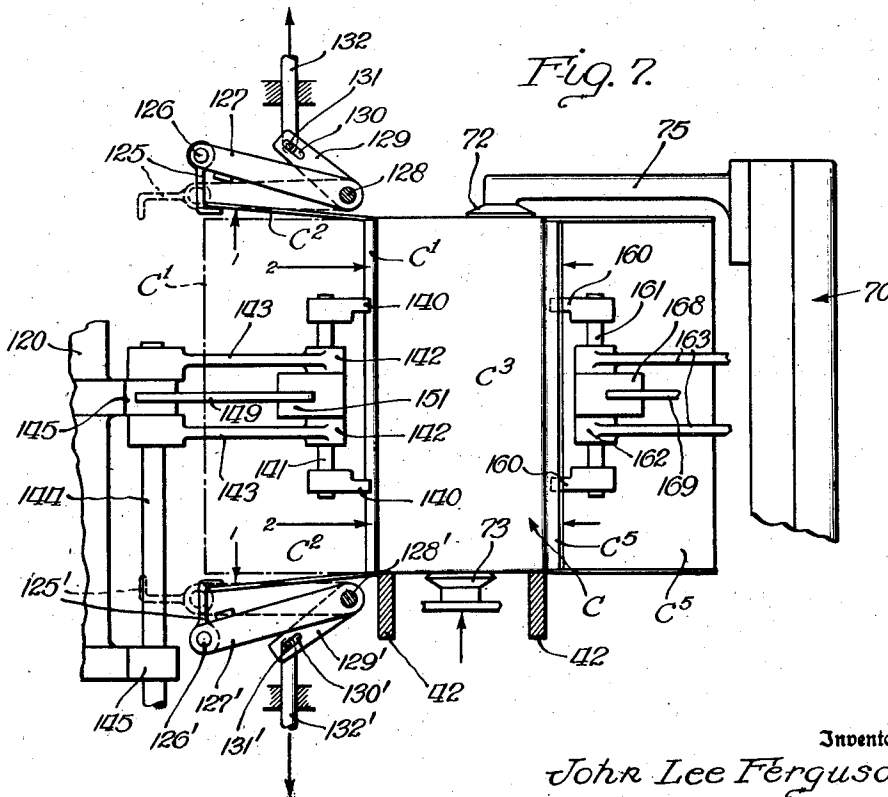


Fig. 7.

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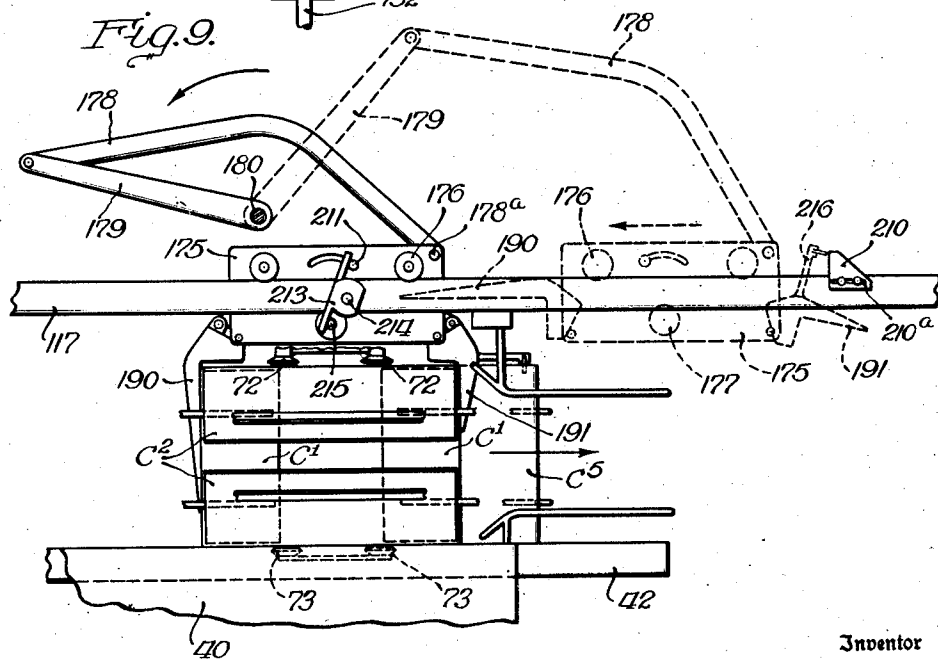
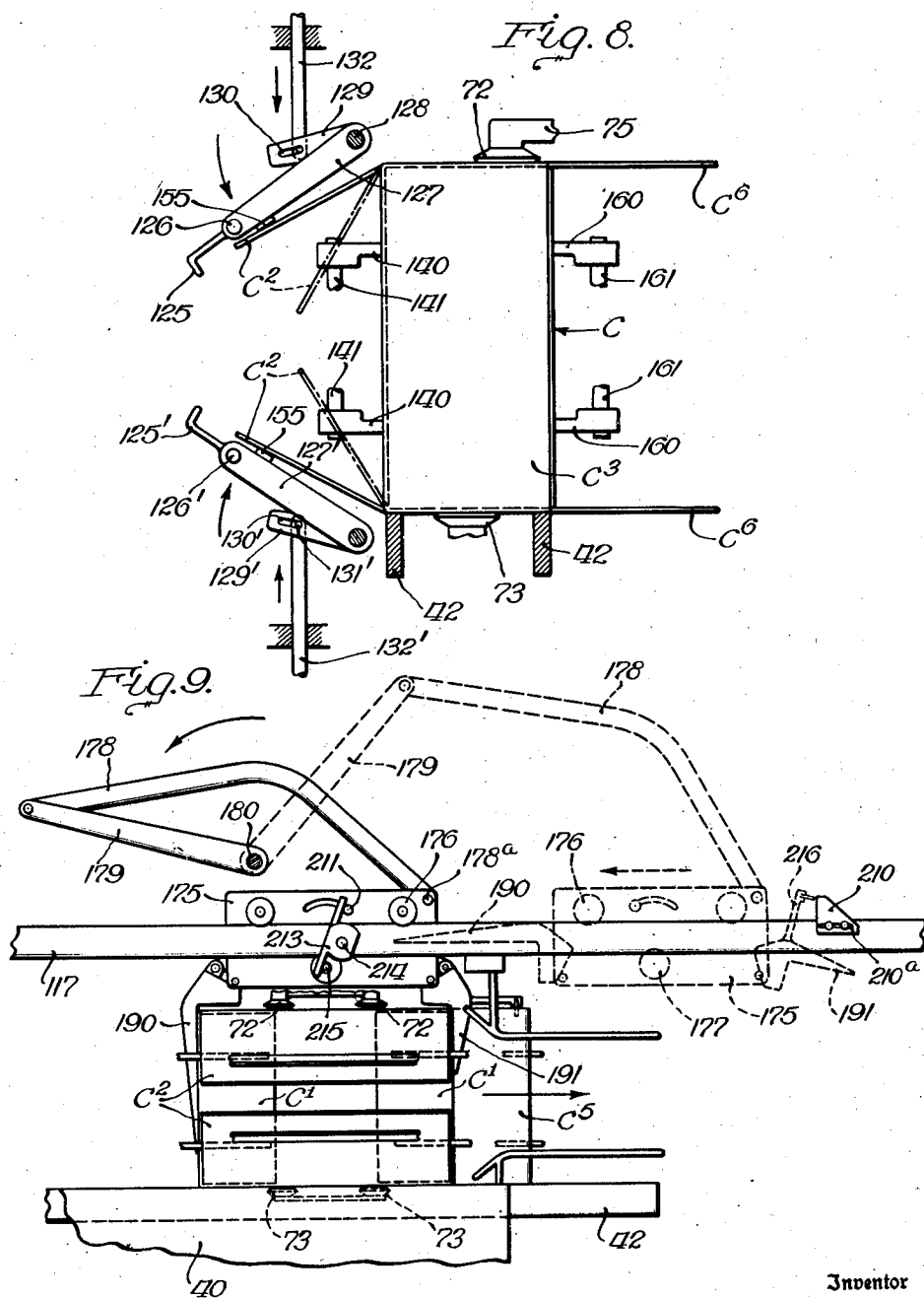
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CARTON OPENING, FOLDING, AND POSITIONING MACHINE

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14 Sheets-Sheet 6



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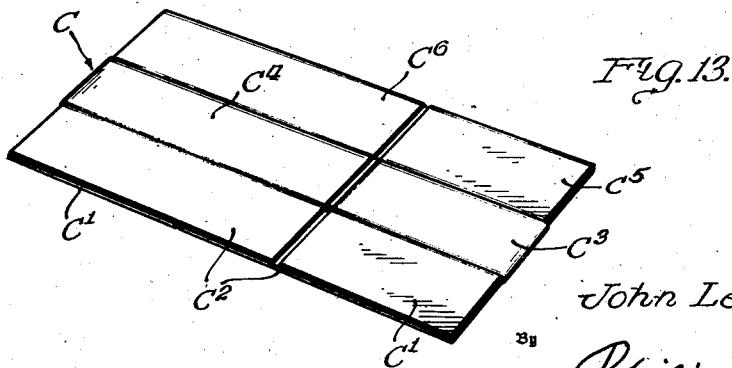
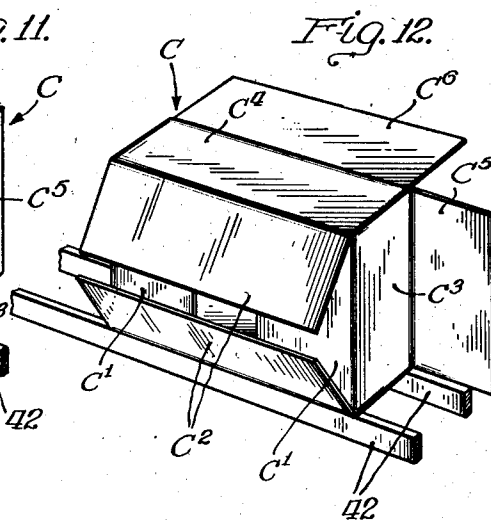
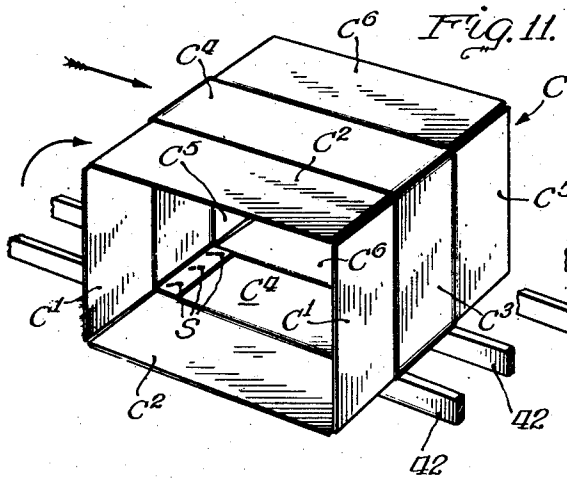
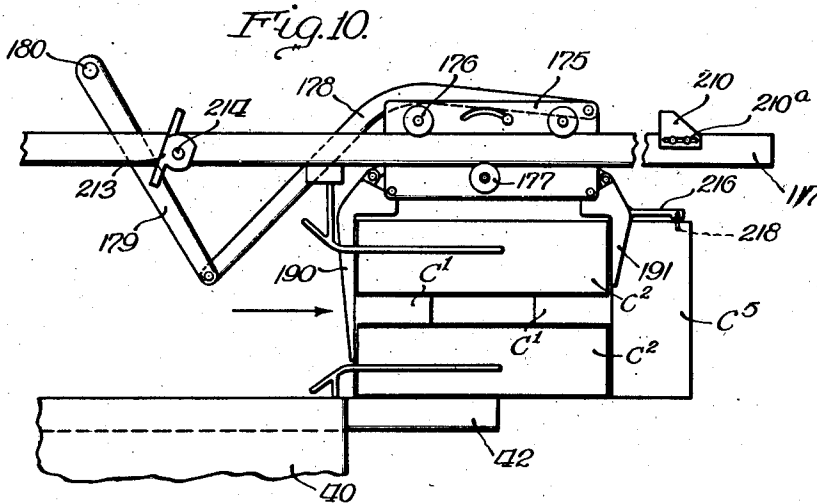
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CARTON OPENING, FOLDING, AND POSITIONING MACHINE

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14 Sheets-Sheet 7



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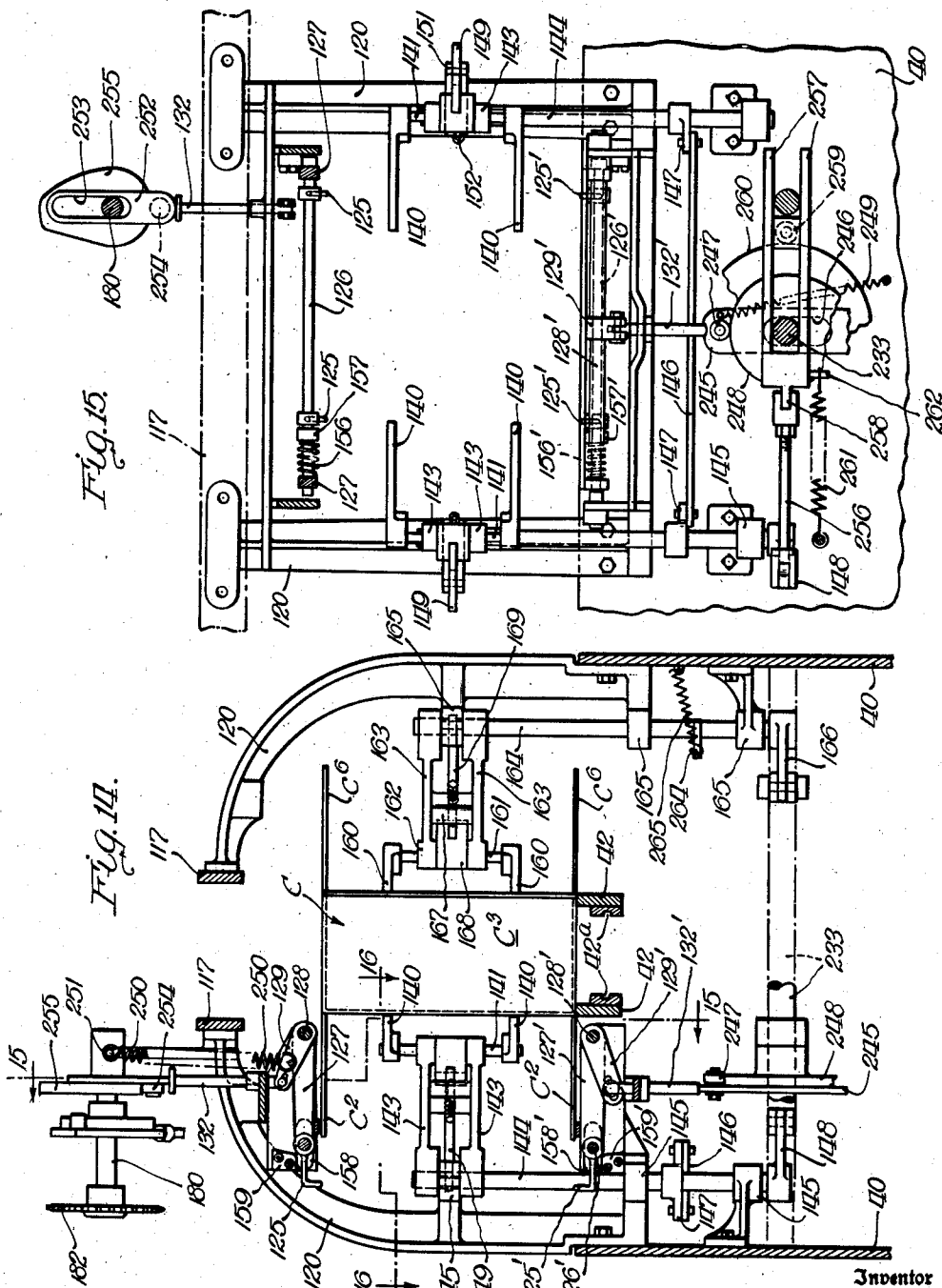
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CARTON OPENING, FOLDING, AND POSITIONING MACHINE

Filed Aug. 3, 1940

14 Sheets-Sheet 8



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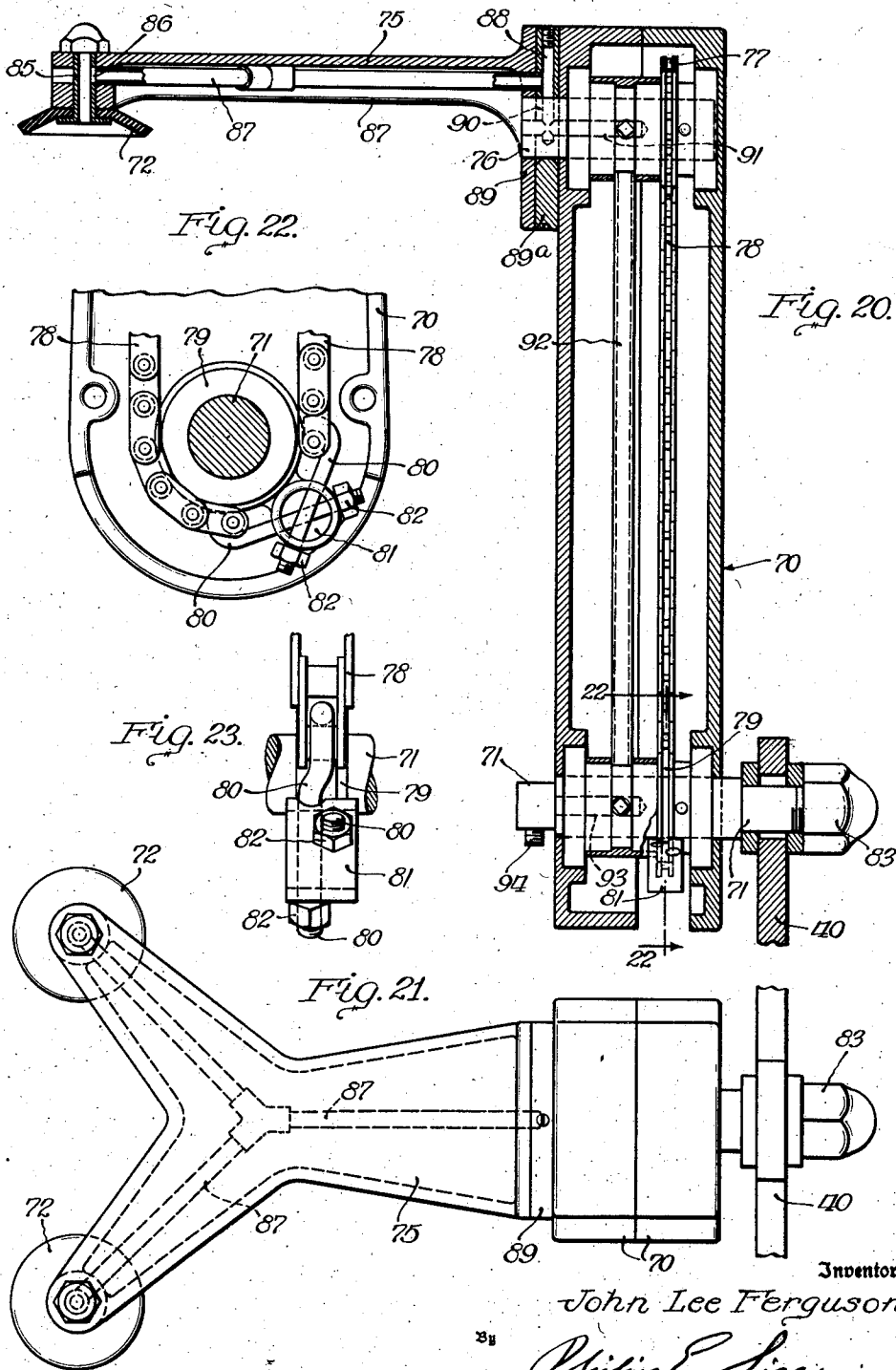
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CARTON OPENING, FOLDING, AND POSITIONING MACHINE

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14 Sheets-Sheet 9



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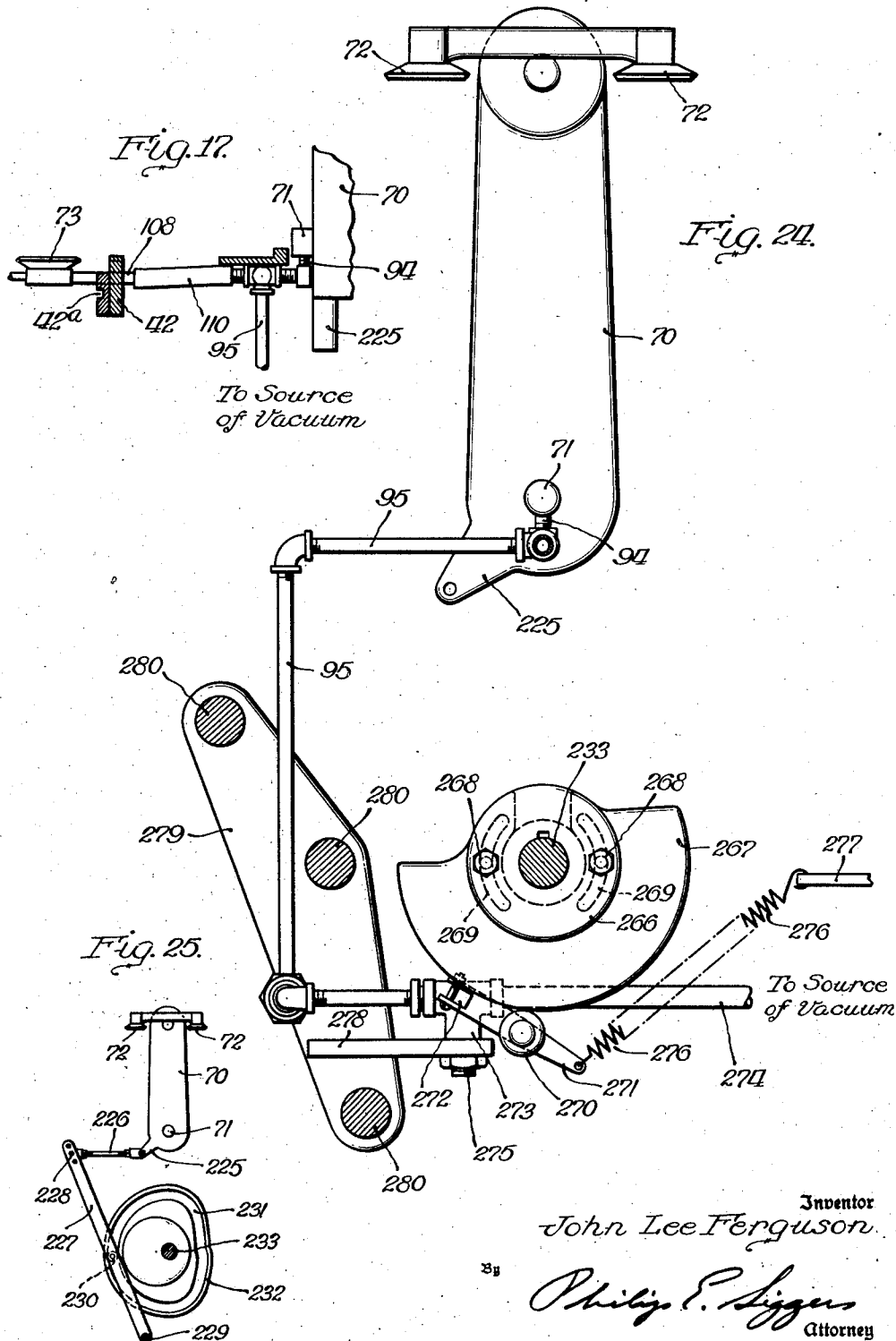
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CARTON OPENING, FOLDING, AND POSITIONING MACHINE

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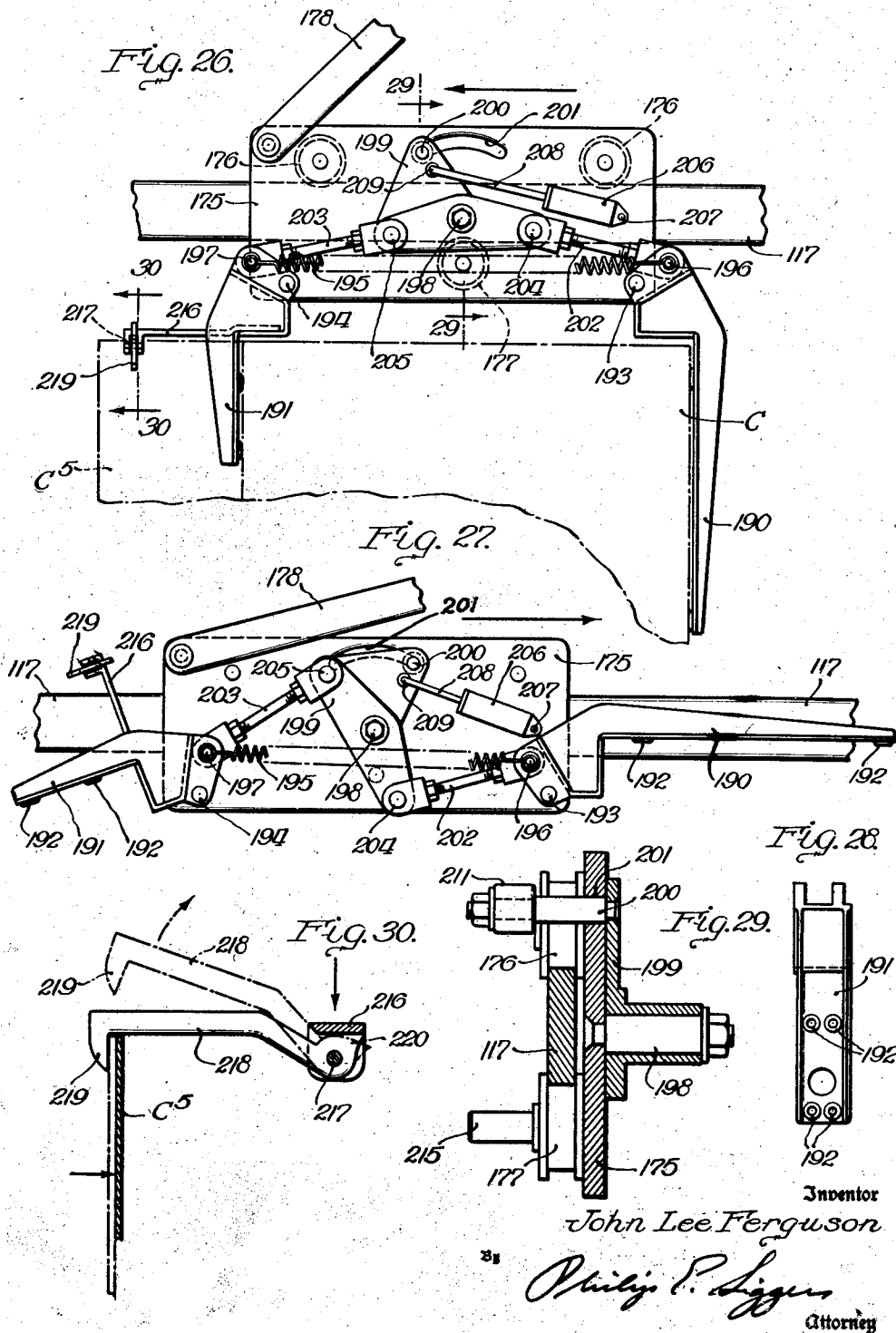
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CARTON OPENING, FOLDING, AND POSITIONING MACHINE

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14 Sheets-Sheet 11



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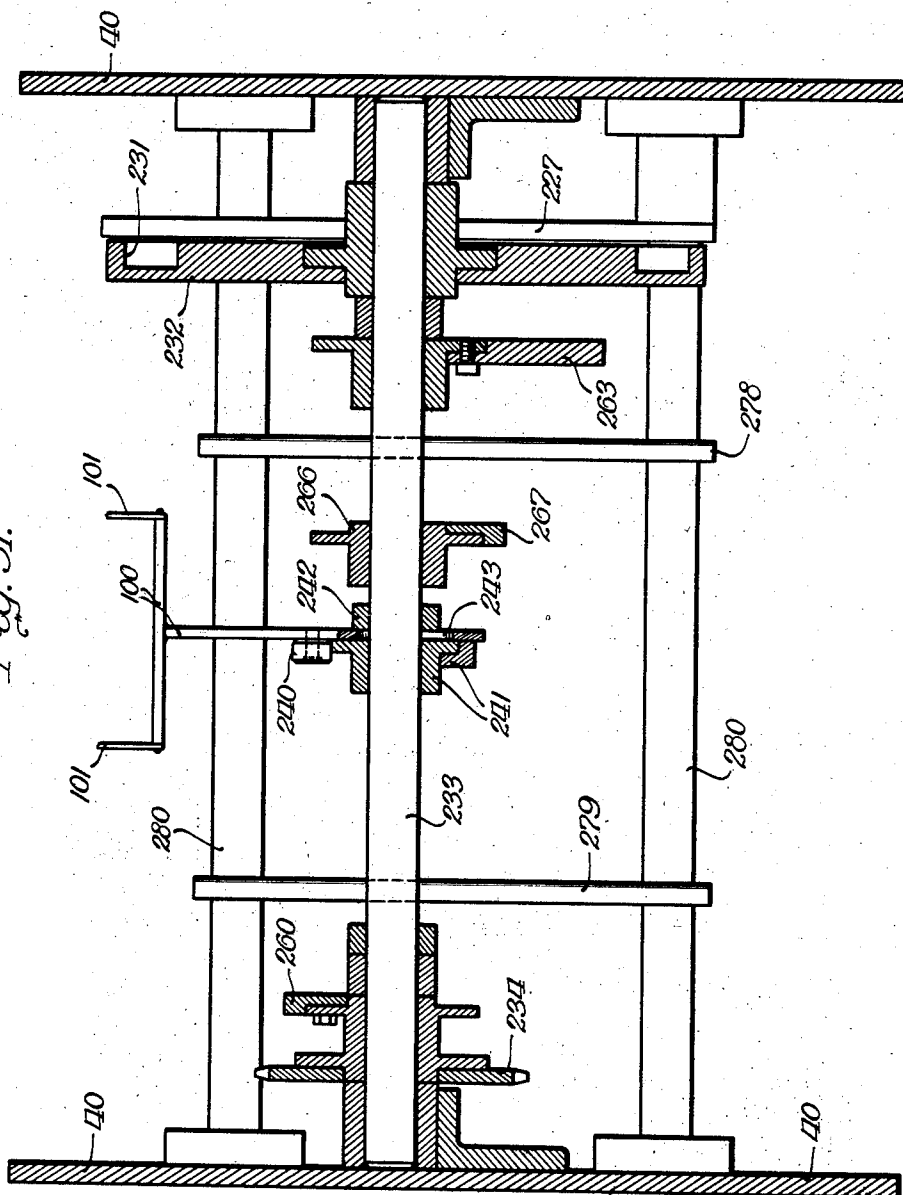
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CARTON OPENING, FOLDING, AND POSITIONING MACHINE

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Fig. 31.



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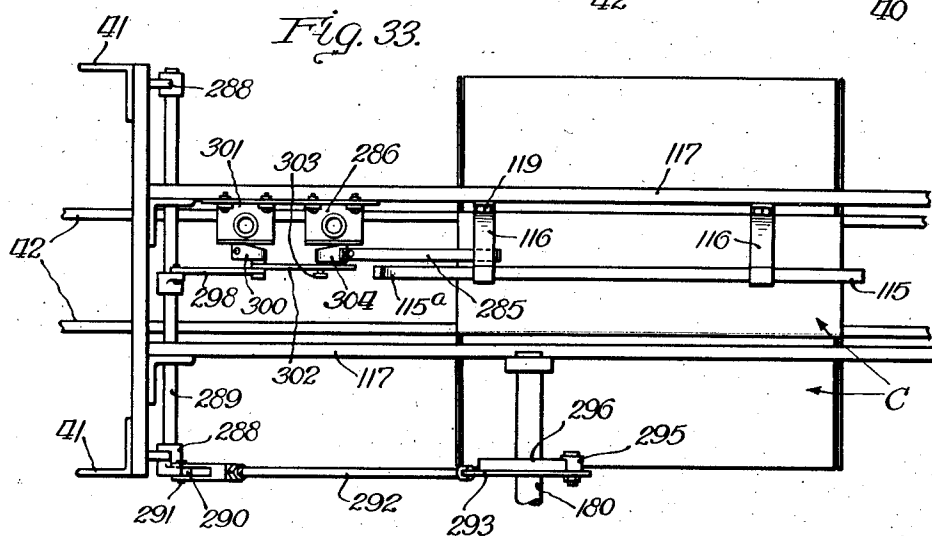
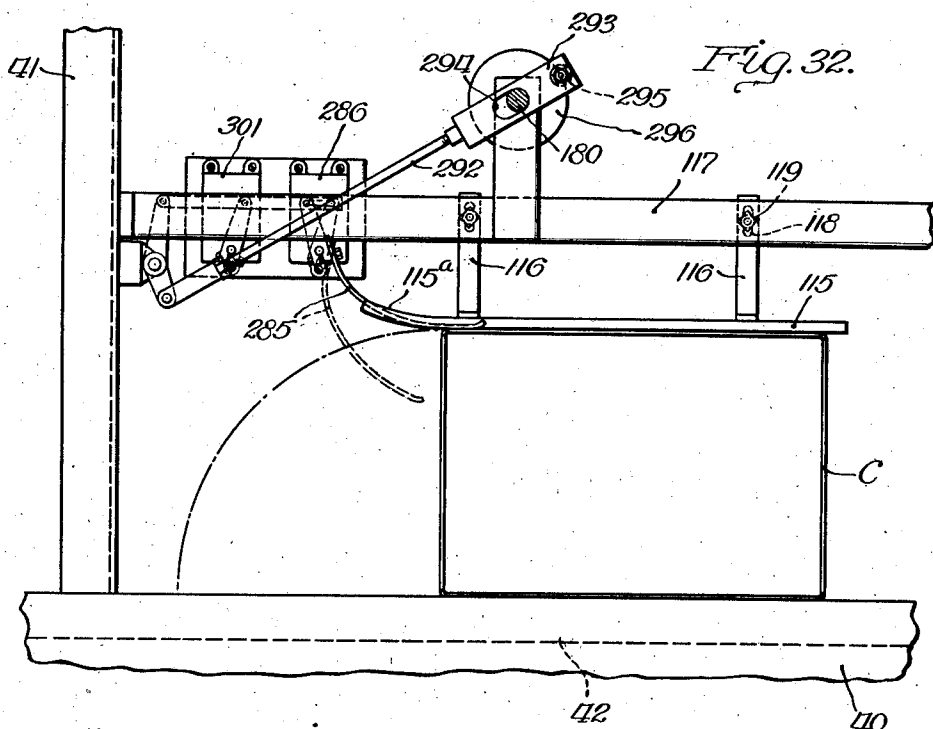
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CARTON OPENING, FOLDING, AND POSITIONING MACHINE

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14 Sheets-Sheet 13



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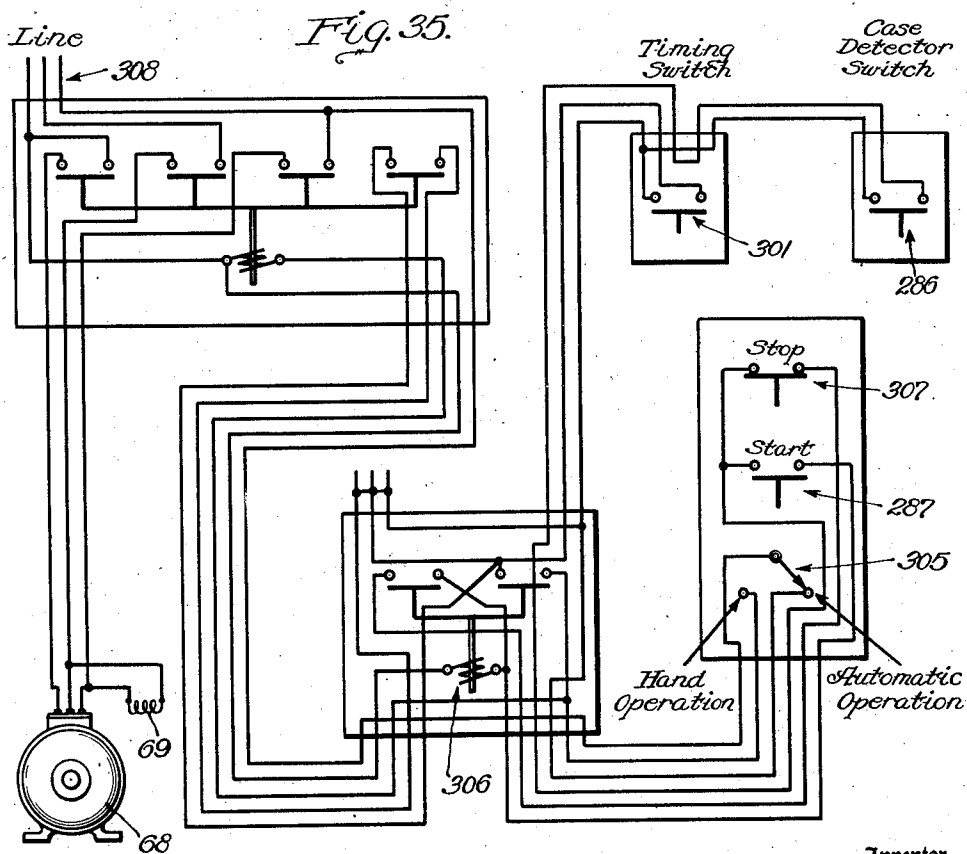
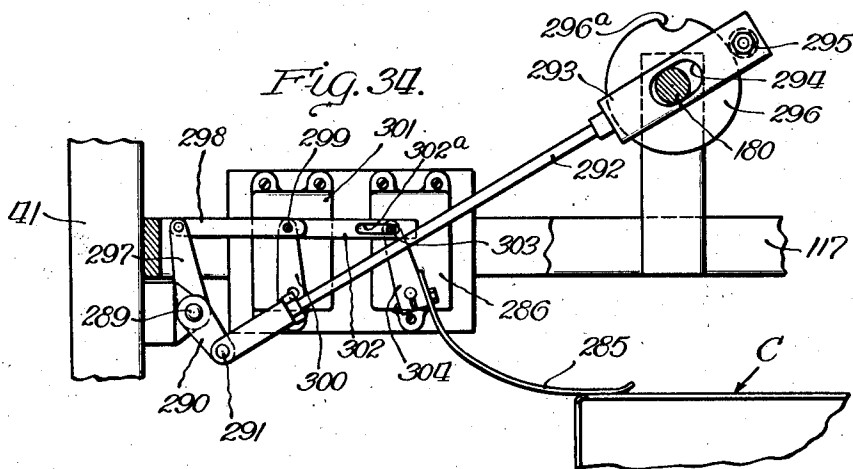
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CARTON OPENING, FOLDING, AND POSITIONING MACHINE

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14 Sheets-Sheet 14



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UNITED STATES PATENT OFFICE

2,280,773

CARTON OPENING, FOLDING, AND
POSITIONING MACHINE

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Application August 3, 1940, Serial No. 350,675

31 Claims. (Cl. 93—53)

This invention relates to carton opening, folding and positioning machines, and in general aims to provide an improved machine of the character stated which will work automatically without attention from an operator (except occasional replenishment of its supply of cartons). The machine of the invention takes a single collapsed carton, as for example a rectangular fiber board box, opens it or sets it up, folds in the four flaps (which together may form either the top or the bottom of the completed box) opens or folds outward the four opposite flaps, and delivers the carton without further operations to another machine (forming no part of the invention) which fills the carton. The invention has many specific objects not stated at this time because they would be unintelligible without an understanding of the construction of the machine; hence in the following description of the preferred embodiment, the specific objects are in large part brought out.

In the accompanying drawings forming a part of this specification—

Fig. 1 is a side elevation of the machine shown without any cartons;

Fig. 2 is an end elevation of the machine viewed from the magazine end;

Fig. 3 is a fragmentary elevation showing the positions of some of the parts when a collapsed carton is about to be moved out of the magazine;

Fig. 4 is a similar view but showing the positions of the same parts after the carton has reached the position where it is to be opened, and also showing the oscillating vacuum arm which assists in the opening or setting up of the carton;

Fig. 5 is an enlarged detail in elevation showing one of the yieldable fingers which engage the edge of the lowermost carton in the magazine to push it forwardly;

Fig. 6 is a fragmentary elevation on a smaller scale showing the collapsed carton with the vacuum arm in full lines and showing in dotted lines the same carton opened and the vacuum arm in the corresponding position;

Fig. 7 is a sectional elevation on a slightly larger scale showing a carton held by vacuum suction and having its flaps held open, also showing part of the flap folding means, the view being from the right side of Fig. 6;

Fig. 8 is an elevation on the scale of Fig. 7 and looking in the same direction, but showing the action of other portions of the flap folding mechanisms;

Fig. 9 is an elevation showing the reciprocating

carriage which moves the opened cartons out of the machine, also showing in dotted lines another position of the carriage and some associated mechanisms;

Fig. 10 is a fragmentary elevation on the scale of Fig. 9 showing the carton and carriage in positions intermediate the full line and the dotted line positions of Fig. 9;

Fig. 11 is a perspective view showing a carton opened but not folded;

Fig. 12 is a perspective view showing a carton partly folded;

Fig. 13 is a perspective view showing one of the cartons collapsed and ready for stacking in the magazine;

Fig. 14 is a fragmentary vertical sectional elevation showing part of the flap folding mechanisms, also showing a carton opened and its inner flaps folded;

Fig. 15 is a section on line 15—15 of Fig. 14, omitting the carton;

Fig. 16 is an enlarged section on line 16—16 of Fig. 14, showing several positions of one of the flap folding mechanisms;

Fig. 17 is a detail sectional elevation showing the vacuum connections for the lower vacuum cups;

Fig. 18 is a vertical section on an enlarged scale showing the lower vacuum cups and some adjacent parts;

Fig. 19 is a side elevation showing both lower vacuum cups and some adjacent parts, the scale being the same as Fig. 18;

Fig. 20 is a vertical longitudinal section on an enlarged scale through the swinging vacuum arm;

Fig. 21 is a top view of said arm, on the same scale;

Fig. 22 is a fragmentary section on line 22—22 of Fig. 20 and on the same scale;

Fig. 23 is a detail in elevation showing the chain tightening means at the pivot end of the vacuum arm;

Fig. 24 is a view in sectional elevation showing particularly the means for controlling the vacuum in the vacuum arm;

Fig. 25 is a detail in elevation, on a reduced scale, showing the means for swinging the vacuum arm;

Fig. 26 is a fragmentary elevation showing the carriage and carton-gripping arms, a portion of the carton being shown in dot and dash lines, the view being from the opposite side of Fig. 1;

Fig. 27 is a similar view of the carriage and gripping arms but omitting the carton and show-

ing the gripping arms in carton-releasing positions;

Fig. 28 is an elevation of the short carton-gripping arm;

Fig. 29 is an enlarged vertical section substantially on line 29—29 of Fig. 26;

Fig. 30 is an enlarged vertical section substantially on line 30—30 of Fig. 26; showing in dotted lines an alternative position of a flap-engaging arm;

Fig. 31 is a vertical section through the lower part of the machine, showing only the main cam shaft and adjacent parts;

Fig. 32 is a side elevation showing particularly an electrically controlled mechanism for stopping the machine, a carton also being illustrated, and showing in dotted lines the machine-stopping position of the part engaged by each carton;

Fig. 33 is a top plan view of the parts of Fig. 32;

Fig. 34 is an enlarged view of the mechanism of Fig. 32 shown with part of a carton and showing the cam in another position;

Fig. 35 is a wiring diagram for the mechanism of Fig. 32.

Before referring particularly to the drawings it should be explained that the preferred embodiment of the invention provides a magazine for holding a supply of collapsed cartons; mechanism for feeding the collapsed cartons one at a time out of the magazine to the opening or setting-up station; mechanism for opening or setting-up and holding a carton at said station; mechanism operative after the carton is opened to fold inwardly in a certain sequence the four flaps of the carton on one side which later may form the top or bottom, and to fold outwardly or spread the opposite flaps of the carton; mechanism to convey the folded carton out of the machine; and means automatically to bring the machine to a stop in the event the cartons are not advancing properly through the machine. The invention also comprises many other mechanisms and novel combinations and arrangements of parts, as will be explained in the following description.

Carton magazine and carton feeding mechanism

Referring particularly to Figs. 1, 3 and 4, the machine of the invention has a frame 40 at one end of which a magazine is provided for holding a supply of collapsed cartons. However, a conveyor (not shown) could be used to convey collapsed cartons into the machine of the invention; a built-in magazine being merely a convenience rather than a necessity. The illustrative magazine comprises four substantially vertical angles 41 secured at their lower ends to frame 40 and so spaced apart that they will hold a stack of collapsed cartons C, the four corners of the cartons fitting inside the four angles 41. If desired, plates (not shown) may be screwed to angles 41 on either side of the machine, further to enclose the cartons in the magazine. The supply of cartons is replenished from time to time from the top of the magazine and the cartons move by gravity to the lower end of the magazine (with the angles serving as carton guides) as the cartons are fed one at a time to the setting-up station. The lowermost carton of the stack in the magazine rests directly on a pair of supports 42 which are preferably rectangular steel strips finished to provide polished upper surfaces along which the cartons slide as they move through the machine. The slides 42 are sufficiently close together to provide an adequate support for the carton when its flaps have

been folded; in other words the distance between the centers of the slides 42 is less than the depth of the carton when folded (see Fig. 12).

To feed the cartons one at a time from the bottom of the magazine, a reciprocating plunger 43 is provided, said plunger being horizontally slidable in guides 42a provided adjacent and below the slides 42. The plunger 43 carries a pair of carton-pushing fingers 44 (Fig. 5), each of said fingers being adapted to swing vertically about a pin 45 fast to the plunger, and being normally urged upwardly into the position illustrated by a coil spring 46, a pin 47 in a slot 48 preventing movement of the finger 44 beyond the position illustrated. The two fingers 44 have upper surfaces 49 which as shown in Figs. 3 and 4 are adapted normally to lie in the plane of the top edges of slides 42 and said fingers each having a curved end 50 to obviate injury to the edges of the cartons. The rear edge of the lowermost carton in the magazine is engaged by the nearly vertical surface 51 on each finger, and the finger may slightly adjust itself because of the yielding permitted by spring 46 in the event of a slight change in the position of the lowermost carton. It will be clear from Figs. 3 and 4 that the fingers 44 when engaging the lowermost carton will also slide under the carton next above (which is moved downwardly by its own weight and the weight of the cartons in the magazine) and that when such engagement takes place, the upper surfaces 52 of the fingers will slide along the bottom of the carton which is moving down to take the place of the one being pushed by the fingers.

Plunger 43 is provided with rack teeth 53 on its bottom, said rack teeth meshing with a spur gear 56 on a countershaft 57 journaled in the frame. Also fast to the countershaft is a pinion 58 meshing with a gear segment 59 which may oscillate on a countershaft 60 having bearings in the frame. A crankshaft 61 is pivotally connected to the gear segment 59, as shown, and is also pivotally connected to the crank 62 fast to the shaft 63 which extends out from one side of the casing of the speed reducer 64 (reduction gear unit), said unit being mounted on the frame as best shown in Fig. 2 and being driven by a belt 65 passing over a pulley 66, while belt 65 is driven by a small pulley 67 on a shaft of an electric motor 68 having a solenoid brake 69 (Fig. 35) on its shaft. All the parts of the machine are preferably driven from this one motor as will be described, although the preferred machine also employs a source of vacuum as a power source to hold and open the cartons. By the described mechanism, the fingers 44, when active, move from the position of Fig. 3 to the position of Fig. 4 and hence move the lowermost carton in the magazine (but no other carton) along the tops of the slides 42 to the extent shown. When the carton is in the position of Fig. 4 it is ready to be opened or set-up and hence in this position it may be said to be at the opening station. At this time the carton is, of course, fully collapsed as illustrated in Fig. 13, and the opening process consists in forcing the carton to assume the position illustrated in Fig. 11.

Setting-up or opening

With the carton at the setting-up station (Figs. 4, 6 and 32), a normally vertical arm 70, which swings in a vertical plane at one side of the carton, as will be clear from Figs. 2 and 7, moves from its upright position to the horizontal full

line position shown in Fig. 6. The axis of swing is the axis of a horizontal pin 71 (Figs. 20-23) fast to the machine frame. When the arm 70 is horizontal, vacuum cups 72, which are connected to a source of vacuum, as will be described, and which are maintained horizontal or parallel to the plane of the collapsed carton, will move downwardly until the flexible edges of said vacuum cups are pressed against the top surface of the carton. Simultaneously the cups 72 are connected with the source of vacuum. Then the cups will be raised by return swinging of the arm 70 and at the same time suction will be applied to the underside of the carton through a pair of vacuum cups 73 (Figs. 6, 7, 18 and 19) so that the lower side of the carton cannot follow the upper side. Thus the carton is fully opened as will appear in Fig. 11. Before being placed in the magazine, the ends of each carton blank are stapled as shown at S, or are otherwise united.

Now referring to Figs. 20-23 inclusive, the arm 70 is hollow, as shown, not only to save weight but also to serve as a housing for parts to be described; said arm carrying at its upper end a bracket 75 which is bifurcated as shown, one of the vacuum cups 72 being mounted on the extremity of each branch or furcation. Bracket 75 is secured to a pin 76 which may oscillate in bearings provided at the outer or free end of the arm 70. Secured to the pin 76 is a sprocket wheel 77 with which a sprocket chain 78 meshes, the chain 78 being wholly within the hollow arm 70. The chain 78 is stationary, its opposite ends being held against movement as illustrated in Figs. 22 and 23. As shown, the ends of the chain 78 are brought around a circular collar 79 on bolt 72, and J-bolts 80 are hooked on the ends of chain 78 and extend through bores in a lug 81 preferably integral with collar 79. Nuts 82 on opposite sides of lug 81 are used to tighten the J-bolts and thus permit adjustment of the tension and position of the chain. As the pin 71 is held stationary on the frame 40 by the nut 83, and lug 81 is also stationary, it follows that the sprocket chain 78 cannot move although because of its link pivots it is free to swing with the swingable arm 70. Thus the pin 76 is turned through an angle equal to the angle of swing of the arm 70, thereby turning the bracket 75 relative to arm 70 to the same extent; and this turning of the bracket 75 exactly counteracts the swing of the arm 70, so that the bracket 75 is always horizontal or parallel to the top surface of the carton C. Thus the flexible lips of the rubber vacuum cups 72 are simultaneously brought into engagement with the top surface of the carton which is to be opened, and when the source of vacuum is connected to the inside of said vacuum cups, said cups will become firmly attached to the upper surface of the cardboard carton and will tend to lift the entire carton when the arm 70 is swung back to its vertical position. However, lifting will be impossible because of the suction of lower vacuum cups 73, and the final result of the opposed pulls of the upper and lower vacuum cups will be the opening of the carton as illustrated.

As shown, each vacuum cup 72 is secured by hollow pin 85 on the end of bracket 75 and said hollow pin is perforated as at 86 so as to be connected to a small tube 87 extending on the underside of the bracket, said small tube 87 branching as shown in Fig. 21 to extend to both vacuum cups 72. At the pivoted end of the bracket 75

tube 87 communicates with a bore 88 in the hub or disk 89 which is secured to pin 76 by set screw 89a. The pin 76 has a lateral bore 90 opening to the bore 88 and has a longitudinal bore 91 communicating with bore 90, while a tube 92 which extends longitudinally inside of arm 70 communicates with the bore 91. Tube 92 leads to a bore 93 in the pin 71 and a short screw threaded union 94, secured to pin 71, Figs. 17 and 24, is connected by pipe fittings with a pipe 95, which as described later is connected through a control valve with a source of vacuum.

Now referring to Figs. 18 and 19, it is seen that the lower vacuum cups 73, which constitute hold-down means for the carton C when it is being set-up, are located between the slides 42 at the setting-up station. The vacuum cups 73 do not travel but are moved a fraction of an inch vertically, that is at right angles to the plane of the top edges of slides 42, by means of a cam as will be explained below. The top plane of the flexible edges of vacuum cups 73 is preferably approximately $\frac{1}{16}$ of an inch below the top plane of the slides 42, except when raised above said slides forcibly to engage the bottom of the carton C. To lift the vacuum cups 73, a cam-actuated T-shaped arm 100 is connected to brackets 101, said brackets having flanges 102 with downturned ends 103 fitting over stationary supports 104 connected to the frame of the machine. A pair of straight rods 105 extend parallel to each other at right angles to the slides 42 and have their ends received in short vertical slots 106 in said slides. The rods 105 are secured to the brackets 101 and thus limit the vertical movement of the vacuum cups 73 to the length of the slots 106. The two vacuum cups 73 have their interiors connected by tubes 107 with a small pipe 108 which extends through a slot 109 in one of the slides 42 and is connected by a flexible tube, for instance a rubber tube 110 (Fig. 17) with pipe 95, which leads to a source of vacuum as stated above. The vacuum will be maintained so long as it is desirable firmly to hold the carton at the setting-up or opening station. When the carton is to be released, the interiors of the vacuum cups 72, 73 will be connected with the atmosphere as described below, so that the suction will be broken.

As the action of the setting-up arm 70 must be positive and unfailing, a strong vacuum suction is applied through its cups 72; but this vacuum suction on the relatively flexible fiber board walls of the carton may be sufficient to cause said carton to bend in the middle, that is, to be higher in the vertical plane of the vacuum cups 72 than at the edges where the flaps are folded. This crowning of the flexible carton might interfere with the subsequent folding of the flaps, and to prevent this crowning, an upper stop and guide 115 (Figs. 32, 33) extends longitudinally of the machine and hence parallel to the top edges of slides 42. The upper stop and guide 115 has its rear end curved upwardly as indicated at 115a so as to obviate possible interference with the carton when its walls are spread apart as described above to assume the open position. The upper stop 115 is secured to brackets 116 which depend from one of two horizontal rails 117, the brackets 116 being vertically adjustable by means of slots 118 and bolts 119 thereby to insure proper spacing of the upper stop above slides 42. By the means described, the side of the carton (which temporarily forms the top when the carton has been set-up), cannot be bent so far out

of its normal plane as to interfere with subsequent bending of the flaps which are in the plane of said carton side.

Rails 117 are supported at one end from the magazine, as best shown in Fig. 33, and are also supported by means of large vertical brackets 120 secured to and forming an extension of the machine frame 40. Brackets 120 are each shaped like an inverted J (Figs. 2 and 14) and at their upper extremities the rails 117 are riveted or bolted. Rails 117 extend parallel to each other all the way to the delivery end of the machine (Figs. 1 and 10).

Flap opening mechanisms

The carton C will now have its flaps folded. Referring to Fig. 11, carton C has a pair of end flaps C1 and side flaps C2 separated by crease lines respectively from the end walls C3 and side walls C4 of the carton. When the carton is first opened, the edges of the side and end flaps C2 and C1 are approximately in contact, as shown, and if an attempt were made to bend inwardly either pair of flaps C1, C2 there might be interference from the other pair, and such interference would cause destruction of or injury to the carton, because the folding mechanisms are quite powerful. Hence the machine of the invention provides means for first bending outwardly the side flaps C2 before bending inwardly the end flaps C1; and after bending inwardly the end flaps C1, the side flaps C2 are folded inwardly so that that side of the carton has the appearance shown in Fig. 12. This outward bending of the side flaps C2 is illustrated in Fig. 7, but in the following description reference should also be made to Figs. 8, 14 and 15.

As illustrated, the side flaps C2 are each engaged by a pair of spaced fingers 125 which have their ends at right angles to the principal length of said fingers, said ends engaging the inside of flap C2 near its free edge when the fingers are simultaneously moved from the horizontal position shown in dotted lines in Fig. 7 (full lines in Figs. 14, 15) to the full line position of Fig. 7. It will be noted that the fingers 125 swing from a horizontal to a vertical position but actually move through more than 90 degrees. The fingers 125 are secured to a horizontal rod 126 which is swung upwardly by a pair of arms 127, said arms being secured to a shaft 128 to which a lever 129 is also secured. Lever 129 has a pin and slot connection 130, 131 with the lower end of a reciprocated vertical rod 132. The rod 132 is actuated by means to be described later and effects simultaneous rocking of arms 127 and of fingers 125 thereby momentarily bending flap C2 outwardly to give clearance on that side of the carton for inward folding of flaps C1.

Since there are two side flaps C2, there are two pairs of fingers 125, 125' which simultaneously engage the side flaps, fingers 125' being secured to a rod 126' rocked by a pair of arms 127' secured on shaft 128' to which a lever 129' is also secured. There is a slot 130' in lever 129', and a pin 131' on the upper end of a reciprocated vertical rod 132', moves in slot 130'. Rod 132' is actuated synchronously with rod 132. Thus the two pairs of fingers 125, 125' simultaneously swing to engage the free edges of both side flaps C2 (which are then at the top and bottom of carton C, though actually both flaps C2 form parts of the bottom or top of the carton when in use.

End flap folding mechanisms

Now referring to Fig. 7, and assuming that the side flaps C2 are both bent outwardly and held as shown in full lines, by the mechanisms just described, the end flaps C1 may now be folded inwardly without any possibility of striking flaps C2 (which might so damage the carton as to make it unusable). The folding of said end flaps is shown in Fig. 16, but the construction of the folders is best shown in Figs. 7, 14 and 15. The actual folding of each of the end flaps C1 is effected by two horizontal, parallel arms 140 whose rounded ends engage the side of end flap C1 and push it in until it lies against the body of the carton; and said arms 140 furthermore hold the end flaps C1 until the side flaps C2 are folded in by means to be described to assume the positions shown in Fig. 12. Then the end flap folding arms 140 move quickly out of the way, assuming the dotted line position shown at the right side of Fig. 16.

The flap folding arms 140 are in pairs as stated, each pair being fixed to the top and bottom ends respectively of a short vertical shaft 141, each shaft 141 being oscillatable on its axis within spaced bearings 142 which are on the free ends of two spaced, connected arms 143. The arms last mentioned are each secured at their opposite ends to a vertical shaft 144 which oscillates on its axis in bearings 145 secured to the machine frame. Preferably upper bearing 145 is provided on an extension of one of the brackets 120, and arms 143 are on either side of said upper bearing. Thus the folding arms 140 may move about two axes, the axis of shaft 141 and that of shaft 144. To make shafts 144 turn together, a link 146 (Fig. 15) is pivotally connected at its opposite ends to short levers 147, each secured to one of the shafts 144. Either shaft 144 has a lever 148 fast to its lower end and said lever 148 is reciprocated by means of a cam, as will be described later. To cause the swing of each shaft 144 to effect the desired motion of flap folding arms 140, a link 149 is connected at one end by a pivot 150 to each upper bracket 145 and extends in a horizontal plane alongside of arms 143. The other end of each link 149 is pivotally secured to the outer end of a short lever 151 fixed to shaft 141, lever 151 being bifurcated to embrace the end of link 149. Arms 143 swing through an arc somewhat less than 90° and this swing pulls the link 149 around, but the fixed end of link 149 causes it to pull lever 151 around, thus swinging folders 140 through an arc of about 120 degrees. The ends of each pair of folders 140 engage flap C1 near its extremity, and push the flap inwardly with a slight sliding movement over the surface of said flap, as will be clear from Fig. 16. A bolt 152 threaded through a block 153 integral with or secured to arms 143 provides an adjustable stop for lever 151, hence for flap folding arms 140.

As shown in dotted lines in Fig. 16, arms 143 and folders 140 are normally retracted to one side of the brackets 120 by which they are supported, that is, the right hand bracket 120 has said arms and folders on the right side, and the left hand bracket 120 on the same side of the machine has the other arms 143 and folders 140 on its left side, thus providing an opening between the two brackets 120 on one side of the machine. Into this opening a carton, opened like the one illustrated in Fig. 11, may be thrust manually at certain times, for a purpose to be ex-

plained. Said opening is shown in Fig. 1 and will be apparent from Fig. 15, if the folders 140 are imagined as being in the retracted positions.

Side flap folding mechanisms

With the end flaps C1 folded inwardly, the other two flaps C2 are to be folded inwardly. It will be recalled that the flaps C2 have been held spread by fingers 125 during the folding of flaps C1, but as soon as that folding is completed, arms 127 swing down to the dotted line position of Fig. 7, and fingers 125 then releases flaps C2. Immediately the arms 127 move inwardly against flaps C2 as shown in Fig. 8, a flat pusher bar 155 actually engaging each of said flaps. Each pusher bar 155 is welded or otherwise secured at its ends to arms 127 and with said arms and rod 126 forms a swinging folding frame movable from the horizontal position—the position of rest—to a vertical position, thereby to close flaps C2 against the body of the carton. However, the resilience of the fiber board usually causes flaps C2 to spring back about to the positions shown in Fig. 12, when the carton is released by the machine.

Actuation of flap spreading fingers

During swinging of the aforesaid folding frames, fingers 125, 125' extend straight out from said frames (Fig. 8), that is, the main portions of said fingers are parallel to the arms 127, 127', though their bent ends are at right angles thereto. However, as previously explained, fingers 125, 125' swing inwardly when said folding frames move away from flaps C2, thereby to cause engagement of the bent ends of said fingers with said flaps, and spreading of the flaps. This simultaneous backward swinging of the folding frames causes simultaneous rocking of the fingers 125, 125' to the full line position shown in Fig. 7, as will now be explained.

Referring to Figs. 14 and 15, it is seen that the rods 126, 126' each carry a torsional spring 156, 156' one end of which is secured to rod 126 through a collar 157, 157' fast to the rod, the other end of the torsional spring bearing against a relatively stationary member, for instance, arm 127. Each torsional spring 156, 156' normally holds its rod 126, 126' in such angular positions that the fingers 125, 125' extend out as in Fig. 8. But rods 126, 126' carry cam followers 158, 158' at one end, and stationary cams 159, 159' are so secured on the machine frame that their edges are engaged by cam followers 158, 158' respectively, when the upper and lower folding frames are moved upwardly and downwardly respectively. This causes rocking of rods 126, 126' against the resistance of their torsional springs, and rocking of fingers 125, 125' as fully explained.

Flap spreading mechanism

Reference should now be made to Figs. 2, 7, 8 and 14, showing the mechanism for folding outwardly or spreading one of the flaps C5. The particular flap spread or folded by the mechanism is the forward flap C5, that is, the flap which is on the leading end of the carton as it is advanced through the machine; in other words, it is the flap C5 which is shown in Figs. 11 and 12. The opposite end flap C5 is spread or folded by means which will be described later.

On the opposite side of the machine from the forward folding arms 140 is an end flap spreader comprising a pair of arms 160 which may be substantially identical in individual construction

to the arms 140. The folding arms 160 are both secured to a vertical rocker shaft 161 journaled in bearings 162 provided on the ends of a pair of spaced pivoted arms 163, each of which is secured at its opposite end to a vertical shaft 164. Bearings 165 secured to the frame of the machine support the vertical shaft 164, and a lever 166, which is fixed on the lower end of shaft 164, when reciprocated by power, will rock said shaft on its axis. Arms 163 are preferably secured to each other by means of a block 167 similar to block 153, and a short lever 168, like lever 151, is secured to shaft 161 at one end and is pivotally connected to a link 169 at its other end, the link 169 being exactly like link 149. Link 169 is pivotally connected at its opposite end to the upper bearing member 165 which forms part of the bracket 120 and hence is a fixed member. As the arms 163 swing on the axis of shaft 164, the link 169 will swing the arms 160 through an angle greater than the angle of swing of the arms 163. The action is exactly the same as that fully shown in Fig. 16, except for the direction of movement of the flaps. The result of the swing of the spreader arms 160 is to move the end flap C5 at the forward end of the cartons outwardly until it lies practically in the plane of the adjacent open side of the carton, as illustrated in Fig. 12, whereas, as will be recalled, the action of the folder arms 140 is a folding in or both end flaps C1. The other end flap C5 is not spread at this time.

Carriage and grippers

As soon as the top end flap C5 is spread or folded outwardly as just explained, the carton, which meanwhile has been released from the grip of the vacuum cups 72, 73, is seized by a pair of vertical grippers or gripping arms (to be described) on a carriage 175, is moved along slides 42 to the forward or discharge end of the machine, is released by the grippers to pass out of the machine, and is filled and sealed by other machines not shown. Referring to Figs. 1, 9, 10 and 26 to 30 inclusive, the carriage 175 is supported on one of the rails 117 by means of a pair of grooved wheels 176 which roll over the top of said rail, a single grooved wheel 177 being secured to the carriage below the rail and being adapted to engage the under edge of said rail thereby to hold the carriage on the rail at all times. To make the carriage travel back and forth, a long, bent crank arm 178 is pivotally connected as at 178a to the forward end of the carriage 175, the rear end of the crank arm 178 being pivotally connected to a crank 179 which is rotated in a vertical plane by a shaft 180 supported in bearings on an extension 181 of the machine frame. The frame extension 181 may be a structural steel member secured to the upright angles 41 and extending horizontally above the rail 117 over which the carriage 175 travels. Secured to one end of the shaft 180 is a sprocket wheel 182 and a sprocket chain 183 meshes with the sprocket wheel 182 and is trained over idler sprockets 184, 185 on frame 40, said chain 183 being driven by a sprocket wheel 186 which is on shaft 187 turned by the motor driven speed reducer 64. The carriage starts to move forwardly from the rearmost position illustrated in Fig. 1 as soon as the flap folding and flap spreading described above are completed.

But before actual forward movement of the carriage, said pair of gripper arms are moved from the positions shown in Fig. 27 to the carton-

gripping positions shown in Fig. 26. These gripper arms not only move the carton positively out of the machine but have the important function of holding the carton against collapsing, that is, the carton must maintain its set-up condition even when engaged by stationary parts (to be described) which would tend to cause the carton to collapse. The gripper arms comprise a long gripper 190 and a short gripper 191, both grippers preferably having rubber contact pieces 192 for direct cushioned engagement with the end walls C3 of the carton. The long gripper 190 is pivoted as at 193 to the rear end of the carriage 175 and the short gripper 191 is pivoted as at 194 to the forward end of the carriage, the pivots 193, 194 being in the same horizontal plane below rails 117. Both gripper arms are L-shaped so that portions of each gripper overlie the top of the carton as shown, thereby preventing tipping of the carton on the slides 42.

To hold the gripper arms spread apart, a coil spring 195 has its ends connected to pins 196, 197 projecting respectively from the long gripper 190 and the short gripper 191 near their respective pivots 193, 194. Pivoted to the carriage on a centrally located pivot 198 is a lever 199 which is generally triangular in shape and which is adapted to be rocked in a vertical plane thereby to move the grippers from the position of Fig. 27 to that of Fig. 26 and back again. The extent of rocking movement permitted lever 199 is regulated by means of a pin 200 which travels in arcuate slot 201 provided in the carriage 175, the center of the arc of said slot being the axis of pivot 198. A pair of links 202, 203, each adjustable in length, as shown, are pivoted to two corners of triangular lever 199 as by pivots 204, 205 respectively. The other ends of links 202, 203 are pivotally connected to the pins 196, 197. The location of the several pivots is such that the parts are locked as by a toggle action when the grippers are moved to vertical positions, or in other words, as shown in Fig. 26, the axis of pivot 205 is slightly below the line joining pin 197 and pivot 198, and the axis of pivot 204 is in line with or slightly below the line joining pin 196 and pivot 198. With the parts slightly beyond dead center, as shown in Fig. 26, the pull of spring 195 will hold the grippers in the vertical positions illustrated and there is no tendency for the gripper arms to separate but rather there is a firm gripping of the carton because of the tension of the spring. As soon, however, as the triangular lever 199 is swung clockwise or toward the position shown in Fig. 27, the dead center is overcome and the spring is then effective to raise both gripper arms and to hold them in the raised positions, with the pin 200 at the right end of the slot 201, as the parts are viewed in Figs. 26 and 27.

To serve as cushioning means for the parts, thus obviating possible crystallization of the metal because of repetition of shocks over a considerable period, also to lessen the noise of operation of the machine, an air cylinder 206 is mounted by a pivot 207 at one end on the carriage 175 and has a close fitting piston (not shown) and a small leak port or valve (not shown), the piston being connected by a piston rod 208 to the lever 199, the connection 209 being, of course, a pivotal one. When the lever 199 moves suddenly from the position of Fig. 26 to that of Fig. 27 and back again, the pivotal connection 209 will effect a sudden inward movement of the piston in the cylinder 206, causing a com-

pression of the air in said cylinder; but the compressed air quickly escapes through the leak port and hence the cushioning action is only momentary, as in a pneumatic door stop. A pneumatic-spring door stop may indeed be used in place of the described cushioning means.

Referring to Figs. 1 and 9, it is seen that the rail 117 on which the carriage travels is provided with a stationary release arm 210 which is so located on said rail that it will be struck by a roller 211 (Fig. 29) provided on the pin 200 which projects through slot 201 sufficiently far on the other side of the carriage 175. Release arm 210 may be slotted as shown at 210^a to permit adjustment of its position on the rail. The movement of carriage is beyond the dotted line position shown in Fig. 9 and is so controlled that the release arm 210 will move the pin 200 for part of the length of the slot 201. As soon as the dead center has been overcome, the spring 195 will complete the movement of the triangular lever 199 and of the grippers, which will then assume the position of Fig. 27. Thus the release arm 210 effects swinging of the grippers to carton-releasing position. The carriage travels back to a position immediately above the next carton, that is, to the setting-up station, as soon as the grippers are released as just described.

Now referring to Figs. 1 and 9, a gripper-operating arm 213 is pivoted as at 214 to the rail 117 on which the carriage travels, the said gripper-operating arm being swingable vertically on its pivot and being located at the limit of rearward travel of carriage 175. Because of the engagement with the gripper operating arm 213 of a pin 215 projecting from the axle of the lower carriage wheel 177, arm 213 will be swung clockwise as the parts are viewed in Fig. 9, thus moving the pin 200 to the right or clockwise, thereby causing the grippers 190, 191 to move from the positions of Fig. 27 to those of Fig. 26.

Because of the peculiar construction and arrangement of parts described above, the action of the gripper arms, both when engaging the carton and when being moved to carton-releasing positions, is very sudden and yet there is no possibility of damaging of the cartons because the grippers cannot move inwardly toward each other when they have attained the vertical positions shown in Figs. 9, 10 and 26. This sudden movement of the grippers is taken advantage of in a manner which will be understood by referring to Figs. 26, 27 and 30. A bracket 216 rigidly secured to the short gripper 191 and extending at right angles thereto, has a pivot 217 on which is mounted a vertically swingable arm 218 having a downward projection 219, said projection being adapted to engage flap C5 as shown in Figs. 9, 10 and 26. Thus said flap is held in the position illustrated in Fig. 12 until the carton is released by the grippers. It is especially desirable to hold the flap C5 substantially at right angles to the end C3 if the carton is to be positioned on a hollow form (not shown) for supporting the carton while being filled by cans or the like. In other words, the flap-holding arm 218 enables the machine of the invention to cooperate with a synchronized carton filling machine forming no part of the invention and hence not shown. In order to insure proper engagement with flap C5 the arm 218 cannot move much below the horizontal position shown in Figs. 26 and 30, the pivoted end of the arm 218 being so shaped (as indicated at 220) that it will engage the bracket 216 on the underside, thereby

stopping downward swinging. However, said arm 218 is free to swing upwardly relative to the bracket 216 and when suddenly dropped, it will actually lag behind the bracket 216 due to its pivotal mounting and its own inertia. Fig. 30 shows in dotted lines a momentary position of the arm 218 caused by its inertia; and after the short gripper arm 191 has been brought into contact with the forward end C3 of the carton, the downwardly extending end 219 of arm 218 will engage the side of flap C5 properly to hold the same in extended position.

Carton guiding and flap holding means

As shown in Figs. 1 and 10, there are two fixed guides 221, 222 which extend horizontally and to one side of slides 42 at a slight angle to the vertical plane of the nearer slide 42, that is the forward ends of guides 221, 222 are nearer said slide 42 than the rear ends. The purpose of these guides is to hold the flaps C2, which slide over the guides, practically closed while the carton is being moved out of the machine by the grippers. The guides 221, 222 would not be used in some instances; but when the machine of the invention cooperates with a carton filling machine of a certain type, it is desired to hold the flaps C2 partly closed while the carton is advancing through the machine. With other types of machines or under other conditions the guides 221, 222 may so closely approach the vertical plane of the nearer guide 42 as completely to close flaps C2, and to hold them closed until some further operation.

As shown in Fig. 1, a horn 223 fixed to a bracket 224 depending from rail 117 extends upwardly at an acute angle to the horizontal and is so positioned above the slides 42 that it will engage the side flap C6 as the carton is advanced out of the machine, thereby to spread or fold flap C6 outwardly sufficiently to insure proper engagement with the form on which the carton is placed for the filling operation.

Main cam shaft and the mechanisms driven thereby

The carton opening arm 70, as shown in Figs. 24 and 25, is really a bell crank lever swung on the axis of pin 71 by means of its short arm 225. Arm 225 is pivotally connected to a link 226 of adjustable length whose other end is pivotally secured to the slotted end of a lever 227, the lever's slot 228 permitting an adjustment of the amount of swing of arm 70. The lower end of lever 227 is pivoted as at 229 to the machine frame, and a cam roller 230 travels in a cam groove 231 provided in a cam 232 fixed to the main cam shaft 233, see Fig. 31. Main cam shaft 233 is driven by a sprocket wheel 234 meshing with a sprocket chain 235 (Figs. 1 and 2), said sprocket chain being driven by a sprocket 236 on the shaft 187. An adjustable chain tightener 237 for chain 235 may also be mounted on the frame of the machine, as shown. Thus the arm 70 is swung through an arc of about 90° to effect engagement of the vacuum cups 72 with the top surface of the carton on the slides 42, and to open the carton and hold it during the folding operations previously described. By the means shown, an adjustment of the angle of swing may be made so as to insure proper engagement with cartons of different thicknesses, for instance, cartons made of double corrugated board, as well as single corrugated board.

Besides operating the setting-up or carton

opening arm, the main cam shaft 233 operates a number of other mechanisms as will now be described. It will be recalled that the lower vacuum cups 73 are adapted to be moved upwardly a short distance to bring their flexible edges in contact with the underside of the carton. Referring to Fig. 31, the T-shaped arm 100 carries a cam roller 240 near its lower end, said cam roller being movable over a cam 241 secured on the cam shaft 233. A collar 242 co-operates with the cam 241 in holding the lower end of T-shaped arm 100 properly relative to the cam. And the lower end of arm 100 has a slot 243 guiding said arm on the main cam shaft 233, when it is reciprocated vertically as the cam roller 240 rides over the rotating cam 241.

To operate the lower side flap holder and folder, the vertical rod 132' is preferably integral with a slotted link 245 having a slot 246 permitting said link to embrace and be guided by the main cam shaft 233 (Figs. 14 and 15). The slotted link also carries cam roller 247 which rides over the cam 248. A coil spring 249 attached at its lower end to the machine frame 40, is secured at its upper end to the slotted link 245 and serves to hold the cam roller 247 on the cam 248, while also serving to hold the lower folder frame down, or in the position of Fig. 14. Obviously as the cam roller 247 moves downwardly from the position shown in Figs. 14 and 15, the fingers 125' will swing inwardly because of the cam 159', as previously explained, thus gripping the side flap C2 and pulling it downwardly to spread it. But when the cam roller 247 rises above the position of Fig. 14, the pivoted folder frame will swing upwardly as shown in Fig. 8 to fold inwardly the side flaps C2.

The upper folding frame on the same side of the machine is operated from the shaft 180 which, as has been explained, is driven from the motor 68 by the sprocket chain 183. Normally, the upper folding frame is held in horizontal position, as shown in Fig. 14, because a coil spring 250 is connected at its lower end to lever 129 and is attached at its upper end to a stationary bracket 251 fixed to the machine frame adjacent shaft 180. The coil spring 250 also tends to move the rod 132 upwardly, said rod 132 being merely an extension of a slotted link 252 having a slot 253 for receiving shaft 180. A cam roller 254 is carried on the slotted link 252 and is pressed by spring 250 against the periphery of a cam 255, which has a shape similar to that of the cam 248, since the motions of the upper and lower folding frames must be identical. As the main cam shaft 233 and the shaft 180 are both driven at the same speed from the same shaft 187 of the speed reducer, the upper and lower folding frames will be simultaneously elevated and depressed, respectively, to cause gripping of the upper and lower flaps C2, will simultaneously swing the flaps C2 inwardly and will simultaneously return to the starting position shown in Fig. 14.

As previously explained, the end flap folders 140 operate simultaneously to push the two end flaps C1 inwardly. By the preferred arrangement, the end flap folders hold the end flaps until the side flaps C2 have been folded in, as heretofore described, and then the end flap folders 140 move out of the way, to either side of the brackets 120. One of the shafts 144 for operating the end flap folders as previously described, has its short arm or lever 148 connected by a link 256 (whose length is adjustable) to a

slotted or bifurcated arm 257, which slides over arm 257 is a pivotal one and slotted arm 257 carries a cam roller 259 which rides over the cam shaft 233 as shown in Fig. 15. The connection 258 between link 256 and the slotted periphery of a cam 260 on the main cam shaft 233. A coil spring 261 has one end attached to the frame 40 and extends horizontally to a pin 262 projecting from the slotted arm 267. Thus the tension of spring 261 tends to hold the cam roller 259 pressed against the periphery of cam 260.

The top end flap spreader 160 is swung by means of the lever 166 as stated above, and said lever 166 is operated from a cam 263 secured to the main cam shaft 233 as shown in Fig. 31. The mechanical connections between the cam 263 and the arm or lever 166 will be perfectly understood when it is explained that an adjustable link like link 256 is used; that the said adjustable link is secured to a slotted arm, like arm 257; that said slotted arm embraces shaft 233 and has a cam roller like cam roller 259, but riding over the periphery of cam 263 instead of cam 260. The vertical rocker shaft 164 has a lever 264 near its lower end (Fig. 14), said lever being connected to a coil spring 265 whose other end is secured to the machine frame. The spring 265 is expanded whenever the spreader arms 160 push a flap open, and hence spring 265 will swing arms 163 and spreader arms 160 back to the inactive positions of said parts when permitted to do so by the cam 263; obviously spring 265 also holds the above mentioned roller on cam 263. Thus the top flap spreader is operated entirely independently of though synchronously with the bottom end flap folders 140.

Now the control of the vacuum to cups 72, 73 will be described. Referring to Fig. 24, the main cam shaft 233 has a collar 266 keyed thereon and a cam 267 is secured by bolts 268 to the collar 266, said bolts passing through slots 269 and permitting angular adjustment of the cam relative to the cam shaft. As cam 267 is rotated by the main cam shaft it actuates a roller 270 on a lever 271 secured to the valve stem 272 of a three-way valve 273. The three-way valve is connected to a pipe 274 which leads to a source of vacuum, for example, a tank (not shown) to which a vacuum pump (not shown) is connected; and the other side of valve 273 is joined as shown to the pipe 95 which, as previously explained, is connected to the interiors of the upper and lower vacuum cups 72 and 73. The three-way valve also has a vent 275 to the atmosphere and thus when said valve is in proper position it will open the interiors of all the vacuum cups to the atmosphere, thereby breaking the suction maintained by the cups on the upper and lower portions of the carton during the folding operations previously described. The source of vacuum is, of course, sealed off from the vent 275 at all times. To hold roller 270 on the periphery of cam 267, I may employ a coil spring 276 attached at one end to lever 271 and at the other end to a bracket 277 secured to the frame 40 in a manner not shown. The three-way valve may be carried upon a bracket 278 integral with a plate 279 secured to tie-rods 280 which extend between the sides of the machine frame 40 and are essentially parts of it. See also Fig. 31. While all the cams are not fully shown, it will be understood that each of them may be angularly adjustable relative to the cam shaft 233 in the same manner as the air valve cam 267, thus

making possible perfect operation of the machine.

No box power cut-off and machine control circuits

Referring to Figs. 1, 32, 33, 34 and 35, it is seen that as a carton is opened by the vacuum arm 70, its top will engage a curved lever 285, the function of which is to render inoperative a switch 286 so connected in the control circuit of motor 68 that it will cause the motor to stop unless switch 286 is made inoperative. So long as the cartons keep rising from the collapsed to the open position at the setting-up station, the arm 285 will make the switch 286 ineffective; but if there is a single failure of a carton to open properly or if the supply of cartons in the magazine runs out, the machine will continue to operate for the remainder of that cycle, that is, until the parts return to the starting positions. Then the machine will automatically come to a stop and will remain stationary until power is again applied to the motor by deliberate closing of the motor switch 287. The free end of arm 285 is held down, not only by gravity, but also by a spring inside of the casing of switch 286, (said spring not being shown because it is part of a switch of standard construction). Switch 286 is secured to the rail 117 which does not support the carriage 175. Journaled in bearings 288 secured to the forward side of the magazine is a horizontal rocker shaft 289 on one end of which is a short lever 290 having a pivotal connection 291 with a rod 292 whose length is adjustable and which extends upwardly toward shaft 180. The upper end of rod 292 is secured to a slotted link 293 whose slot 294 permits it to be guided by shaft 180. Slotted link 293 carries a cam roller 295 adapted to roll over the periphery of a cam 296 secured to shaft 180 and hence rotated by power when the machine operates. Cam 296 has a depression 296a in its periphery (Fig. 34) and obviously if cam roller 295 enters said depression rocker shaft 289 will be rocked on its axis. Attached to rocker shaft 289 is a lever 287 to which a link 298 is pivotally connected at one end. Link 298 also has a pivotal connection 299 with a switch arm 300 for operating a timing switch 301 preferably located adjacent switch 286 and similarly supported. Also secured to switch arm 300 at connection 299 is another link 302 having a slot 302a in which a pin 303 fits, said pin projecting from and being attached to a switch arm 304 which operates switch 286, and to which the arm 285 is also secured, as shown. Because of the depression 296a in cam 296, shaft 289 will oscillate once during each revolution of cam 296, and link 298 will simultaneously reciprocate, but while link 302 also reciprocates in unison, its slot 302a merely slides along pin 303 so long as arm 285 is in the position shown in Fig. 34. But if arm 285 stays in the dotted line position of Fig. 32 at the moment during the cycle of the machine when the carton should open up, then switch arm 304 will move to the right hand position shown in dotted lines in Fig. 32, as pin 303 will be at the right end of slot 302a; and in this position, switch 286 will not short circuit timing switch 301. The last named switch will then set the time relay 306 into action, and the machine will come to rest at the moment which is predetermined to end the cycle of the machine. However, if control switch 305 (Fig. 35) is moved from "automatic" to "hand" position, the motor control circuit will operate to cut off power to

the motor when the cycle next reaches the predetermined stopping point, even though a carton is in the proper position to lift arm 285 to render switch 286 inoperative.

Referring further to Fig. 35, switch 301 is a timing switch controlled through the case detector switch 286. The timing switch is a standard article controlling a standard time relay 300 connected in the control circuit of the motor as shown. When it is desired to stop the motor immediately, a stop switch 307 in the form of a push button switch is opened, thus cutting off the power from the line 308, whereupon the solenoid brake of the motor brings it to an almost instant stop, thus stopping all parts of the machine almost instantaneously. If then the machine is started up by pushing the button of switch 287 it will work continuously (unless stopped as previously described) so long as switch 305 is in the "automatic" position; but if the switch 305 is in the "hand operation" position, the machine will operate through one cycle and then automatically will come to a stop. Thus hand-controlled operation (a single cycle followed by a full stop, with manual operation of the starting switch 287 necessary to start up again), as well as automatic or continuous operation, are both permitted by the control circuits of the invention.

Without further description, it will be clear that the described machine realizes the stated objects of the invention, and also many specific objects not stated. For instance, the machine is especially designed to permit a set-up box to be inserted into the machine when stationary, as will be highly desirable at certain times. The action of the machine is sensitive and delicate, yet positive and sure, and cartons handled by the machine are very seldom damaged. If a carton magazine is used, as described, the collapsed cartons are so stacked that they will slide under one another without the possibility of catching or "snagging" on each other.

Obviously the invention may assume various forms, not illustrated, and I do not wish to be limited by the above description of a machine successfully tested by me but only by the following claims interpreted in the light of the prior art.

Having described a preferred embodiment of the invention, what I claim as new and desire to secure by Letters Patent is:

1. A machine of the character described comprising, in combination, means for feeding collapsed cartons one at a time forwardly of the machine; power-actuated means for opening the cartons; an arm lying in the path of a carton as it expands from collapsed to open position; a switch operated by said arm; an electric motor having a control circuit and driving said carton-feeding means; said switch being so connected in said circuit that the motor is continued in circuit so long as the cartons continue one at a time to open against said arm; said motor circuit being broken when there is a single failure by a carton to open; and a solenoid brake in the motor circuit stopping the motor and hence the machine after said motor circuit is broken.

2. The invention according to claim 1, wherein the means for opening the cartons comprises two vacuum cups, one engaging the underside of each carton, the other being on a swingable arm and engaging the top of each carton; a source of vacuum and means connecting it to the vacuum cups; means operated by said motor to connect and cut off the source of vacuum and said vacuum

cups; and means operated by said motor to swing said arm down to engage the carton with the vacuum cup thereon and to swing the arm back again to pull the top of the carton away from the bottom, which is then held by the bottom vacuum cup.

3. The invention according to claim 1, wherein there is means to hold the underside of the carton during the opening operation; a swinging arm being operated by the motor to move above the carton; a vacuum cup on the free end of said swinging arm; a source of vacuum connected to said vacuum cup; means to connect or cut off the source of vacuum; and means for mounting said vacuum cup on said arm so as to maintain its edges always parallel to the bottom of the collapsed carton.

4. The invention according to claim 1, wherein there is a second switch and a time relay in the control circuit of the motor; the two switches being electrically connected so that the first named switch short circuits the second switch whenever said arm is swung by an opening carton; said second switch starting said time relay to operate whenever it remains in circuit; said time relay acting to break the motor circuit after a predetermined time interval.

5. A machine of the character described comprising, in combination, a motor; means driven by the motor to open fully collapsed cartons, one at a time; means driven by the motor to convey the opened cartons away, switch means and electrical connections to said motor; said switch means being opened by each carton as it opens to allow both said motor driven means to continue to operate through another cycle, the machine thereby operating continuously so long as cartons operate the switch means, but stopping when there is a single failure of a carton to open against said switch means.

6. A machine of the class described comprising, in combination, means to open collapsed cartons, one at a time; means to fold certain flaps of each carton after it is opened; means to convey the cartons away after flap-folding; a motor for operating all of said means, said motor having control circuits and a solenoid brake; the control circuits comprising a switch having a contact and a time relay connected with the motor so that when said switch is closed, the machine operates through a single cycle and comes to a stop; said switch have another contact with connections such that continuous automatic operation of the machine takes place when said switch is closed against said other contact; another switch to start operation of the machine when the first mentioned switch is closed against the first mentioned contact; and another switch controlled by hand to open all the circuits instantly thereby to bring the machine to a sudden stop.

7. The invention according to claim 6 wherein there is another switch connected in the motor control circuit so that when said last named switch is opened, the machine will come to a stop at the end of the particular cycle during which opening of said switch occurs; and means operated by each carton, as it is opened in the machine, to open the last mentioned switch.

8. A machine of the character described comprising, in combination, automatic means for spreading apart and holding spread apart two opposite flaps of the four bendable flaps on one side of a rectangular carton, the amount of the spreading being sufficient to permit the other two flaps to be folded inwardly without touch-

ing the spread flaps; other automatic means for folding inwardly said other two flaps while the two flaps first mentioned are held spread; and means mechanically connected with and associated with the first-named means and acting automatically to fold in the two flaps first mentioned immediately after said other two flaps have been folded in, whereby all four flaps are folded in without interference from each other.

9. The invention according to claim 8 wherein the means to spread apart and hold spread apart said two flaps are swingable simultaneously to engage the free edges of said two flaps, the first-named means being carried by the means which later bend the same flaps inwardly; and automatically acting means to swing said first-named means inwardly to engage said flaps, then to pull the first-named means outwardly to spread and hold said flaps, then to swing said first-named means outwardly to release said flaps.

10. A machine of the character described comprising, in combination, power-actuated means to feed collapsed cartons one at a time into the machine; power-actuated means to open the collapsed cartons comprising a swingable arm having a vacuum cup on its free end, said arm swinging down to bring said vacuum cup into contact with the top surface of the collapsed carton; a source of vacuum; means to connect said vacuum cup with said source of vacuum; valve means to control suction through said connecting means and to open said cup to the atmosphere; means to operate said valve means; means automatically holding down and immovably securing the underside of the carton as the upperside thereof is raised by pull of said vacuum cup; the vacuum cup on the swinging arm being movably mounted thereon to turn as the swinging arm moves down toward the top surface of the collapsed carton, the amount of turning of said vacuum cup exactly compensating for the angle through which said arm swings, thereby to maintain the vacuum cup always parallel to the top surface of the carton.

11. A machine of the character described comprising, in combination, an arm swingable from a vertical position to a horizontal position and back again; a vacuum cup mounted on the free end of the arm; a source of vacuum and connections, including a valve, between the source of vacuum and the vacuum cup; a generally horizontal support for cartons extending alongside of the swinging arm; another vacuum cup supported below the level of the carton support and adapted to be moved upwardly to come in contact with the underside of a carton on said carton support; means connecting the second named vacuum cup with the valve and with the source of vacuum; power-actuated means to swing said arm and to raise and lower the second named vacuum cup; and power-actuated means to operate said valve to put the vacuum cups under suction and to cut off said suction; said suction being sufficient to hold the underside of the carton immovably during opening of the carton; said valve being a three-way valve with an exhaust to the atmosphere, so that atmospheric pressure may be admitted to the interiors of said vacuum cups after said suction is cut off.

12. A machine of the character described comprising vacuum means for immovably holding the bottom side of a collapsed carton; power-actuated means to move said vacuum means into contact with said bottom side and to move it

away again after a predetermined time interval; a source of vacuum; means operated by power to connect the vacuum means with the source of vacuum as said vacuum means comes into contact with said bottom side; means operated by power to cut off the source of vacuum and to open the vacuum means to atmospheric pressure; and swingable vacuum means also connected with the source of vacuum and movable by power into contact with the topside of the collapsed carton, there being pipe connections between the two vacuum means so that both are in suction or are under atmospheric pressure at the same time.

13. A machine of the character described comprising, in combination, a hopper for holding and feeding by gravity a plurality of collapsed cartons having flaps; a pair of spaced rails below the lower end of the hopper and extending through the entire machine; means to push a single collapsed carton from the lower end of the hopper along the rails to a certain point in the machine; means to open the carton at that point; said carton-opening means also holding the carton immovably on the rails both during the opening and for some time thereafter; means for folding in certain of the flaps of the carton; means for folding out another flap on the opposite side of the carton; said folding in and folding out means operating while the carton is held immovably; means for effecting releasing of the carton after said folding is completed; and means for gripping the folded carton and moving it along the rails of the machine.

14. A machine of the character described comprising, in combination, means for feeding collapsed cartons having top and bottom flaps one at a time to a certain point in the machine; means for opening the cartons at that point; means for folding in the flaps which are at the bottom of the carton; means for spreading or folding out a top flap substantially at right angles to the adjacent end wall of the carton; means for holding the carton rigidly as its flaps are folded in and out; and means for conveying the folded carton away.

15. A machine of the character described comprising, in combination, means for feeding one at a time collapsed cartons having top and bottom flaps to a certain point in the machine; means for opening the cartons at that point; means for folding in the flaps which are to be at the bottom of the carton; means for spreading or folding out a top flap; means for conveying the folded cartons away one at a time; the means to convey the cartons away comprising a pair of arms which clamp the opposite ends of the carton and hold the carton rigidly as it is moved away; and a stationary horn being provided for engagement with one of the top flaps to spread the same as the carton is moved out of the machine.

16. A machine of the character described comprising, in combination, means for feeding one at a time collapsed cartons having top and bottom flaps to a certain point in the machine; means for opening the cartons at that point; means for folding in the flaps which are to be at the bottom of the carton; means for spreading or folding out a top flap; means for conveying the folded cartons away one at a time; the carton having four bottom flaps, two attached to the ends, and two to the sides, along fold lines; and the machine having automatically acting folders which push two opposite bottom flaps

inwardly, and other automatically acting folders which push the other two opposite bottom flaps inwardly.

17. A machine of the character described comprising, in combination a support for a carton having top and bottom flaps, the bottom flaps consisting of two end flaps and two side flaps, each bendable along fold lines; means for spreading apart the side flaps; means for folding in the end flaps while the side flaps are held spread; means for folding in the side flaps after the end flaps are folded in; means for holding the carton immovable on said support while said flaps are spread apart and folded in as aforesaid; and means for conveying the folded carton out of the machine.

18. The invention according to claim 17, wherein the machine has stationary means engaging the outsides of the folded in side flaps to hold said side flaps pressed inwardly as the conveying means moves the carton outwardly.

19. The invention according to claim 17, wherein the machine has automatic, power-actuated means, and stationary means, to spread outwardly respectively two top flaps of the carton.

20. The invention according to claim 17, wherein there is an automatic power-actuated folder mechanism which spreads one of the top flaps outwardly until it lies about in the plane of the open top of the carton; and means are provided to hold said top flap in the described spread position as the carton is conveyed out of the machine.

21. A machine of the character described comprising means for holding a carton having four top and four bottom flaps, with all said flaps initially extending outwardly in the respective planes of the side and end walls to which the flaps are attached; means for folding in all four of the bottom flaps in a predetermined order; and means for simultaneously folding or spreading out a single top flap until it lies substantially at right angles to the adjacent end wall of the carton.

22. A machine of the character described comprising, in combination, means for delivering collapsed cartons, one at a time, to a certain point in the machine; means to open each carton when it reaches that certain point; and means to convey the opened carton away comprising slides over which the carton moves, and a pair of arms which grasp the opened carton between them and which travel above said slides in a path parallel to said slides; a traveling carriage supporting said arms; and means to move said arms from carton-grasping to carton-releasing positions.

23. A machine of the character described comprising, in combination, a support over which an opened carton may be slid; a rail parallel to said support and spaced above it; a carriage movable along said rail; power-actuated means to move the carriage back and forth; a pair of arms pivoted on the carriage and so spaced apart that when they are vertical, they will hold between them a carton supported on said support; means connected to said arms to hold them alternately in vertical positions, or spread apart to release the cartons; and stationary means engaged by said arm-holding means to move the arms alternately into carton-holding and carton-releasing positions.

24. The invention according to claim 23, wherein the pivoted arms are pivotally connected

to two links, each link being pivotally connected to a lever swingable on the carriage in a vertical plane; said carriage have an arcuate slot and the lever having a pin movable in said slot, whereby rocking of the lever and swinging of the arms on their pivots are definitely limited; and means to hold the arms in either of the extreme positions permitted by said slot and pin.

25. The invention according to claim 23, wherein the arm-holding means comprises a coil spring, and the several pivots are so located that the arms are subjected to the tension of said spring whether in carton-releasing or in carton-holding positions.

26. The invention according to claim 23, wherein means are provided to limit the arcs of swing of the arms, and cushioning means is mounted on the carriage to cushion the shock of sudden stop of the arms as they reach either extreme position.

27. The invention according to claim 23, wherein the arm-moving means comprises a stop fast to the rail near one limit of travel of the carriage, and a swingable lever near the other limit of travel of the carriage, said lever also being on the rail, and the carriage having a projecting member which swings said lever to cause it to move the arms to carton-holding positions.

28. The invention according to claim 22, wherein there is a mechanism connecting the two arms together, said mechanism comprising links and levers so pivoted to the carriage and to each other that when the arms are in carton-grasping positions, the links and levers are past dead center or arm-locking positions.

29. The invention according to claim 22, wherein the arms are pivoted on the carriage, and means connect the arms so they must open and close together; means being interposed between the carriage and arms to limit movement of the arms in either direction; and a spring to hold the arms at either limit of movement.

30. A machine of the character described having a carton conveyor comprising the combination of a support over which cartons may be slid; a pair of arms adapted to engage the forward and rear ends of the carton to slide it over said support; a carriage traveling above said support and pivotally supporting said arms; means to hold said arms only in carton-holding or carton-releasing positions; and plural stationary means acting through power derived from the traveling carriage to overcome said arm-holding means and to move said arms to either of the positions permitted.

31. A machine of the character described comprising, in combination, vacuum means to hold that face of a rectangular carton which is lowermost down upon a support, said carton having flaps which are subsequently to be folded, other cooperating vacuum means to grip by vacuum the face of the carton which is uppermost and to move in such a path that the carton is fully opened without permanent distortion or tearing; means to operate and control both said vacuum means; and an upper stop and guide extending longitudinally of the machine and parallel to the support and being so spaced above the support that the upper face of the carton engages it, so that said upper face cannot be bent so far out of its normal plane as to interfere with subsequent folding of the flaps which are in the plane of said upper face.

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