June 5, 1956 M. W. HAYDEN 2,749,116

SHEET FOLDING APPARATUS

Filed Feb. 24, 1953 4 Sheets-Sheet 1

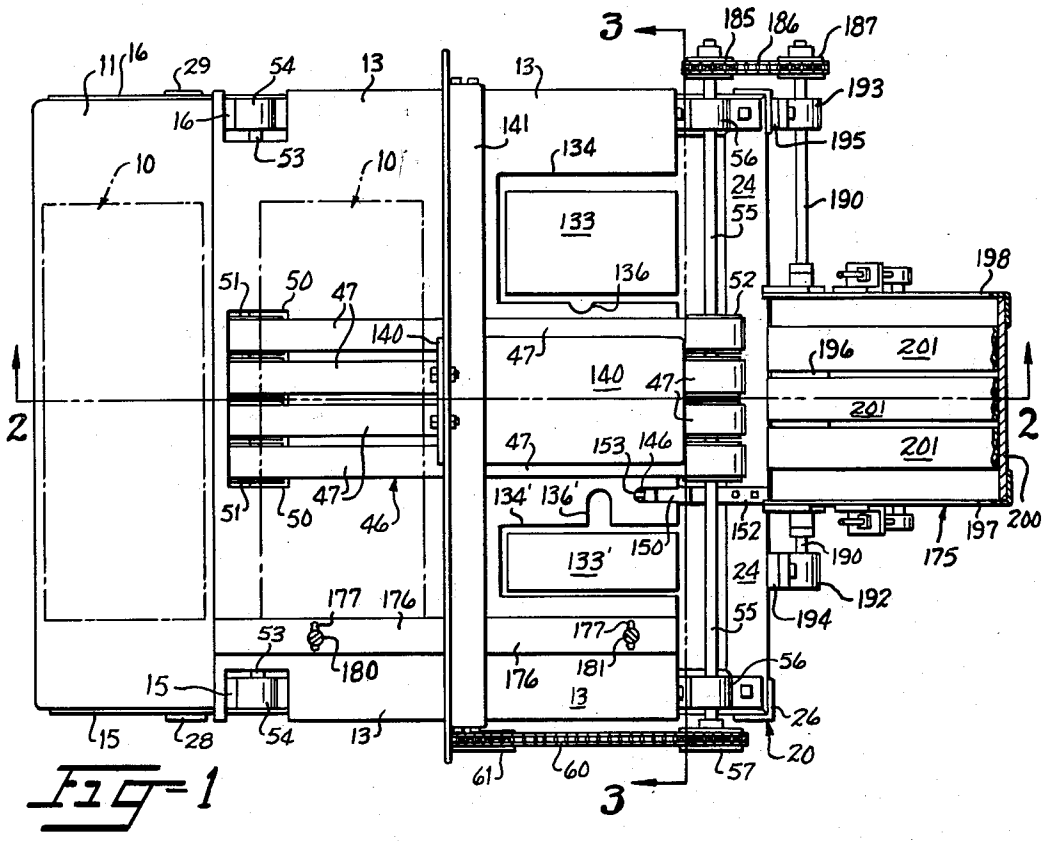


Fig-1

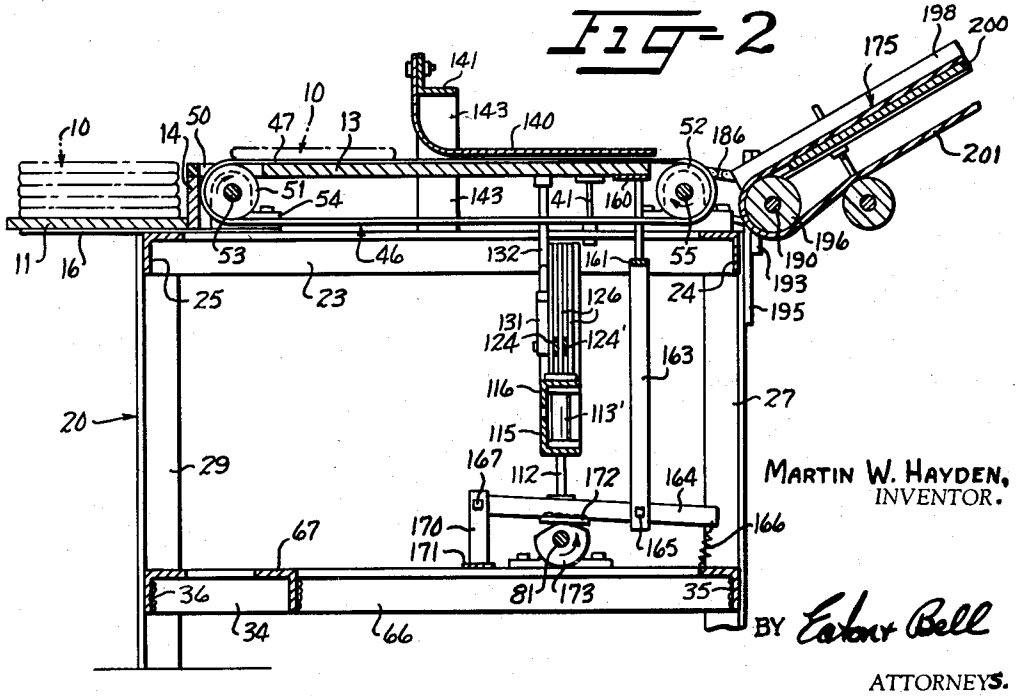


Fig-2

MARTIN W. HAYDEN,
INVENTOR.

BY Eaton Bell

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SHEET FOLDING APPARATUS

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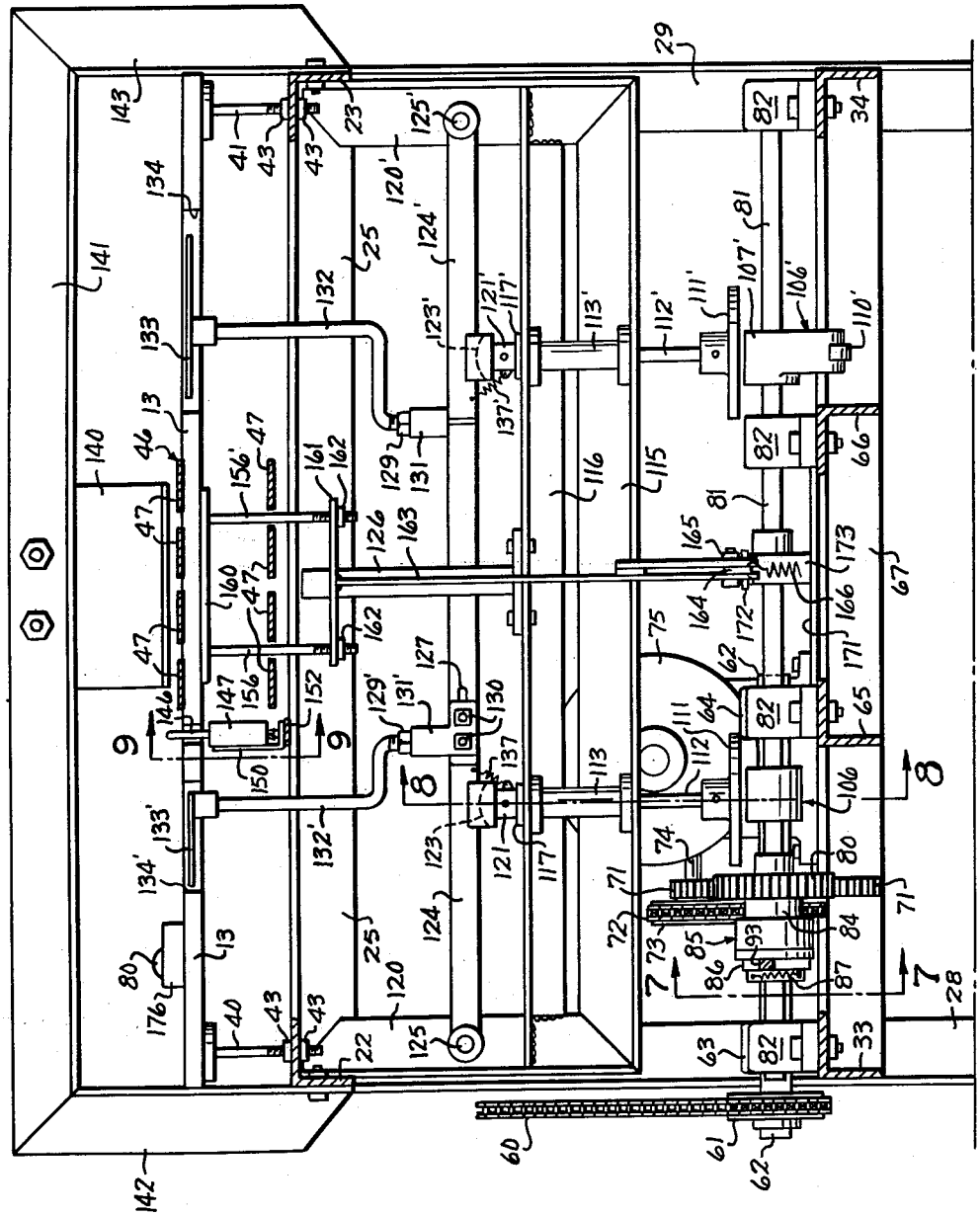


FIG. 3

MARTIN W. HAYDEN,
INVENTOR.

BY Eaton & Bell

ATTORNEYS.

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SHEET FOLDING APPARATUS

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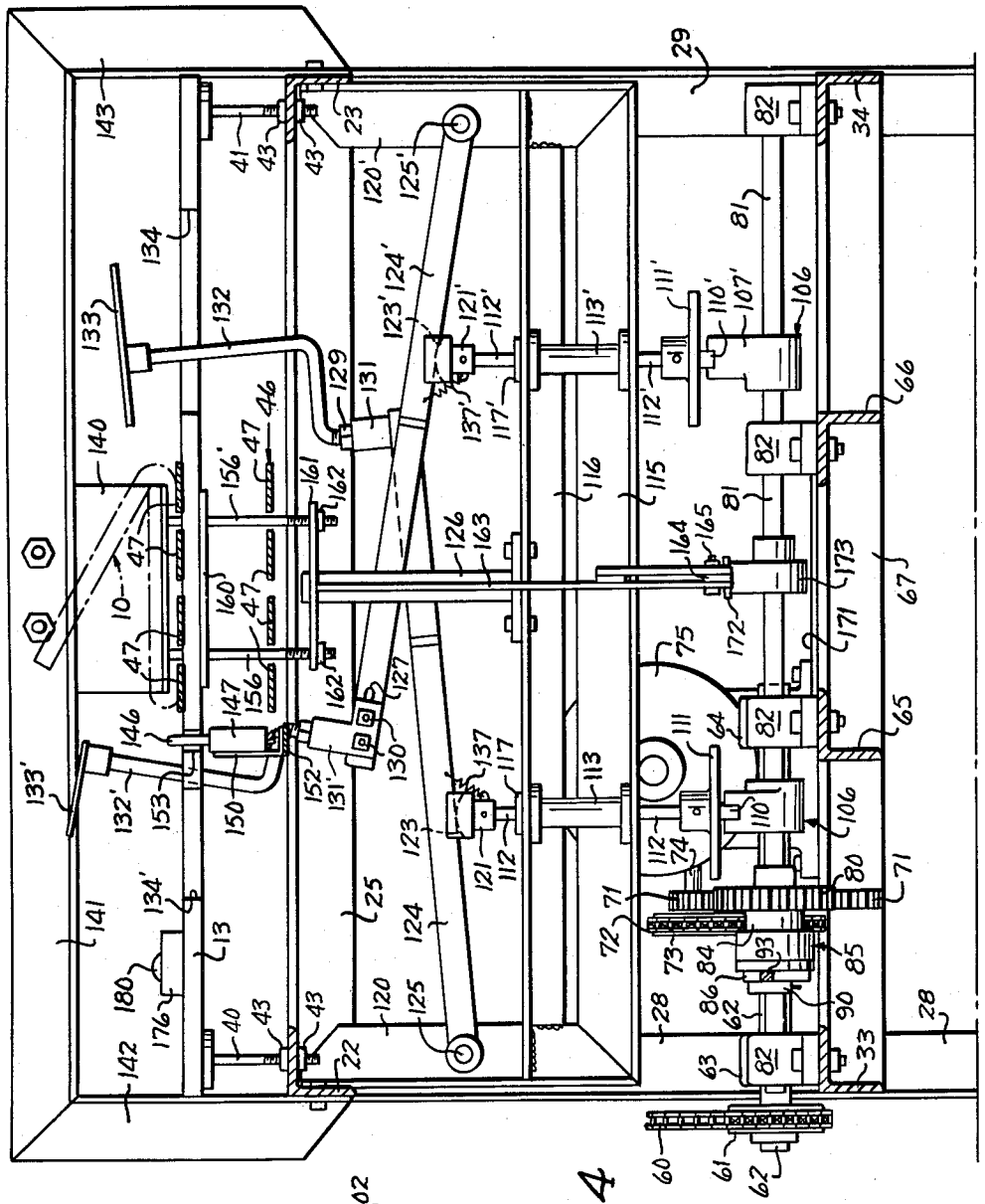


FIG. 4

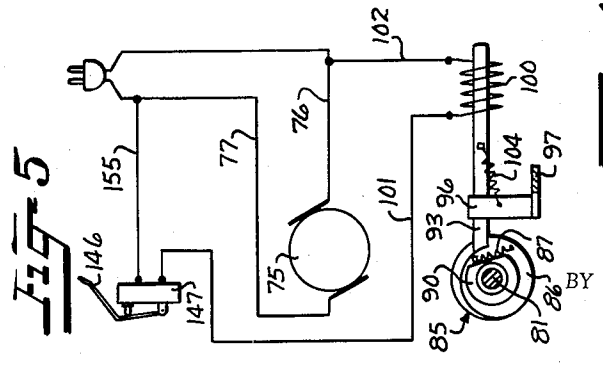


FIG. 5

MARTIN W. HAYDEN,
INVENTOR.

BY

Eaton & Bell

ATTORNEYS.

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Fig. 6

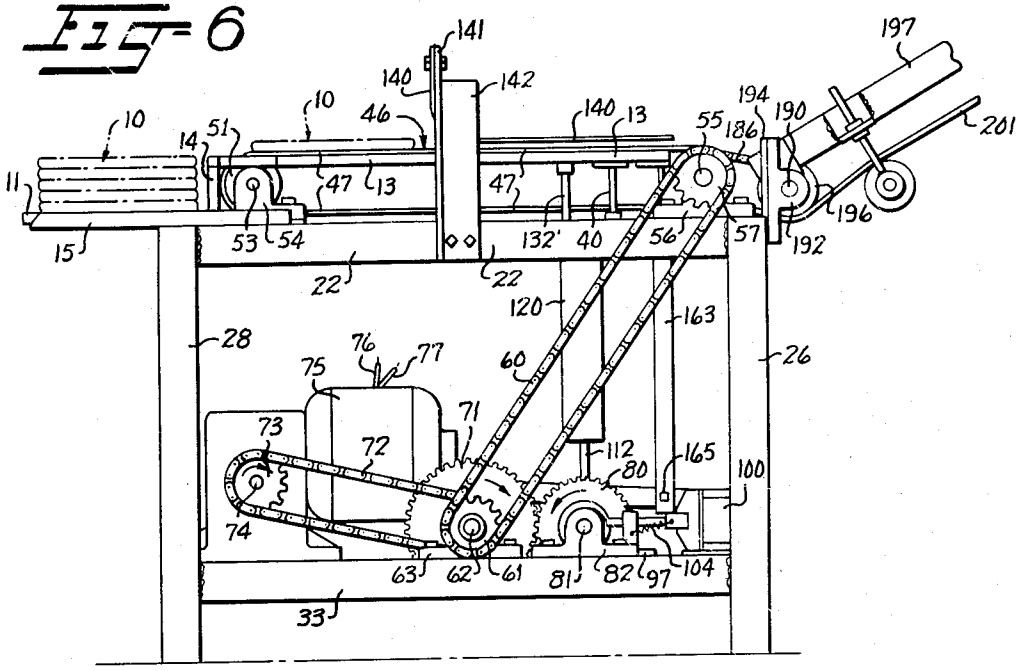
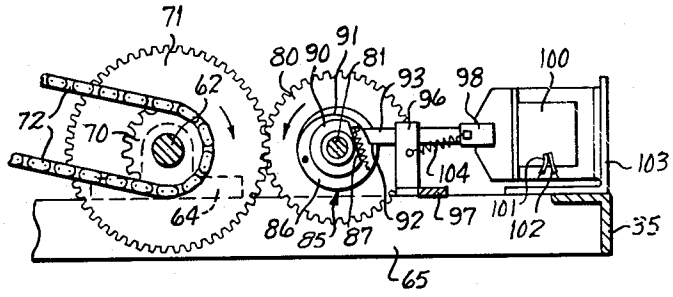


Fig. 7



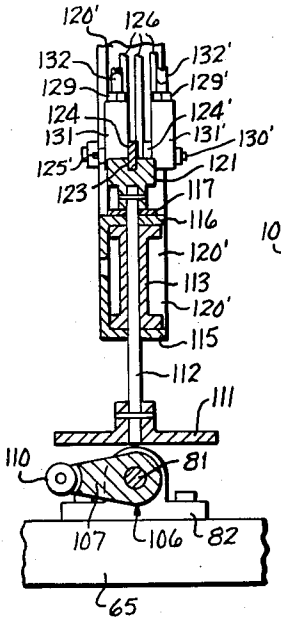


Fig. 8

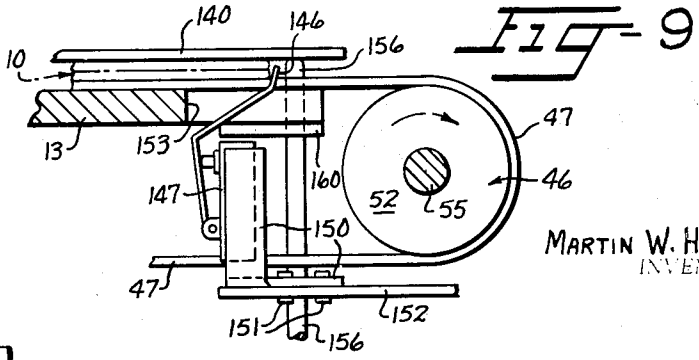


Fig. 9

MARTIN W. HAYDEN,
INVENTOR.

BY Eaton & Bell

ATTORNEYS.

United States Patent Office

2,749,116

Patented June 5, 1956

2,749,116

SHEET FOLDING APPARATUS

Martin W. Hayden, Leaksville, N. C., assignor, by mesne assignments, to Fieldcrest Mills, Inc., a corporation of Delaware

Application February 24, 1953, Serial No. 338,421

12 Claims. (Cl. 270—84)

This invention relates to an apparatus for folding pliable articles and more especially to an improved apparatus for folding elongated substantially rectangular articles, such as partially folded bed sheets and the like, and wherein means are provided for folding opposite end portions of the partially folded bed sheets in overlapping relationship over the central portion of the corresponding bed sheet or pliable article.

During the process of inspecting conventional size bed sheets having a length of, say, one hundred seven inches and having a width of, say, seventy-two inches, the inspectors usually partially fold each bed sheet or blanket into a substantially rectangular shape of a relatively smaller size of, say, ten inches wide and twenty-five inches long, in which state they are stacked on trucks or the like and transported to the packaging department.

Heretofore, in order to package the bed sheets and the like, it has been necessary to manually fold the end portions of each of the partially folded bed sheets or the like in overlapping relation to each other and so the end portions are disposed in superposed relation to the central portion of the bed sheet or other pliable article to form the same into a substantially square compact mass. Since this operation has been performed manually, it has thus been costly and time consuming and it is the primary object of this invention to provide a simple and effective automatic means for folding opposite end portions of such partially folded bed sheets or other pliable articles in overlapping relation to each other and in superposed relation to the central portions thereof and wherein means are provided for automatically feeding the then completely folded articles in rapid succession from the improved folding apparatus onto a suitable conveyor or the like for feeding the then completely folded articles to a succeeding process, such as pressing or ironing and packaging.

More specifically, it is an object of this invention to provide a folding apparatus of the character described comprising an endless conveyor onto which the partially folded bed sheets or other pliable articles may be successively manually placed, one at a time, and wherein the width of the conveyor is substantially less than the length of the pliable articles so that the end portions of the pliable articles extend outwardly beyond the opposite sides of the conveyor. The conveyor then advances each successive article so that its central portion is disposed beneath and in close proximity to a retaining plate, fixed center folding plate or hold-down plate and so that the end portions of each successive article are positioned above a pair of alternately vertically movable flippers or end folder plates.

As each successive pliable article moves to a predetermined position beneath the retaining plate with its end portions above said pair of end folder plates or flippers, automatically operable means, actuated by the leading edge of each successive pliable article, causes first one and then the other of the end folder plates to dart upwardly to thereby successively throw opposite end portions of the corresponding sheet or other pliable article upwardly

and whereupon the centrally disposed retaining plate will cause the end portions to be successively folded in overlapping relation to each other, due to the momentum of movement transmitted to the end portions of the bed sheet or other pliable article, and whereupon the then completely folded pliable article is discharged from the folding apparatus as a succeeding article is positioned in register with the folding devices.

It is still another object of this invention to provide an apparatus of the character described wherein means are provided to restrain forward movement of each successive pliable article during the folding operation and in such a manner that the conveyor may continue to move during the folding operation and wherein means are provided to automatically release each successive article from the restraining means following each folding operation.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds, when taken in connection with the accompanying drawings, in which—

Figure 1 is a top plan view of the improved pliable article folding apparatus showing a portion of a secondary or discharge conveyor in association therewith and also showing two of the blanks or pliable articles, in broken lines, resting on the apparatus;

Figure 2 is a longitudinal vertical sectional view through the machine taken along the line 2—2 in Figure 1;

Figure 3 is an enlarged transverse vertical sectional view through the machine showing the operating means for the flippers or end folding plates and the article restraining means in elevation and in lowered position and being taken substantially along the line 3—3 in Figure 1;

Figure 4 is a view similar to Figure 3, but showing the flippers and the restraining means in different positions from that shown in Figure 3, and also showing a substantially completely folded article in association therewith in broken lines;

Figure 5 is a schematic diagram of the electrical circuit of the machine;

Figure 6 is a right-hand side elevation of the machine looking at the lower side of Figure 1;

Figure 7 is a fragmentary vertical sectional view, mostly in elevation, taken substantially along the line 7—7 in Figure 3;

Figure 8 is a fragmentary vertical sectional view showing the actuating means for one of the flippers or end folding plates and being taken substantially along the line 8—8 in Figure 3;

Figure 9 is a fragmentary longitudinal sectional view taken substantially along the line 9—9 in Figure 3 and illustrating the switch for controlling actuation of the end folding plates or flippers and also showing the restraining means in a raised or operative position.

Referring more specifically to the drawings, the numeral 10 generally designates elongated substantially rectangular foldable or pliable articles such as partially folded bed sheets, blankets or the like, each of which articles is relatively thin; say, one inch thick and are usually relatively long as compared to the width thereof. As a matter of fact, the standard sizes of bed sheets, blankets and the like are usually folded to a size approximately ten inches wide and twenty-five inches long. Of course, it is to be understood that these sizes are merely stated here for example and the sizes and types of the articles to be operated upon by the improved folding apparatus, to be presently described, should merely be of workable proportions.

A plurality of said articles 10, which may also be termed as blanks, are preferably supported on a stationary article storage tray or platform 11 so they may be readily

placed upon the conveyor and table of the improved apparatus by an operator. Disposed forwardly of the tray or storage platform **11**, and also preferably being disposed at a higher elevation than the storage platform **11**, is a conveyor platform or table **13** whose rear edge rests upon and is suitably secured to a transverse frame member **14**.

Opposite ends of the transverse frame member **14** are suitably secured to relatively short frame members **15** and **16**, shown in the form of angle bars, which extend rearwardly beyond a frame broadly designated at **20** and which support opposite ends of the storage platform **11**. The frame **20** also comprises a substantially rectangular framework including upper longitudinally extending side frame members or angle bars **22** and **23** whose opposite ends are connected to respective front and rear upper frame members or angle bars **24** and **25**. The corners of the substantially rectangular framework, including the members **22** to **25**, inclusive, are suitably secured to the upper ends of corner posts or legs **26** to **29**, inclusive.

The medial portions of the legs **26** to **29**, inclusive, also support a lower substantially rectangular framework including longitudinally extending side frame members or angle bars **33** and **34** and respective front and rear frame members or angle bars **35** and **36**. The front portions of the storage platform supporting angle bars **15** and **16** are suitably secured to the upper surfaces of the upper longitudinally extending angle bars or frame members **22** and **23**, respectively.

The front end of the conveyor table or platform **13** is suitably supported on the upper ends of uprights or standards **40** and **41** which are preferably vertically adjustable to facilitate adjustment of the front end of the conveyor table or platform **13**. To this end, the lower portion of each of the standards **40** and **41** loosely penetrates the corresponding frame members **22** and **23** and the threaded lower end of each of the standards **40** and **41** has a pair of lock nuts **43** thereon which engage the respective upper and lower surfaces of the frame members **22** and **23**.

Feed conveyor

The frame **20** carries a primary, first or feed conveyor, broadly designated at **46**, which comprises a plurality of closely spaced parallel endless belts each designated at **47**. The upper reaches of the endless belts **47** are driven to move forwardly in sliding engagement with the upper surface of the conveyor table or platform **13** and the rear portion of the platform **13** has a transverse opening or slot **50** therein through which the rear portions of the endless belts **47** extend in engagement with respective pulleys or rollers **51**. The front portions of the endless conveyor belts **47** extend beyond the front edge of the conveyor table or platform **13** and are mounted on respective driven pulleys, wheels or rollers **52**.

The rear rollers **51** are fixed on a common transverse idler shaft **53** rotatably mounted in bearing blocks **54** carried by the frame **20**. In this instance, the bearing blocks **54** are suitably secured to the front portions of the storage platform supporting bars **15** and **16** (Figures 1, 2 and 6). The front pulleys or rollers **52** are also fixed on a common transverse, constantly driven shaft **55** rotatably mounted in a pair of bearing blocks **56** suitably secured to the transverse frame member **54** and the corresponding side frame members **22** and **23**.

One end of the front shaft **55** has a sprocket wheel or pulley **57** fixed thereon which is engaged by an endless belt or sprocket chain **60**. The endless belt or sprocket chain **60** extends downwardly and rearwardly at an angle in Figure 6 and is mounted on a sprocket wheel or pulley **61** fixed on a transverse jack shaft **62**. Opposite ends of the jack shaft **62** are journaled in bearing blocks **63** and **64**.

The bearing block **63** is suitably secured to the upper surface of the lower longitudinal side frame member **33** and the bearing block **64** is fixed on one of a pair of lower intermediate longitudinally extending frame members or angle bars **65** and **66** (Figures 2, 3, 4, 7 and 8). The front ends of the intermediate longitudinal frame members **65** and **66** are fixed to the front lower transverse frame member **35** and the rear ends thereof are fixed to a common intermediate transverse frame member or angle bar **67** whose opposite ends are suitably secured to the side frame members **33** and **34**.

The shaft **62** also has a sprocket wheel or pulley **70** and a relatively large gear **71** fixed thereon. The sprocket wheel or pulley **70** is engaged by an endless sprocket chain or belt **72** which extends rearwardly and upwardly in Figure 6 and is mounted on a sprocket wheel or pulley **73** fixed on a shaft **74** of a gear reduction electric motor **75**. The electric motor **75** is suitably secured to the rear and intermediate transverse frame members **36** and **67**. The electric motor **75** has wires or conductors **76** and **77** extending therefrom to a suitable source of electrical energy, not shown. It is thus seen that the conveyor **46** and gear **71** are constanttly driven in a clockwise direction in Figures 2, 6, 7 and 9.

Cam shaft and drive therefor

The gear **71** meshes with a relatively smaller gear **80** rotatably mounted on a transverse cam shaft **81**. The cam shaft **81** is rotatably mounted in a plurality of transversely spaced bearing blocks **82** one each suitably secured to the lower longitudinal frame members **33**, **34**, **65** and **66**. The gear **80** is fixed to a hub member **84** of a suitable single revolution clutch **85**. There are many different types of single revolution clutches which may be employed to serve the purpose of the clutch **85** shown in Figures 3, 4, 6 and 7, the particular clutch shown being of a type disclosed in the patent to Richard D. Dickens, No. 2,140,737, dated December 20, 1938. Therefore, a complete illustration and description of the clutch **85** is deemed unnecessary. It might be stated, however, that the clutch **85** also includes an intermediate cam plate **86** which loosely encircles the shaft **81** and is effective in normally maintaining a fixed connection between the hub member **84** thereof and the cam shaft **81** when it is in operative position, to which it is urged by a tension spring **87**.

One end of the tension spring **87** is connected to the outer face of the cam plate **86** and the other end thereof is connected to an outer hub plate **90** which is also, at times, rotatable relative to the cam shaft **81**. The elements **84**, **86**, **87** and **90** are the equivalent of the respective elements **7**, **21**, **25** and **23** shown in said Patent No. 2,140,737. It will be noted in Figure 7 that the cam plate **86** is formed with a cam surface **91** culminating in a raised portion or shoulder **92** with which a trip bar **93** may engage.

Now, it is evident that continuous rotation of the gear **80** in a counterclockwise direction in Figure 7 tends to rotate the cam plate **86** in a like direction. However, when the intermediate cam member is restrained from rotation, as by the trip bar **93** engaging the shoulder **92**, the tension spring **87** permits relative movement between the cam member **86** and the hub **84** whereby conventional means such as shown in said Patent No. 2,140,737 permit the gear **80** to rotate freely on the cam shaft **81**.

The trip bar **93** is mounted for longitudinal or forward and rearward sliding movement in a standard **96** (Figures 6 and 7) whose lower end is suitably secured to a substantially L-shaped bracket or plate **97**, one leg of which extends toward the observer in Figures 6 and 7 and is suitably secured to the longitudinal side frame member **33**. The front end of the trip bar **93** is pivotally connected to a plunger **98** of a solenoid **100** having wires **101** and **102** connected to opposite ends of the coil thereof. The solenoid **100** is suitably secured to a bracket or angle clip **103** fixed to the front lower trans-

verse frame member 35. The trip bar 93 is normally urged rearwardly or to operative position by a tension spring 104.

It is thus seen that, upon energization of the solenoid 100, by means to be later described, the trip bar 93 is moved forwardly; out of engagement with the shoulder 92 on the cam plate 86 of the single revolution clutch 85, whereupon the tension spring 87 causes the cam plate 86 to swing about its pivot point to establish a fixed connection between the gear 80 and the shaft 81 by means clearly shown in said Patent No. 2,140,737. It is evident that, with rotation of the cam plate 86, the spring 104 urges the trip bar 93 into engagement with the cam surface 91 of cam plate 86, since the solenoid 100 is only momentarily energized, and, whereupon the trip bar 93 will engage the shoulder 92 to disengage the clutch mechanism and to cause the cam shaft 81 to rotate exactly one revolution each time the solenoid 100 is energized.

End folding means

Now, it will be observed in Figures 3, 4 and 8 that the cam shaft 81 has three longitudinally spaced cams thereon indicated at 106, 106' and 173. Since the cams 106 and 106' are identical, except for the high points thereof being positioned at different relative angles, only the cam 106 and its associated parts will be described in detail and like parts associated with the cam 106' shall bear the same reference characters with the prime notation added.

Referring to Figure 8, it will be observed that the cam 106 is shown in the form of a crank arm 107 fixed on the cam shaft 81 and the bifurcated free end of the crank arm 107 has a cam follower or roller 110 mounted thereon which is adapted to, at times, engage a plate 111 fixed on the lower end of a vertically movable plunger or connecting rod 112. The connecting rod 112 is mounted for vertical sliding movement in a guide block 113 disposed between, and being suitably secured to, a pair of transverse frame members 115 and 116 shown in the form of angle bars. The shaft 112 also slidably penetrates the angle bars 115 and 116. Opposite ends of the transverse frame members 115 and 116 are suitably secured to the lower portions of upright frame members 120 and 120' whose upper ends are suitably secured to the medial portions of the respective upper side frame members 22 and 23.

The upper portion of the vertically movable shaft or connecting rod 112 also slidably penetrates a resilient shock absorbing washer 117 and has a cuff member 121 fixed on the upper end thereof which is provided with a transversely extending slot or groove 123 in the upper end thereof. The bottoms of the grooves 123 and 123' are preferably convex, as best shown in Figures 3 and 4, and have the medial portions of respective fold plate levers or flipper levers 124 and 124' resting thereupon. The proximal portions of the levers 124 and 124' are guided in their vertical movement by upstanding guide bars 126 the lower ends of which are fixedly secured to the transverse frame member 116. The distal ends of the levers 124 and 124' are pivotally connected as at 125 and 125' to the respective upright frame members 120 and 120'. It will be observed in Figures 3 and 4 that the proximal or free ends of the levers 124 and 124' are offset relative to each other so the proximal portions may move freely past each other during vertical movement thereof.

The free end of each lever 124 and 124' has a longitudinally extending slot 127 therein (Figures 3 and 4) which is penetrated by bolts 130 for securing blocks 131 and 131' to the free overlapping end portions of the levers 124 and 124' respectively. The lower ends of flipper or folding plate support bars or rods 132 and 132' are threadably embedded in the respective blocks 131 and 131' and are locked therein, as by lock nuts 129 and 129'. The flipper support bars 132 and 132' extend upwardly from the respective blocks 131 and 131' and then outwardly and again upwardly and have respective substantially horizontally disposed end folding plates or flippers 133 and 133' suitably secured to the upper ends thereof.

It will be observed in Figure 1 that the conveyor table or platform 13 has a pair of substantially rectangular openings or apertures 134 and 134' therein through which the respective plates 133 and 133' have free vertical movement. The plate 133' may be termed a first folding plate or flipper and the plate 133 may be termed a second folding plate or flipper for purposes of clarity in the claims. These first and second folding plates 133' and 133, respectively, normally occupy a position slightly below the level of the upper surface of the conveyor table or platform 13, as shown in Figure 3, and are held in this position due to the lower ends of the respective blocks or cuff members 121' and 121 resting upon the washers 117 and 117', which then engage the frame member 116.

Now, upon each revolution of the cam shaft 81 in a clockwise direction in Figures 2, 6, 7 and 8, the followers 110' and 110 of the respective cams 106' and 106 are caused to engage and raise the respective plates 111' and 111 in rapid succession. In so doing, the levers 124' and 124 are successively moved upwardly and then lowered in rapid succession to correspondingly move the plates 133' and 133 in a folding operation, as will be more fully described later in this context. It will be observed in Figure 1 that the proximal walls of the openings or apertures 134 and 134' have respective slots or notches 136 and 136' therein, through which the respective flipper support members or rods 132 and 132' project when the flippers 133 and 133' are in substantially the position occupied by the flipper or first folding plate 133' shown in Figure 4.

The grooves 123 and 123' are provided to facilitate free manual raising and lowering of the respective levers 124 and 124' and the respective folding plates or flippers 133 and 133', if desired. Accordingly, the levers 124 and 124' are resiliently held in engagement with the curved or convex bottoms of the grooves 123 and 123' by respective tension springs 137 and 137'. The upper ends of the tension springs 137 and 137' are connected to the medial portions of the respective levers 124 and 124' and the lower ends thereof are connected to the cuff members 121 and 121', respectively.

The resilient connections between the levers 124 and 124' and the respective cuff members 121 and 121' are also provided to prevent undue strain on the levers 124 and 124' as the followers 110 and 110' of the respective cams 106 and 106' move out of engagement with the respective plates 111 and 111' and permit the cuff members 121 and 121' to suddenly move downwardly, by gravity. As the flippers or folding plates 133' and 133 move upwardly in rapid succession, the corresponding end portions of the corresponding blank 10 disposed thereabove are thrown upwardly and then fall successively upon and in overlapping relation to each other substantially as indicated in Figure 4.

Article hold-down plate

Now, in order to hold the corresponding blank 10 against the upper surfaces of the belts 47 and to thereby cause the end portions of the corresponding blank 10 to be folded upon each other, a hold-down plate, center folding plate or retaining plate 140 is spaced closely above the front portions of the belts 47 so the medial portion of each successive blank 10 occupies a position between the hold-down plate 140 and the belts 47 when it is moved forwardly by said belts. It will be observed in Figure 2 that the front edge of the hold-down plate 140 is free and the rear portion thereof is curved upwardly and suitably secured, adjacent its upper end, to a transverse hold-down plate supporting frame member

or angle bar **141**. Opposite ends of the frame member **141** are suitably secured to uprights or standards **142** and **143** which extend downwardly and are suitably secured to the distal surfaces of the upper longitudinal frame members **22** and **23** respectively.

It is thus seen that the curved rear portion of the hold-down plate **140** assists in directing each successive blank **10** therebeneath and, thus, the central portion of each successive blank **10** is compressed slightly between hold-down plate **140** and the upper surfaces of the conveyor belts **47** to thereby maintain traction between the belts **47** and the article or blank **10**. It is evident that, during the folding operation; that is, as the first and second folding plates or flippers **133'** and **133** move upwardly in rapid succession, the corresponding end portions of the blank disposed thereabove are caused to swing inwardly at opposite side edges of the central folding plate or hold-down plate **140** so that the first fold is positioned upon the upper surface of the hold-down plate **140** and the second fold is positioned upon the upper surface of the first fold in overlapping relation thereto.

Control for clutch

Now, in order to actuate the cam shaft **81** as each successive blank is moved to folding position and to also momentarily restrain each successive blank in folding position during the sudden upward movement of the folding plates or flippers **133** and **133'**, the leading edge of each successive blank **10** first engages a switch arm **146** pivotally connected to a normally open switch **147**. The switch **147** is suitably secured to an angle clip or bracket **150** (Figures 3, 4 and 8). The bracket **150** is suitably secured, as by screws **151**, to the rear portion of a support bar **152** which extends forwardly in Figure 1 and is suitably secured to the upper front transverse frame member **24**.

The conveyor platform or table **113** is provided with a notch or slot **153** in the front edge thereof through which the upper portion of the switch arm **146** projects so as to be disposed in the path of travel of the blanks **10** as they are carried forwardly by the conveyor belt **47**. The switch arm **146** is preferably made from a flexible material so that it will bend downwardly and thereby be moved out of the path of travel of the blanks **10** as the blanks **10** are subsequently permitted to move forwardly to be discharged from the folding apparatus.

Now, it will be observed in Figure 5 that the normally open switch **147** has one end of the wire **101** extending from the solenoid **100** connected to one side thereof and the other side of the switch **147** has a wire **155** connected thereto which extends to the lead wire **77**. It is thus seen that, upon the leading edge of each successive article or blank **10** engaging and imparting forward movement to the switch arm **146**, the switch **147** is closed to complete a circuit to the coil of solenoid **100**. This causes the solenoid plunger **98** and the trip bar **93** (Figures 6 and 7) to move forwardly thereby moving the trip bar **93** out of engagement with the shoulder **92** on the cam plate **86** of the single revolution clutch mechanism **85**.

As heretofore stated, upon movement of the trip bar out of engagement with the shoulder **92**, the spring **87** causes relative movement between the cam plate **86** and the housing or hollow hub portion **84** of the clutch mechanism **85** to thus engage the clutch mechanism **85**. Since the gear **80** rotates continuously, the gear **80** will thus transmit rotation to the cam shaft **81** in a counterclockwise direction in Figure 7. In so doing, the cam shaft **81** causes a pair of normally inoperative or lowered article arresting rods or stop members **156** and **156'** to dart upwardly against the lower surface of the hold-down plate **140**, to raise the same slightly and to thereby free the corresponding blank or article **10** from the conveyor belt **47**, whereupon the leading edge of the article or blank **10** engages and is stopped by the arresting rods or bars **156** and **156'**.

Article arresting means

Referring to Figures 3, 4 and 9, it will be observed that the medial portions of the arresting rods or bars **156** and **156'** extend between the lower reaches of adjacent outermost conveyor belts **47** and, of course, when the arresting bars **156** and **156'** are in raised or operative position, as shown in Figures 4 and 8, the upper portions of the arresting bars **156** and **156'** are also disposed between the upper reaches of adjacent outermost conveyor belts **47**.

The upper portions of the arresting bars **156** and **157** are mounted for vertical sliding movement in the front portion of the conveyor platform or table **13** and, since this conveyor platform or table **13** is preferably made from a light material such as wood, a reinforcing guide plate **160** is suitably secured to the lower surface thereof and is also slidably penetrated by the vertically disposed arresting rods or bars **156** and **156'**. The threaded lower ends of the arresting bars **156** and **156'** threadably penetrate a transverse bar **161** and are held in adjusted position therein by suitable lock nuts **162**.

The medial portion of the bar **161** is fixed, as by welding, to the upper end of a connecting rod or yoke member **163** which extends downwardly and straddles the medial portion of a lever **164**, to which the lower end of the connecting rod or yoke member **163** is pivotally connected, as at **165**. The front end of the lever **164** is urged downwardly by a tension spring **166** connected at its upper end to the front end of the lever **164** and being suitably connected at its lower end to the lower front transverse frame member **35**. The lever **164** extends rearwardly above the cam shaft **81** and is pivotally connected, as at **167**, to a standard **170** carried by a transverse bar **171** (Figures 2, 3 and 4), opposite ends of which are suitably secured to the intermediate longitudinal frame members **65** and **66**.

Now, the medial portion of the lever **164** has a suitable follower or plate **172** fixed to the lower surface thereof (Figure 2) which is urged into engagement with an irregularly shaped cam wheel **173** fixed on the central portion of the cam shaft **81**. The cam wheel **173** normally occupies the position shown in Figure 2, that is, with the low surface of the cam **173** normally being in engagement with the follower **172** of the lever **164**, and, thus, the arresting bars **156** and **156'** are normally in lowered or inoperative position. Of course, upon the switch **147** being closed, as shown in Figure 9, rotational movement is imparted to the cam shaft **81**, in the manner heretofore described, whereupon the high surface of the cam **172** moves into engagement with the follower **172** to elevate the arresting rods or bars **156** and **156'** to the operative position shown in Figures 4 and 9. As heretofore stated the upper ends of the arresting rods or bars **156** and **156'** engage and bias the front end of the hold-down plate **140** upwardly and are then engaged by the leading edge of the corresponding blank **10**.

Thus, the belts **47** may continue their movement and will slide against the lower surface of the blank **10** as it is momentarily held in stationary position by the arresting bars **156** and **156'**. Immediately thereafter, the flippers **133'** and **133** operate in rapid succession, in the manner heretofore described, to fold the opposite ends portions of the corresponding blanks over the hold-down plate **140**. Immediately following, or in the course of, downward movement of the flippers or folding plates **133** and **133'**, to the inoperative position shown in Figure 3, the low surface of the cam **173** (Figure 2) moves into engagement with the follower **172**, thereby permitting the arresting bars **156** and **156'** to move downwardly to the inoperative position shown in Figure 3.

Of course, upon movement of the arresting bars or rods **156** and **156'** to inoperative position, the carrier belts **47**, which move continuously, discharge the completely folded article or blank **10** from the folding appara-

tus into a container or, as shown in the drawings, onto a suitable conveyor, generally designated at **175**, for directing each successive completely folded article or blank **10** to a suitable press or to other points for further processing. The upper reaches of the conveyor belts **47** move forwardly relatively fast and, thus, the trailing edge of each successive blank moves beyond the switch bar **146** before the cam shaft **81** has completed its corresponding revolution. Thus, the switch **147** will be permitted to open and the tension spring **104** (Figure 7) will return the trip bar **93** to operative position, whereupon it will engage the cam surface **91** of the cam plate **86** and will ultimately engage the shoulder **92**, to stop rotation of the cam shaft **81** at the completion of a single revolution.

In order to insure that each successive blank or article **10** is properly positioned on the exposed rear portions of the upper reaches of the conveyor belts **47** by the operator, a guide bar **176** is adjustably secured to the upper surface of the conveyor table or platform **13** to one side of, and in substantially parallel relation to, the conveyor belt **47** (Figure 1). In this instance, the guide bar **176** is provided with a pair of transverse adjustment slots **177**, each of which is penetrated by a screw **180** for adjustably securing the guide bar **176** to the upper surface of the conveyor table or platform **13**.

The conveyor **175** may be of any desired or conventional construction and, since it is preferable that this conveyor **175** is driven at a rate corresponding to the rate of speed of the conveyor belts **47**, it will be observed in Figures 1, 2 and 6 that the end of the shaft **55**, remote from the end on which the sprocket wheel **57** is mounted, has a sprocket wheel or pulley **185** fixed thereon which is engaged by an endless sprocket chain or belt **186** which is also mounted on a sprocket wheel or pulley **187**. The sprocket wheel or pulley **187** is fixed on one end of an auxiliary conveyor shaft **190** which is a part of the discharge conveyor **175**.

The shaft **190** is rotatably mounted in bearing blocks **192** and **193** fixed to the front surfaces of respective uprights **195**, which extend downwardly and are suitably secured to the front surfaces of the leg **27** and the front upper transverse frame member **24**, respectively. A roller or pulley **196** is fixed on the medial portion of the shaft **190** and is suitably journaled in the framework including members **197** and **198**, which framework supports an angularly disposed platform **200** against the upper surface of which the upper reaches of a plurality of closely spaced conveyor belts **201** have sliding movement. The conveyor belts **201** are mounted on the pulley or roller **196** and, thus driven thereby.

A further description of the conveyor **175** is deemed unnecessary, since there are many different types of conveyors which may be utilized for the purpose set forth and conveyor **175** is shown merely to illustrate means for driving the same at the same rate of speed as that of the conveyor belts **47** of the conveyor **46**.

It is evident that, upon each successive blank **10** being deposited on the exposed rear portions of the upper reaches of the conveyor belts **47**, with one edge thereof against the guide bar **176**, the operation of the improved folding apparatus will be repeated in the manner heretofore described.

It is thus seen that I have provided an improved apparatus for folding substantially rectangularly shaped pliable articles, such as partially folded bed sheets and the like, comprising an endless conveyor onto which an operator may successively place the blanks one at a time and wherein means are provided which are automatically responsive to the proper positioning of each successive blank for arresting forward movement of each successive blank with the central portion thereof beneath the hold-down plate **140** and other means also responsive to the proper positioning of each successive blank successively moves the flippers or end folding members **133'** and **133** upwardly, in rapid succession, to thereby successively fold the corresponding end portions of each successive blank over the upper surface of the hold-down plate. Thereafter, the arresting means is automatically moved to inoperative position to again permit the blank or article to be advanced forwardly and discharged from the machine in completely folded position and whereupon the machine is again automatically conditioned for operating upon the next successive article or blank.

In the drawings and specification there has been set forth a preferred embodiment of the invention and although specific terms are employed, they are used in a generic and descriptive sense only, and not for purposes of limitation, the scope of the invention being defined in the claims.

I claim:

1. Apparatus for folding opposite end portions of substantially rectangular, pliable articles in overlapping relation to each other and in overlapping relation to the central portions thereof, said articles having been previously folded along lines disposed transversely of their path of travel into a plurality of superposed layers, comprising a platform on which successive previously folded articles are adapted to be placed, means for moving each successive article in a given direction along said platform, first and second normally substantially horizontally disposed folding plates spaced laterally from each other relative to the direction of travel of each successive article and over which the end portions of each successive article are moved, means operable automatically upon the end portions of each successive article moving to a position above the folding plates for arresting movement of the corresponding article, and means automatically operable upon the end portions of each successive article moving to a position above said folding plates for moving each of the folding plates in phased vertical reciprocating motion with an upward velocity sufficient to impart an impulse of motion to each of said end portions to cause them to be thrown upwardly and inwardly in overlapping relation to the central portion of the article and in overlapping relation to each other, said motion of the folding plates being restricted to a part only of the path executed by the end portions.

2. Apparatus for folding opposite end portions of substantially rectangular, pliable articles in overlapping relation to each other and in overlapping relation to the central portions thereof, said articles having been previously folded along lines disposed transversely of their path of travel into a plurality of superposed layers, comprising a platform on which successive previously folded articles are adapted to be placed, means for moving each successive article in a given direction along said platform, first and second normally substantially horizontally disposed folding plates spaced laterally from each other relative to the direction of travel of each successive article and over which the end portions of each successive article are moved, means operable automatically upon the end portions of each successive article moving to a position above the folding plates for arresting movement of the corresponding article, means automatically operable upon the end portions of each successive article moving to a position above said folding plates for moving each of the folding plates in phased vertical reciprocating motion with an upward velocity sufficient to impart an impulse of motion to each of said end portions to cause them to be thrown upwardly and inwardly in overlapping relation to the central portion of the article and in overlapping relation to each other, said motion of the folding plates being restricted to a part only of the path executed by the end portions, and means for restraining upward movement of the central portion of each successive article as the end portions thereof are tossed upwardly successively by the first and second folding plates.

3. Apparatus for folding opposite end portions of substantially rectangular, pliable articles in overlapping relation to each other and in overlapping relation to the central portions thereof, said articles having been previously folded along lines disposed transversely of their path of travel into a plurality of superposed layers, comprising a platform on which successive articles are adapted to be placed, means for moving each successive article in a given direction along said platform, first and second normally substantially horizontally disposed folding plates spaced laterally from each other relative to the direction of travel of each successive article and over which the end portions of each successive article are moved, and means operable automatically upon the end portions of each successive article moving to a position above the folding plates for moving each of the folding plates in phased vertical reciprocating motion with an upward velocity sufficient to impart an impulse of motion to each of said end portions to cause them to be thrown upwardly and inwardly in overlapping relation to the central portion of the article and in overlapping relation to each other, said motion of the folding plates being restricted to a part only of the path executed by the end portions.

4. Apparatus for folding opposite end portions of pliable blanks in overlapping relation to the central portion thereof and in overlapping relation to each other, said articles having been previously folded along lines disposed transversely of their path of travel into a plurality of superposed layers, comprising a constantly driven endless horizontally disposed conveyor onto which each successive previously folded blank may be manually deposited, a hold-down plate spaced closely above a portion of said conveyor and having its front edge, relative to the direction of movement of the conveyor, free, a pair of normally substantially horizontally disposed flippers disposed adjacent opposite sides of said conveyor and also being disposed adjacent opposite sides of the hold-down plate and onto which opposite end portions of each successive blank are directed by said conveyor, and means responsive to the positioning of each successive blank beneath the hold-down plate for moving each of the flippers in phased vertical reciprocating motion with an upward velocity sufficient to impart an impulse of motion to each of said end portions to cause them to be thrown across the hold-down plate and folded along opposite side edges of said hold-down plate, said motion of the flippers being restricted to a part only of the path executed by the end portions.

5. An apparatus for folding opposite end portions of substantially rectangular, pliable articles in overlapping relation to each other and in overlapping relation to the central portions thereof, said articles having been previously folded along lines disposed at right angles to the lines of the second folding operation, said second folding means comprising a platform, a plurality of constantly driven closely spaced substantially parallel endless belts having their upper reaches movable in sliding engagement with the upper surface of said platform and on which successive articles may be manually positioned, first and second normally substantially horizontally disposed folding plates disposed astride said plurality of belts, a resilient hold-down plate normally spaced above a portion of said plurality of belts a distance somewhat less than the thickness of the articles and being disposed between said folding plates, means supporting the rear portion of said hold-down plate relative to the direction of movement of said endless belts whereby each successive article is held in engagement with said belts by the hold-down plate to insure traction between the articles and the endless belts, at least one vertically movable arresting bar having its upper end normally spaced below the path of travel of each successive article as it is moved beneath said hold-down plate by said belts, said arresting bar also being disposed in a lateral plane approximating that of the front edges of said folding plates, means engageable by the leading edge of each successive article for momentarily imparting upward movement to said arresting bar for arresting movement of the corresponding article, the upward movement of said arresting bar being such as to raise the hold-down plate relative to the endless belts to thereby permit the endless belts to continue movement independently of the corresponding article, and means operable automatically upon the end portions of each successive article moving to a position above said folding plates for moving each of the folding plates in phased vertical reciprocating motion with an upward velocity sufficient to impart an impulse of motion to each of said end portions to cause them to be thrown across the hold-down plate and folded along opposite side edges of the hold-down plate, said motion of the folding plates being restricted to a part only of the path executed by the end portions.

6. An apparatus for folding opposite end portions of substantially rectangular, pliable articles in overlapping relation to each other and in overlapping relation to the central portions thereof, said articles having been previously folded along lines disposed at right angles to the lines of the second folding operation, said second folding means comprising a platform, a constantly driven conveyor having its upper reach movable in sliding engagement with the upper surface of said platform and on which successive articles may be manually positioned, first and second normally substantially horizontally disposed folding plates disposed astride said conveyor, a resilient hold-down plate disposed between said folding plates and normally being spaced above said conveyor a distance somewhat less than the thickness of the articles, means supporting the rear portion of said hold-down plate relative to the direction of movement of said conveyor whereby each successive article is held in engagement with said conveyor by the hold-down plate to insure traction between the articles and the conveyor, at least one arresting bar normally spaced adjacent the path of travel of each successive article as it is moved forwardly by said conveyor, said arresting bar also normally being disposed in a lateral plane approximating that of the front edges of said folding plates, means engageable by the leading edge of each successive article for momentarily moving the arresting bar into the path of the corresponding article for arresting movement thereof, and to thereby permit the endless belts to continue movement independently of the corresponding article, and means operable automatically upon the end portions of each successive article moving to a position above said folding plates for moving each of the folding plates in phased vertical reciprocating motion with an upward velocity sufficient to impart an impulse of motion to each of said end portions to cause them to be thrown across the hold-down plate and folded along opposite side edges of the hold-down plate, said motion of the folding plates being restricted to a part only of the path executed by the end portions.

7. In a structure according to claim 13, said means for moving the folding plates comprising a frame, a pair of levers pivotally mounted on said frame beneath said platform, said platform having a pair of openings therein in which said folding plates are normally disposed, means connecting each of the folding plates to a corresponding one of the levers, a cam shaft, cam members fixed on said cam shaft, mechanical connections between each of the levers and one of the cam members, a continuously driven rotary element disposed adjacent the cam shaft, a normally inactive clutch means connecting the rotary element with the cam shaft, a switch, means engageable by the leading edge of each successive article for closing said switch, electrically operable means interposed in a circuit connected to said switch for activating said clutch means upon said switch being closed to thereby impart rotation to the cam shaft, and said cam means being so arranged as

to successively impart upward and then downward movement to the levers and, accordingly, to the folding plates to effect said phased vertical reciprocating motion.

8. Means for effecting substantially parallel folds of relatively heavy, flexible cloth material comprising a substantially horizontal stationary central plate and a pair of vertically movable side plates straddling the central plate, all of said plates normally being positioned on substantially the same level and having cooperating substantially straight edges lying in substantially parallel planes, means underlying the material for feeding and directing the material so that a central portion thereof underlies the central plate and the side portions thereof overlie the side plates, and means for moving each of the side plates in phased vertical reciprocating motion with an upward velocity sufficient to impart an impulse of motion to each of said side portions to cause them to be thrown across the central plate and folded along the edges of the central plate, said motion of the side plates being restricted to a part only of the path executed by the side portions.

9. Means for effecting substantially parallel folds of multi-layer, pliable sheet material comprising a stationary substantially horizontal central plate and a pair of vertically movable side plates, all of said plates having cooperating substantially straight edges lying in substantially parallel planes, the side plates being in substantially the same plane and in a plane below the plane of the central plate, means underlying the material for feeding and directing the material so that a central portion thereof underlies the central plate and the side portions thereof overlie the side plates, and means for moving each of the side plates in phased vertical reciprocating motion with an upward velocity sufficient to impart an impulse of motion to each of said side portions to cause them to be thrown across the central plate and folded along the edges of the central plate, said motion of the side plates being restricted to a part only of the path executed by the side portions.

10. Apparatus for effecting parallel folds of relatively thick, multi-layer, pliable web material comprising a stationary substantially horizontally disposed central plate, a pair of substantially horizontally disposed side plates spaced from and straddling the central plate, adjacent edges of the side plates extending substantially parallel with the side edges of the central plate, said side plates normally being disposed in substantially the same horizontal plane and on a level below that of the central plate, means for feeding and directing the web material so that a portion thereof underlies the central plate and the side portions thereof overlie the side plates, and means for moving each of the side plates in phased vertical reciprocating motion with an upward velocity sufficient to impart an impulse of motion to each of said side portions to cause them to be thrown across the central plate and folded along the edges of the central plate, said motion of the side plates being restricted to a part only of the path executed by the side portions.

11. Apparatus for effecting parallel folds of relatively thick, pliable web material comprising a stationary substantially horizontally disposed central plate, a pair of substantially horizontally disposed side plates spaced from and straddling the central plate, adjacent edges of the side plates extending substantially parallel with the side edges of the central plate, said plates normally being disposed on substantially the same level, means for feeding and directing the web material so that a portion thereof underlies the central plate and the side portions thereof overlie the side plates, and means for moving each of the side plates in phased vertical reciprocating motion with an upward velocity sufficient to impart an impulse of motion to each of said side portions to cause them to be thrown across the central plate and folded along the edges of the central plate, said motion of the side plates being restricted to a part only of the path executed by the side portions.

12. Apparatus for folding opposite end portions of relatively small pliable rectangular articles in overlapping relation to each other and in overlapping relation to the central portions thereof, said articles having been previously folded along lines disposed transversely of their path of travel into a plurality of superposed layers, said apparatus comprising an endless driven conveyor, a hold-down plate positioned above at least a portion of said conveyor and being of such width that a medial portion of each successive article passes between the hold-down plate and the conveyor, means disposed normally in the path of travel of the articles and responsive to movement of each successive article to a position beneath the hold-down plate for arresting movement of the corresponding article, a pair of vertically movable substantially horizontal side plates straddling the conveyor and over which opposite end portions of the article are positioned when arrested, means also responsive to the positioning of a medial portion of each successive article beneath the hold-down plate for moving each of the side plates in phased vertical reciprocating motion with an upward velocity sufficient to impart an impulse of motion to each of said end portions to cause them to be thrown across the upper surface of the hold-down plate and in overlapping relation to each other and folded along the edges of the hold-down plate, said motion of the side plates being restricted to a part only of the path executed by the end portions, and means for moving the arresting means out of the path of travel of each successive folded article following the folding of the opposite end portions thereof over the hold-down plate to permit succeeding movement of the folded article by said conveyor.

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